

**UNITED STATES
SECURITIES AND EXCHANGE COMMISSION
WASHINGTON, D.C. 20549
FORM 10-K**

(MARK ONE)

ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934

For the fiscal year ended December 31, 2022

Or

TRANSITION REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934

For the transition period from _____ to _____

Commission File number 0-23621

MKS INSTRUMENTS, INC.

(Exact Name of Registrant as Specified in Its Charter)

Massachusetts
*(State or other Jurisdiction of
Incorporation or Organization)*

2 Tech Drive, Suite 201, Andover, Massachusetts
(Address of Principal Executive Offices)

04-2277512
*(I.R.S. Employer
Identification No.)*

01810
(Zip Code)

(978) 645-5500

(Registrant's Telephone Number, including area code)

Securities registered pursuant to Section 12(b) of the Act:

Title of each class	Trading Symbol(s)	Name of each exchange on which registered
Common Stock, no par value	MKSI	Nasdaq Global Select Market

Securities registered pursuant to Section 12(g) of the Act: None

Indicate by check mark if the registrant is a well-known seasoned issuer, as defined in Rule 405 of the Securities Act. Yes No

Indicate by check mark if the registrant is not required to file reports pursuant to Section 13 or Section 15(d) of the Act. Yes No

Indicate by check mark whether the registrant (1) has filed all reports required to be filed by Section 13 or 15(d) of the Securities Exchange Act of 1934 during the preceding 12 months (or for such shorter period that the registrant was required to file such reports), and (2) has been subject to such filing requirements for the past 90 days. Yes No

Indicate by check mark whether the registrant has submitted electronically every Interactive Data File required to be submitted pursuant to Rule 405 of Regulation S-T (§ 232.405 of this chapter) during the preceding 12 months (or for such shorter period that the registrant was required to submit such files). Yes No

Indicate by check mark whether the registrant is a large accelerated filer, an accelerated filer, a non-accelerated filer, a smaller reporting company, or an emerging growth company. See the definitions of "large accelerated filer," "accelerated filer," "smaller reporting company," and "emerging growth company" in Rule 12b-2 of the Exchange Act.

Large accelerated filer	<input checked="" type="checkbox"/>	Accelerated filer	<input type="checkbox"/>	Emerging growth company	<input type="checkbox"/>
Non-accelerated filer	<input type="checkbox"/>	Smaller reporting company	<input type="checkbox"/>		

If an emerging growth company, indicate by check mark if the registrant has elected not to use the extended transition period for complying with any new or revised financial accounting standards provided pursuant to Section 13(a) of the Exchange Act.

Indicate by check mark whether the registrant has filed a report on and attestation to its management's assessment of the effectiveness of its internal control over financial reporting under Section 404(b) of the Sarbanes-Oxley Act (15 U.S.C. 7262(b)) by the registered public accounting firm that prepared or issued its audit report.

If securities are registered pursuant to Section 12(b) of the Act, indicate by check mark whether the financial statements of the registrant included in the filing reflect the correction of an error to previously issued financial statements.

Indicate by check mark whether any of those error corrections are restatements that required a recovery analysis of incentive-based compensation received by any of the registrant's executive officers during the relevant recovery period pursuant to §240.10D-1(b).

Indicate by check mark whether the registrant is a shell company (as defined in Rule 12b-2 of the Exchange Act). Yes No

Aggregate market value of the voting and non-voting common equity held by nonaffiliates of the registrant as of June 30, 2022 based on the closing price of the registrant's common stock on such date as reported by the Nasdaq Global Select Market: \$5,720,758,869.

Number of shares outstanding of the issuer's common stock, no par value, as of March 6, 2023: 66,669,254

DOCUMENTS INCORPORATED BY REFERENCE

Portions of the definitive Proxy Statement for our 2023 Annual Meeting of Shareholders, to be filed with the Securities and Exchange Commission no later than 120 days after the close of our fiscal year ended December 31, 2022, are incorporated by reference into Part III of this Annual Report on Form 10-K.

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SPECIAL NOTE REGARDING FORWARD-LOOKING STATEMENTS

This Annual Report on Form 10-K contains “forward-looking statements” within the meaning of the Private Securities Litigation Reform Act of 1995, Section 27A of the Securities Act of 1933 and Section 21E of the Securities Exchange Act of 1934 regarding the future financial performance, business prospects and growth of MKS Instruments, Inc. (“MKS”, the “Company”, “our”, or “we”), and the impact of the ransomware event we identified on February 3, 2023. These statements are only predictions based on current assumptions and expectations. Any statements that are not statements of historical fact (including statements containing the words “will,” “projects,” “intends,” “believes,” “plans,” “anticipates,” “expects,” “estimates,” “forecasts,” “continues” and similar expressions) should be considered to be forward-looking statements. Actual events or results may differ materially from those in the forward-looking statements set forth herein. Among the important factors that could cause actual events to differ materially from those in the forward-looking statements that we make are the need to generate sufficient cash flows to service and repay the substantial indebtedness we have incurred in connection with our acquisition of Atotech Limited (“Atotech” and such transaction, the “Atotech Acquisition”), which we completed in August 2022; the terms of our existing term loans under which we incurred such debt; our entry into the chemicals technology business through the Atotech Acquisition, in which we do not have experience and which may expose us to significant additional liabilities; the risk that we are unable to integrate the Atotech Acquisition successfully or realize the anticipated synergies, cost savings and other benefits of the Atotech Acquisition; the ongoing assessment and impact of the ransomware event we identified on February 3, 2023, including legal, reputational, financial and contractual risks resulting from the incident, and other risks related to cybersecurity, data privacy and intellectual property; competition from larger, more advanced or more established companies in our markets; the ability to successfully grow our business and the businesses of Atotech and Electro Scientific Industries, Inc., which we acquired in February 2019, and financial risks associated with those and potential future acquisitions, including goodwill and intangible asset impairments; manufacturing and sourcing risks, including those associated with limited and sole source suppliers and the impact and duration of supply chain disruptions, component shortages, and price increases; changes in global demand; the impact of COVID-19 or any other pandemic, including with respect to such supply chain disruptions, component shortages and price increases; risks associated with doing business internationally, including trade compliance, regulatory restrictions on our products, components or markets, particularly the semiconductor market, and unfavorable currency exchange and tax rate fluctuations, which risks become more significant as we grow our business internationally and in China specifically; conditions affecting the markets in which we operate, including fluctuations in capital spending in the semiconductor, electronics manufacturing and automotive industries, and fluctuations in sales to our major customers; disruptions or delays from third-party service providers upon which our operations may rely; the ability to anticipate and meet customer demand; the challenges, risks and costs involved with integrating or transitioning local and international operations of the companies we have acquired; risks associated with the attraction and retention of key personnel; potential fluctuations in quarterly results; dependence on new product development; rapid technological and market change; acquisition strategy; volatility of stock price; risks associated with chemical manufacturing and environmental regulation compliance; risks related to defective products; financial and legal risk management; and the other important factors described in Part I, Item 1A of this Annual Report on Form 10-K. We are under no obligation to, and expressly disclaim any obligation to, update or alter these forward-looking statements, whether as a result of new information, future events or otherwise, even if subsequent events cause our views to change.

SUMMARY OF RISK FACTORS

Below is a summary of the principal factors that make an investment in MKS speculative or risky. This summary does not contain all of the information that may be important to you, and you should read the below summary in conjunction with the more detailed discussion of risks set forth under the heading “Risk Factors” in Part I, Item 1A of this Annual Report on Form 10-K.

Acquisition Risks

- *The Atotech Acquisition involves numerous risks, and we may not be able to effectively integrate Atotech's business and operations or realize the expected benefits from the acquisition, which could materially harm our operating results.*
- *As part of our business strategy, we have entered into and may continue to pursue business combinations and acquisitions that may be difficult to identify and complete, challenging and costly to integrate, disruptive to our business and our management, and/or dilutive to stockholder value.*

Financial Risks

- *Our consolidated indebtedness has increased substantially as a result of the Atotech Acquisition. This increased level of indebtedness could adversely affect us, including by increasing our interest expense and decreasing our business flexibility.*
- *The terms of our New Term Loan Facility and New Revolving Facility (each as defined below) impose significant financial obligations and risks upon us, limit our ability to take certain actions, and could discourage a change in control.*
- *A material amount of our assets represents goodwill and intangible assets, and our net income would be reduced if our goodwill or intangible assets become impaired.*

Risks Related to Cybersecurity, Data Privacy and Intellectual Property Protection

- *We are exposed to risks related to cybersecurity and data privacy threats and incidents, including the ransomware event we identified on February 3, 2023, and we are subject to restrictions and changes in laws and regulations governing data privacy and data protection, any of which could have a material adverse effect on our business.*
- *Our proprietary technology is important to the continued success of our business. Our failure to protect this proprietary technology may significantly impair our competitive position.*

Risks Related to Our Operations

- *Supply chain disruptions and other manufacturing interruptions or delays have affected our ability to meet customer demand and have led to higher costs, while the failure to estimate customer demand accurately has resulted in excess or obsolete inventory, all of which has negatively impacted, and we expect will continue to impact, our business.*
- *Our dependence on sole and limited source suppliers and international suppliers has negatively impacted, and could continue to impact our ability to manufacture products and systems.*
- *Our failure to successfully manage the transition of certain of our products to other manufacturing locations and/or to contract manufacturers and the transition of certain other functions to centralized locations would likely harm our business, financial condition and operating results.*
- *Our products could contain defects, which would increase our costs and seriously harm our business, financial condition, operating results and customer relationships.*
- *Chemical manufacturing is inherently hazardous and could result in accidents that disrupt our operations or expose us to significant losses or liabilities.*
- *We outsource a number of services to third-party service providers, which decreases our control over the performance of these functions. Disruptions or delays at our third-party service providers could adversely impact our operations.*
- *The loss of net revenues from any one of our major customers would likely have a material adverse effect on us.*
- *Key personnel have been, and may continue to be, difficult to attract and retain.*

Risks Related to Our Industries and Markets

- *The semiconductor, electronics manufacturing and automotive industries we serve are characterized by periodic fluctuations in business activity that may cause a reduction in demand for our products.*
- *Many of the markets and industries we serve are highly competitive, are subject to rapid technological advancement, and have narrow design windows, and if we fail to introduce new and innovative products or improve our existing products, or if our products or the applications we invest in do not achieve widespread adoption, our business, financial condition and operating results will be harmed.*
- *We offer products for multiple markets and must face the challenges of supporting the distinct needs of each of the markets we serve.*

Risks Related to Operating a Global Business

- *We face significant risks associated with doing business internationally.*
- *We face significant risks associated with doing increased business in China in particular.*
- *Unfavorable currency exchange rate fluctuations may lead to lower operating results or may cause us to change customer pricing, which could result in reduced sales and losses.*

Legal, Tax, Regulatory and Compliance Risks

- *We have identified a material weakness in our internal control over financial reporting and that weakness has led to a conclusion that our internal control over financial reporting and disclosure controls and procedures were not effective as of December 31, 2022. Our inability to remediate the material weakness, our discovery of additional weaknesses, and our inability to achieve and maintain effective disclosure controls and procedures and internal control over financial reporting could adversely affect our results of operations, our stock price and investor confidence in our Company.*
- *If significant trade restrictions or tariffs on our products or components that are imported from or exported to China continue or are increased, our business, financial condition and operating results may be materially harmed.*
- *We are subject to international trade compliance regulations, and violations of those regulations could result in fines or trade restrictions, which could have a material adverse effect on us.*
- *Changes in tax rates or tax regulation or the termination of tax incentives could affect our operating results.*
- *Many of our products and customers are subject to numerous laws regulating the production and use of chemical substances, and some of our products may need to be reformulated or discontinued to comply with these laws and regulations.*
- *We are subject to environmental regulations. If we fail to comply with these regulations, our business could be harmed.*
- *We are exposed to various risks related to legal proceedings, including for example, product liability claims, intellectual property infringement claims, contractual claims and securities class action litigation, which if successful, could have a material adverse effect on our commercial relationships, business, financial condition and operating results.*

Risks Related to the COVID-19 Pandemic and other Widespread Health Crises

- *The continued effects of the COVID-19 pandemic or the emergence of other widespread health crises may have an adverse effect on our business, financial condition and operating results.*

Risks Related to Owning Our Common Stock

- *Our quarterly operating results have fluctuated, and are likely to continue to vary significantly, which may result in volatility in the market price of our common stock.*
- *The future exercise of registration rights may adversely affect the market price of our common stock.*
- *The market price of our common stock has fluctuated and may continue to fluctuate for reasons over which we have no control.*

Item 1. Business

MKS Instruments, Inc. (“MKS” or the “Company”) was founded in 1961 as a Massachusetts corporation. We enable technologies that transform our world. We deliver foundational technology solutions to leading edge semiconductor manufacturing, electronics and packaging, and specialty industrial applications. We apply our broad science and engineering capabilities to create instruments, subsystems, systems, process control solutions and specialty chemicals technology that improve process performance, optimize productivity and enable unique innovations for many of the world's leading technology and industrial companies. Our solutions are critical to addressing the challenges of miniaturization and complexity in advanced device manufacturing by enabling increased power, speed, feature enhancement, and optimized connectivity. Our solutions are also critical to addressing ever-increasing performance requirements across a wide array of specialty industrial applications.

Where You Can Find More Information

We file reports, proxy statements and other documents with the Securities and Exchange Commission (“SEC”). Our SEC filings are available to you on the SEC’s website at <http://www.sec.gov>.

Our website is <http://www.mks.com>. We are not including the information contained in our website as part of, or incorporating it by reference into, this Annual Report on Form 10-K. We make available free of charge through our website our Annual Reports on Form 10-K, Quarterly Reports on Form 10-Q, Current Reports on Form 8-K and amendments to these reports filed or furnished pursuant to Section 13(a) or 15(d) of the Securities Exchange Act of 1934, as amended (the “Exchange Act”), as soon as reasonably practicable after we electronically file such materials with, or furnish them to, the SEC.

Atotech Acquisition

On August 17, 2022 (the “Effective Date”), we completed the acquisition of Atotech Limited (“Atotech”), through the acquisition of the entire issued share capital of Atotech by Atotech Manufacturing, Inc. (“Bidco”), a Delaware corporation and indirect wholly owned subsidiary of the Company (the “Atotech Acquisition”). The Atotech Acquisition was implemented by means of a scheme of arrangement under the laws of Jersey (the “Scheme”) pursuant to the definitive agreement entered into by the Company and Atotech on July 1, 2021, as amended by the Letter Agreement dated October 29, 2021 by and among the Company, Atotech and Bidco, and as further amended by the Amendment to the Implementation Agreement dated April 1, 2022 by and among the Company, Atotech and Bidco (together, the “Implementation Agreement”).

Atotech, which we operate as our Materials Solutions Division, develops leading process and manufacturing technologies for advanced surface modification, electroless and electrolytic plating, and surface finishing. Applying a comprehensive systems-and-solutions approach, Atotech's portfolio includes chemistry, equipment, software, and services for innovative and high-technology applications in a wide variety of end markets. Atotech further broadens the Company's capabilities by bringing leadership in critical chemistry solutions for electronics and packaging and specialty industrial applications.

On the Effective Date, pursuant to the Scheme and in accordance with the terms and conditions of the Implementation Agreement, Bidco acquired each issued and outstanding ordinary share of Atotech in exchange for per share consideration of \$16.20 in cash and 0.0552 of a share of Company common stock. The total net purchase price, including cash consideration, net of cash acquired, value of MKS shares issued, repayment of Atotech debt and settlement of certain Atotech share-based awards totaled \$5.7 billion. The Company funded the payment of the aggregate cash consideration with a combination of cash on hand and the proceeds from the New Term Loan Facility, as defined below. As a result of the Atotech Acquisition, the Company issued an aggregate of 10.7 million shares of Company common stock to the former Atotech shareholders.

In connection with the completion of the Atotech Acquisition, the Company entered into a credit agreement with JPMorgan Chase Bank, N.A., as administrative agent and collateral agent, Barclays Bank PLC, and the lenders from time to time party thereto (the “New Credit Agreement”). The New Credit Agreement provides for (i) a senior secured term loan facility (the “New Term Loan Facility”) comprised of three tranches: a \$1.0 billion loan (the “USD Tranche A”), a \$3.6 billion loan (the “USD Tranche B”) and a EUR 600 million loan (the “Euro Tranche B”), each of which were borrowed in full on the Effective Date, and (ii) a senior secured revolving credit facility of \$500 million (the “New Revolving Facility” and, together with the New Term Loan Facility, the “New Credit Facilities”), with the commitments under each of the foregoing facilities subject to increase from time to time subject to certain conditions.

Markets and Applications

Since our inception, we have focused on satisfying the needs of our customers by establishing long-term collaborative relationships. We have a diverse base of customers across our primary served markets, which include semiconductor, electronics and packaging, and specialty industrial.

We have developed the following two product strategies that have been instrumental in delivering value to our customers and helping them solve their most complex problems:

- Our Surround the WaferSM offering includes a wide range of products, design and development services, system level integration, training programs, calibration, service, and repair for our semiconductor customers. This unique combination of products and services enables our customers to solve the challenges of ultra-thin layers, new materials and complex 3D structures while maintaining quality and productivity levels. We have cultivated this strategy over the past two decades by adding critical enabling technologies to our portfolio. The Surround the Wafer offering is an update from what we previously referred to as Surround the Chamber®, given our broadened exposure in photonics solutions for lithography, metrology and inspection, which extends beyond just the vacuum chamber.
- Our Surround the Workpiece® offering includes product design and development, system level integration, research and development, system, subsystem and component selection, and maintenance, repair and calibration services in the field of laser-based guidance and control for manufacturing processes. With the recent acquisition of Atotech, we have introduced an extension of the Surround the Workpiece offering called Optimize the InterconnectSM, which refers to MKS' combined laser drilling and chemistry solutions geared towards accelerating innovation and customers' time-to-market in printed circuit board ("PCB") and package substrate manufacturing.

At our core, MKS is a foundational enabler of miniaturization and complexity. We believe there are three secular trends benefitting MKS. First is the impact of a world that continues to be increasingly interconnected, driving the need for smaller, more powerful and feature-rich advanced electronic devices, which is enabled by semiconductor manufacturing, laser processing and chemistry solutions. Second is the increasing complexity of technology transitions in semiconductor, PCB and package substrate manufacturing, which leads to inflections, such as extreme vertical structures and process engineering at the atomic level, as well as increased interconnect density and smaller features. These inflections provide additional growth opportunities for MKS, as we believe we are uniquely positioned to deliver the broadest and deepest portfolio of solutions. Third is the accelerating need for laser-based precision manufacturing techniques, which are enabled by lasers, photonics, optics, precision motion control, vibration control and systems solutions.

We believe our long history and deep expertise in solving critical problems position us well to address these challenges for our customers.

Semiconductor Market

MKS is a critical solutions provider for semiconductor manufacturing. Our products are used in major semiconductor processing steps, such as depositing thin films of material onto silicon wafer substrates, etching, cleaning, lithography, metrology, and inspection. The semiconductor industry continually faces new challenges, as products become smaller, more powerful and highly mobile. Ultra-thin layers, smaller critical dimensions, new materials, 3D structures, and the ongoing need for higher yield and productivity drive the need for tighter process measurement and control, all of which MKS supports. We believe we are the broadest critical subsystem provider in the wafer fabrication equipment ecosystem and address over 85% of the market. We have characterized our broad and unique offering as Surround the Wafer to reflect the technology enablement we provide across almost every major process in semiconductor manufacturing today.

The semiconductor market is subject to rapid demand shifts, which are difficult to predict. We cannot be certain as to the timing or extent of future demand or any future weakness in the semiconductor capital equipment industry. For example, our semiconductor market revenue sequentially increased 12% in 2022, 32% in 2021, and 49% in 2020. We anticipate that our semiconductor revenue could decrease in 2023, as a result of expected softening in the semiconductor market following three years of significant growth, due, in part, to new U.S. government regulations, as further described under Part II, Item 7, "Management's Discussion and Analysis of Financial Condition and Results of Operations—Segments and Markets—Semiconductor Market."

Approximately 58%, 62%, and 59% of our net revenues for 2022, 2021, and 2020, respectively, were from sales to our semiconductor market. Following the Atotech Acquisition, MKS' end-market exposure has become more diversified and in the fourth quarter of 2022, revenue from the semiconductor market was 46% of total net revenues.

Electronics and Packaging Market

MKS is a foundational solutions provider for the electronics and packaging market. Our portfolio includes photonics components, laser drilling systems, electronics chemistries and plating equipment, that are critical for the manufacturing of PCBs and package substrates, as well as in wafer level packaging (“WLP”) applications. Similar to the semiconductor industry, the PCB, package substrate and WLP industries demand smaller features, greater density, and better performance. In addition, the electronics and packaging market also includes sales of our vacuum and photonics solutions for display manufacturing applications. We characterize our complementary offering of laser systems and chemistry solutions as Optimize the InterconnectSM, to reflect the unique technology enablement we provide at the interconnect level within PCBs, package substrates and WLPs.

Approximately 15%, 12%, and 11% of our net revenues for 2022, 2021, and 2020, respectively, were from sales to our electronics and packaging market.

Specialty Industrial Market

MKS’ strategy in specialty industrial is to leverage our domain expertise and proprietary technologies across a broad array of applications in industrial technologies, life and health sciences, and research and defense markets.

Industrial Technologies

Industrial technologies encompasses a wide range of diverse applications, including chemistries for functional coatings, surface finishing and wear resistance in the automobile industry, vacuum solutions for synthetic diamond manufacturing and photonics for solar manufacturing. Other applications include vacuum and photonics solutions for light emitting diode and laser diode manufacturing.

Life and Health Sciences

Our products for life and health sciences are used in a diverse array of applications, including bioimaging, medical instrument sterilization, medical device manufacturing, analytical, diagnostic and surgical instrumentation, consumable medical supply manufacturing and pharmaceutical production.

Research and Defense

Our products for research and defense are sold to government, university and industrial laboratories for applications involving research and development in materials science, physical chemistry, photonics, optics and electronics materials. Our products are also sold for monitoring and defense applications including surveillance, imaging and infrastructure protection.

Approximately 27%, 26%, and 29% of our net revenues for 2022, 2021, and 2020, respectively, were from sales to our specialty industrial market.

International Markets

A significant portion of our net revenues is from sales to customers in international markets. For 2022, 2021, and 2020, international net revenues accounted for approximately 58%, 57% and 55%, respectively, of our total net revenues. A significant portion of our international net revenues were from sales to customers in China, Germany and South Korea. We expect that international revenues will continue to account for a significant percentage of total net revenues for the foreseeable future. Long-lived assets located outside of the United States accounted for approximately 57% and 28% of our total long-lived assets in 2022 and 2021, respectively. The increase in long-lived assets outside of the United States primarily related to the Atotech Acquisition. Long-lived assets include property, plant and equipment, net, right-of-use assets, and certain other assets and exclude goodwill, intangible assets and long-term tax-related accounts.

Reportable Segments, and Product and Service Offerings

In the first quarter of 2022, we updated the names of our then-three divisions in order to simplify our naming convention. These three divisions, formerly known as the Vacuum & Analysis Division, the Light & Motion Division and the Equipment & Solutions Division, were renamed the Vacuum Solutions Division (“VSD”), the Photonics Solutions Division (“PSD”) and the Equipment Solutions Division (“ESD”), respectively. Following the Atotech Acquisition, we refer to the Atotech business as the Materials Solutions Division (“MSD”). During the third quarter of 2022, we consolidated our equipment solutions business (“ESB”), previously ESD, into a component of PSD. We group our product offerings by our reportable segments: VSD, PSD and MSD. Global Service represents our service offerings and consists of total services for all three of our reportable segments.

VSD delivers foundational technology solutions to leading edge semiconductor manufacturing, electronics and packaging and specialty industrial applications. VSD products are derived from our core competencies in pressure measurement and control, flow measurement and control, gas and vapor delivery, gas composition analysis, electronic control technology, reactive gas generation and delivery, power generation and delivery and vacuum technology. Its products include:

- *Pressure and Vacuum Control Solutions Products*, which consist of direct and indirect pressure measurement.
- *Materials Delivery Solutions Products*, which include flow and valve technologies as well as integrated pressure measurement and control subsystems, which provide customers with precise control capabilities.
- *Power Solutions Products*, which consist of microwave and radio frequency power delivery systems, radio frequency matching networks and metrology products. Our power delivery solutions are used to provide energy to various etching, stripping and deposition processes.
- *Plasma and Reactive Gas Products*, which consist of remote plasma and ozone generators that create reactive species. A reactive gas is used to facilitate various chemical reactions in the processing of thin films, including the deposition of films, etching and cleaning of films and surface modifications.

PSD provides a broad range of instruments, components and subsystems to leading edge semiconductor manufacturing, electronics and packaging and specialty industrial applications. PSD products are derived from our core competencies in lasers, photonics, optics, temperature sensing, precision motion control and vibration control. Its products include:

- *Laser Products*, which consist of continuous wave and pulsed nanosecond and ultrafast lasers based on diode, diode-pumped solid-state and fiber laser technologies.
- *Photonics Products*, which include precision motion control, optical tables and vibration isolation systems, photonic instruments, high-performance optics and optical assemblies, opto-mechanical components, temperature-sensing products for wafer fabrication systems, laser and LED measurement products, including laser power and energy meters and laser beam profilers and complex optical and photonic subsystems.
- *Laser-based systems for PCB manufacturing*, which include flexible interconnect PCB processing systems and high-density interconnect solutions for rigid PCB manufacturing and substrate processing.
- *Multi-layer ceramic capacitor (“MLCC”) test systems*, which include testing of ultra-small form factor MLCCs, used mainly in smartphones and other electronics manufacturing and large chip MLCCs, used mainly in automotive and communications infrastructure applications.

MSD develops leading process and manufacturing technologies for advanced surface modification, electroless and electrolytic plating, and surface finishing. Atotech is a brand within MSD. Applying a comprehensive systems-and-solutions approach, MSD's portfolio includes chemistry, equipment, software, and services for innovative and high-technology applications in our electronics and packaging and specialty industrial markets. Its products include:

- *Chemical processes and production equipment for PCB manufacturing*, which include flexible, rigid-flexible, multilayer, high-density interconnect PCB processing, package substrate and wafer level packaging used in a wide spectrum of industries such as consumer electronics, communications infrastructure, automotive electronics, medical and industrial.
- *Chemical processes and production equipment for decorative and functional surface finishing*, which include decorative, corrosion-protective, and wear-resistant coatings for various end markets such as the automotive, construction, energy, and heavy machinery industries.
- *Chemical processes for paint applications* including pretreatment, stripping and overspray treatment for the automotive and household appliance industries.

For further information on our segments, see Note 20 to the Notes to Consolidated Financial Statements contained in Part II, Item 8 of this Annual Report on Form 10-K.

Global Service includes:

- Installation services and training for many of our products.
- Technical support offices and technology centers located near many of our customers' facilities.
- Repair and calibration services at internal service depots and authorized service providers located worldwide.
- Warranties on our products that typically range from one to three years, with the majority of the warranties on our products ranging from one to two years. We typically provide warranties on our repair services for periods ranging from 90 days to up to one year, depending upon the type of repair. We also offer extended warranties ranging from one to five years.

Customers

We sell our products and services to thousands of customers worldwide, in a wide range of end markets. Revenues from our top ten customers accounted for 42%, 46% and 44% of net revenues for 2022, 2021 and 2020, respectively. Lam Research Corporation and Applied Materials, Inc. were our top two customers in 2022 and together accounted for approximately 24% of our net revenues. Both of these customers are in the semiconductor market.

Sales and Marketing

Our worldwide sales and marketing organizations are also critical to our strategy of maintaining close relationships with a wide array of customers across a diverse set of advanced applications, including semiconductor capital equipment manufacturers, semiconductor device manufacturers, PCB and package substrate manufacturers, and customers across a range of specialty industrial applications. We market and sell our products and services through our global direct sales organization, an international network of independent distributors and sales representatives, our websites and product catalogs. We maintain a marketing staff that identifies customer requirements, assists in product planning and specifications, and focuses on future trends in the markets we serve.

Research and Development

Our products incorporate sophisticated technologies to measure, monitor, deliver, analyze, power, control and improve complex semiconductor and advanced manufacturing processes, thereby enhancing uptime, yield and throughput for our customers. With the Atotech Acquisition, we also offer a broad portfolio of specialty chemistry solutions for advanced surface modification, electroless and electrolytic plating, surface finishing, functional coating and corrosion resistance applications. MSD is supported by 15 state-of-the-art global technology centers, which are used to conduct extensive research and development in order to anticipate future industry requirements.

We continue to develop our products as we strive to meet our customers' evolving needs. We have developed, and continue to develop, new products to address industry trends, such as the shrinking of integrated circuit critical dimensions and technology inflections, and, in the flat panel display and solar markets, the transition to larger substrate sizes, which require more advanced processing and process control technology, the continuing drive toward more complex and accurate components and devices within the handset, tablet and high performance computing markets, the transition to 5G for both communications devices and infrastructure, the growth in units and via counts in the high density interconnect PCB and package substrate markets, and the industry transition to battery-powered vehicles in the automotive market. In addition, we have developed, and continue to develop, products that support the migration to new classes of materials, ultra-thin layers, and 3D structures that are used in small geometry manufacturing. In our chemistry and equipment plating businesses, a majority of our research and development investment supports existing customers' product improvement needs and their short-term research and development goals, which enables us to pioneer new high-value solutions while limiting commercial risk.

We involve our marketing, engineering, manufacturing and sales personnel in the development of new products in order to reduce the time to market for new products. Our employees also work closely with our customers' development personnel, helping us to identify and define future technical needs on which to focus research and development efforts. We support research at academic institutions targeted at advances in materials science, semiconductor process development and photonics.

Our research and development expenses were \$241 million, \$200 million and \$173 million for 2022, 2021 and 2020, respectively. Our research and development efforts include numerous projects, none of which are individually material, and

generally have a duration of 3 to 36 months, depending upon whether the product is an enhancement of existing technology or a new product. Our current initiatives include projects to enhance the performance characteristics of older products, to develop new products and to integrate various technologies into subsystems.

Manufacturing

Manufacturing activities include the assembly and testing of components and subassemblies, which are integrated into our products. Our manufacturing facilities are located in Austria, Brazil, Canada, China, Czech Republic, France, Germany, India, Israel, Italy, Malaysia, Mexico, Romania, Singapore, South Korea and the United States. In addition, we rely on significant subcontracted operations in Mexico and selected contract manufacturers in Asia. Our business depends on the timely supply of products and services that meet the rapidly changing technical and volume requirements of our customers, which depends in part on the timely delivery of parts, components and subassemblies from suppliers, including contract manufacturers. We purchase a wide range of electronic, optical, mechanical and electrical components, some of which are designed to our specifications. We consider our lean manufacturing techniques and responsiveness to customers' significantly fluctuating product demands to be a competitive advantage.

Backlog

We generally schedule production of our products based upon our customers' delivery requirements. Lead times for many of our products are very short, as a large portion of our orders are received and shipped within 90 days. Some of the plating equipment manufactured by MSD has longer lead times of up to 12 months. In many cases, orders may be subject to cancellation or rescheduling by the customer with limited or no penalty. Our backlog at any particular date, therefore, is not necessarily indicative of actual sales which may be generated for any succeeding period. Historically, our backlog levels have fluctuated based upon the ordering patterns of our customers and changes in our manufacturing capacity. Order patterns exiting 2022 reflected a softening demand for semiconductor capital equipment anticipated for 2023.

Competition

The market for our products is cyclical and highly competitive. Principal competitive factors include product quality, performance and price, historical customer relationships, breadth of product line, ease of use, manufacturing capabilities and responsiveness, and customer service and support. Although we believe that we compete favorably with respect to these factors, we can make no assurances that we will continue to do so.

We encounter substantial competition in most of our product lines, although no single competitor competes with us across all product lines. Certain of our competitors have greater financial and other resources than we do. In some cases, competitors are smaller than we are, but are well established in specific product niches.

For example, in VSD, Advanced Energy Industries, Inc. offers products that compete with our power solutions, plasma and reactive gas and photonics products. Inficon, Inc. offers products that compete with our pressure and vacuum control solutions products. Hitachi Ltd., Horiba Ltd., Brooks Instrument and VAT, Inc. offer products that compete with our materials delivery solutions products.

In PSD, Trumpf Group, Lumentum Holdings Inc., IPG Photonics Corporation, EdgeWave GmbH and Amplitude Systemes SA offer products that compete with our laser products. Coherent Corp., Qioptiq Ltd., Jenoptik AG and Thorlabs, Inc. offer products that compete with our laser and photonics products. Sigma Koki Co., Ltd. and PI miCos GmbH offer products that compete with our photonics products. Our laser-based systems for PCB manufacturing primarily compete with laser-based systems provided by Via Mechanics, Ltd., EO Technics Co., Ltd. and Mitsubishi Electric Corporation. Our MLCC test systems primarily compete with Humo Laboratory Ltd., as well as component manufacturers that develop systems for internal use.

In MSD, Element Solutions Inc., DuPont de Nemours, Inc., Uyemura, Dipsol Chemicals Co., Ltd., JCU International, Inc. and Okuno Chemical Industries Co., Ltd. offer products that compete with our chemistry products. Schmid Group, Process Automation International Limited and Manz AG offer products that compete with our plating equipment products.

Patents and Other Intellectual Property Rights

We rely on a combination of patent, copyright, trademark and trade secret laws and license agreements to establish and protect our proprietary rights. As of December 31, 2022, we owned 764 U.S. patents and 3,430 foreign patents that expire at various dates through 2044. As of December 31, 2022, we had 144 pending U.S. patent applications. Foreign counterparts of certain U.S. applications have been filed or may be filed at the appropriate time.

We require each of our employees, including our executive officers, to enter into standard agreements pursuant to which the employee agrees to keep confidential all of our proprietary information and to assign to us all inventions while they are employed by us.

Government Regulations

We are subject to various federal, state, local and international laws and regulations relating to the development, manufacture, sale and distribution of our products and services, and it is our policy to comply with the laws in every jurisdiction in which we conduct business. Regulations include, but are not limited to, those related to the environment, corruption, bribery, import and export controls, competition, product safety, workplace health and safety, employment, labor and data privacy. The following describes certain significant regulations that may have a material effect on our capital expenditures, earnings and competitive position. For additional information about risks related to government regulations, please refer to “Risk Factors—Legal, Tax, Regulatory and Compliance Risks” in Part I, Item 1A of this Annual Report on Form 10-K.

Trade Compliance

We are subject to trade compliance laws in both the United States and other jurisdictions where we operate, including export regulations such as the U.S. Export Administration Regulations, administered by the U.S. Department of Commerce’s Bureau of Industry and Security, and the International Traffic in Arms Regulation, administered by the Department of State’s Directorate of Defense Trade Controls.

Environmental Regulations

We are subject to various, federal, state, local and international laws and regulations relating to environmental protection, including those governing discharges of pollutants into the air, water and land, the reporting, generation, use, handling, storage, transportation, treatment and disposal of hazardous substances, waste and other materials and the cleanup of contaminated sites. These environmental regulations include the European Union Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (“EU REACH”) and the Toxic Substances Control Act (the “TSCA”) in the United States.

Human Capital

In order to compete and succeed in highly competitive markets and industries that are subject to rapid technological change, we believe it is critical to attract, motivate and retain a dedicated, talented and innovative team of employees. As part of these efforts, we strive to foster a diverse, equitable and inclusive community, invest in continuous learning and development, engage meaningfully with employees, offer a competitive compensation and benefits program and provide a safe and healthy workplace.

Our total workforce and geographic presence significantly increased as a result of the Atotech Acquisition. As of December 31, 2022, we had a total workforce of approximately 10,900 individuals, excluding contracted employees, across 39 countries, with 31% located in the Asia-Pacific region, 31% located in Europe, the Middle East and India, and 38% located in the Americas. Of our total workforce, approximately 10,450 were employees and approximately 450 were temporary workers. Of our total workforce, 14% work in research and development, 50% work in operations, manufacturing, service and quality assurance, and 36% work in sales, order administration, marketing, finance, legal, information technology, general management and other administrative functions.

Diversity, Equity and Inclusion

At MKS, our commitment to diversity, equity and inclusion (“DE&I”) is core to our culture. We believe that diversity of gender, race, ethnicity, sexual orientation, culture, education, background and experience fuels innovation and results, as well as enables our employees to succeed. Our executive team is comprised of 22% female members and 22% racially diverse members. Our Board of Directors is comprised of 33% female members, 22% racially diverse members and 11% LGBTQ+ members, and our Lead Director is a woman. We have been recognized for our commitment to advancing women’s representation on the boards of directors of public companies.

We have taken a number of steps to foster DE&I at MKS:

- Over the last three years, approximately 320 of our leaders around the world completed a six-week DE&I program hosted by a consulting firm recognized as best-in-class in the area of DE&I capability building.
- In 2022, we continued to offer DE&I training for all employees and bias awareness training for our global talent acquisition and management teams.

- We proactively provide our hiring managers with diverse candidate slates in our employee recruiting process and, in accordance with our Corporate Governance Guidelines, seek diverse candidates for the pool from which our Board of Director nominees are chosen.
- We regularly conduct robust analyses of pay practices across gender globally and other diversity factors within the United States to detect any existing disparities within base and total compensation, taking prompt and effective action to correct any identified disparities. Our most recent analysis of our global employees' compensation, which was conducted over the past several years, has, with minimal required adjustments, resulted in equitable pay for our employees.
- We offer regional and global initiatives that afford employees opportunities to engage in mentoring programs, book reading groups and facilitated discussion groups, webinars and workshops that celebrate and recognize awareness months and days.

Learning and Development

MKS is committed to investing in learning and professional development. Our employees have access to a wide range of programs, classes and resources to help them excel in their careers and share what they learn with their colleagues. Our performance management process includes performance feedback and career development discussions that are dynamic and actionable throughout the year. In 2022, we continued to broadly roll out courses to develop our focus on employee engagement, change management and leadership excellence. Over the past three years, our leaders also completed the DE&I course described above. In addition, we provide financial support for college and graduate education for U.S. employees and access to online learning for all employees in local languages to help further the careers of our entire workforce.

Employee Engagement

MKS is committed to meaningful engagement with its employees. In 2022, we engaged a firm that specializes in corporate culture to conduct a global survey on company culture, in order to understand the values, beliefs and behaviors that shape our organization. The results of the survey are expected to inform how we manage our business and build relationships.

In addition, in 2022, MKS conducted its second annual global employee engagement survey, which, due to the timing of the closing of the Atotech Acquisition, did not include Atotech employees. The results of the survey were thoroughly assessed and shared with our Chief Executive Officer and executive leadership team as well as our Board of Directors. In 2023, we plan to include all employees in the global employee engagement survey, using the feedback we receive to examine current practices and drive new initiatives.

Our executive management team also conducts regular calls with employees around the world to ensure they are connected to the progress of the Company.

Compensation and Benefits

MKS is committed to providing total compensation packages that attract, motivate and retain our employees. Additionally, MKS is committed to recognizing and rewarding each employee's sustained performance and results. We run a recognition program for all U.S. employees, which allows peer-to-peer recognition and recognition by managers. We continue to assess the potential expansion of this recognition program globally. We also maintain a global flexible work policy. We are committed to ensuring that our total compensation packages are externally competitive and internally equitable, while supporting our business plans and strategies.

As employee turnover is an indicator of employee satisfaction, we monitor turnover globally. MKS has a very stable and committed workforce, as evidenced by low voluntary turnover. Our 12-month rolling average for voluntary turnover at the end of 2022 was below 6%. Our employee average tenure is more than 9 years.

Health and Safety

MKS is committed to providing a safe and healthy workplace for all employees. We accomplish this through strict compliance with applicable laws and regulations regarding workplace safety, including recognition and control of workplace hazards, tracking injury and illness rates, utilizing a global travel health program and maintaining detailed emergency and business continuity plans. We also offer employees and eligible family members a full range of health and wellness programs, as well as many clinical and administrative services.

Additional information regarding MKS' activities related to its people and sustainability can be found in our Environmental, Social, Governance Report, which is accessible through the Environmental, Social and Governance section of our website. Our Environmental, Social, Governance Report is updated periodically. This website address is intended to be an inactive textual reference only. None of the information on, or accessible through, MKS' website is part of this Annual Report on Form 10-K or is incorporated by reference herein.

Item 1A. Risk Factors

This section describes certain risks we face in our business. Additional risks that we do not yet know of or that we currently believe are immaterial may also impair our business. If any of the events or circumstances described in this section actually occurs, our business, financial condition or operating results could suffer, and the market price of our common stock could decline. In assessing these risks, investors should also refer to the other information contained in or incorporated by reference into this report and our other filings with the Securities and Exchange Commission ("SEC").

Acquisition Risks

The Atotech Acquisition involves numerous risks, and we may not be able to effectively integrate Atotech's business and operations or realize the expected benefits from the acquisition, which could materially harm our operating results.

The acquisition of Atotech Limited ("Atotech") in August 2022 (the "Atotech Acquisition") significantly increased our size, including with respect to revenue, product offerings, number of employees and facilities, and geographic exposure. Atotech's products and technology, and certain of its markets and customer base, are significantly different from our historical experience. In particular, we do not have previous experience in the specialty chemistry industry, which Atotech serves. Atotech's chemistry business is also subject to highly complex environmental regulations, across multiple jurisdictions around the globe, and may expose us to significant additional liabilities for past or future activities.

Integrating Atotech's business and operations with ours has been and will continue to be complex, challenging and time-consuming and has required and continues to require significant efforts and expenditures, and we may not be able to achieve the integration in an effective, complete, timely or cost-efficient manner.

Other potential risks related to the Atotech Acquisition include our ability to:

- expand our financial and management controls and reporting systems and procedures to integrate and manage Atotech;
- integrate our information technology systems to enable the management and operation of the combined business;
- realize expected synergies resulting from the Atotech Acquisition during our expected timeframe;
- maintain and improve Atotech's operations;
- retain and expand Atotech's customer base while aligning our sales efforts;
- avoid lost revenue resulting from the distraction of our personnel as a consequence of the Atotech Acquisition and ongoing integration efforts;
- retain key Atotech personnel;
- recognize and capitalize on technology enhancement opportunities presented by our combined businesses;
- adequately familiarize ourselves with Atotech's products and technology and certain of its markets and customer base such that we can manage Atotech's business effectively; and
- successfully integrate our respective corporate cultures such that we achieve the benefits of acting as a unified company.

Other potential risks related to the Atotech Acquisition include:

- operating in geographies that are new to us, and increasing our exposure to high-risk geographies;
- the assumption of unknown or contingent liabilities, or other unanticipated events or circumstances; and
- the potential to incur or record significant cash charges, such as integration and restructuring, or non-cash charges, such as the write down of the carrying value of fixed assets, intangible assets and goodwill obtained in the Atotech Acquisition, which could adversely impact our cash flow or lower our earnings in the period or periods for which we incur such charges or write down such assets.

If we are unable to successfully or timely integrate the operations of Atotech's business into our business, we may be unable to realize the revenue growth, synergies and other anticipated benefits resulting from the Atotech Acquisition and our business could be adversely affected. Additionally, we have incurred and will continue to incur transaction-related costs, including legal, regulatory and other costs associated with implementing integration plans, including facilities and systems consolidation costs and employment-related costs. Although we expect that the elimination of duplicative costs, as well as the realization of other efficiencies related to the integration of the businesses, should allow us to offset certain transaction and integration-related costs over time, this net benefit may not be achieved in the near term, or at all. Further, we may not realize the expected benefits from the Atotech Acquisition. Atotech's business and operations may not achieve the anticipated revenues and operating results. Any of the foregoing risks could materially harm our combined business, financial condition and results of operations.

As part of our business strategy, we have entered into and may continue to pursue business combinations and acquisitions that may be difficult to identify and complete, challenging and costly to integrate, disruptive to our business and our management, and/or dilutive to stockholder value.

As a part of our business strategy, we have entered into and continue to pursue business combinations and acquisitions. Our ability to successfully identify suitable acquisition targets, complete acquisitions on acceptable terms, and efficiently, effectively and profitably integrate and operate our acquired businesses is critical to our growth. We may not be able to identify target companies that meet our strategic objectives or successfully negotiate and complete acquisitions with companies we have identified on acceptable terms. Further, we may incur significant expense in pursuing acquisitions that cannot be completed, or are significantly delayed, due to regulatory or other restrictions. Additionally, our credit facilities only permit us to make acquisitions under certain circumstances, and also restrict our ability to incur additional indebtedness in certain circumstances. As a result, our ability to pursue our acquisition strategy may be hindered by our indebtedness. Moreover, we may not realize the benefits we anticipate from these acquisitions, because of significant challenges, such as:

- The difficulty, distraction, resource requirements, cost and disruption of integrating the operations, technology and personnel of the acquired companies;
- The potential disruption of our ongoing business and distraction of management;
- Possible internal control or other compliance weaknesses of the acquired companies;
- Significant expenses related to the acquisitions, including any resulting shareholder litigation;
- The assumption of unknown or contingent liabilities associated with acquired businesses;
- The potential to incur or record significant cash or non-cash charges or write down the carrying value of intangible assets and goodwill obtained in the acquisitions, which could adversely impact our cash flow or lower our earnings in the period or periods for which we incur such charges or write down such assets;
- Potentially incompatible cultural differences between us and the companies we acquire;
- Incorporating the acquired companies' technology and products into our current and future product lines, and successfully generating market demand for these expanded product lines;
- Potential additional geographic dispersion of operations;
- The difficulty in achieving anticipated synergies and efficiencies;
- The difficulty in leveraging the acquired companies' and our combined technologies and capabilities across our product lines and customer base;
- Burdensome requirements or conditions imposed by government regulators in connection with their review of acquisitions, including divestitures and restrictions on the conduct of our business or the business of the acquired companies; and
- Our ability to retain key customers, suppliers and employees of the acquired companies.

We may also face competitive disadvantages by selling products that are new to us and/or selling products in markets and geographies that are new to us. In addition, if we are not successful in completing acquisitions or integrating acquired businesses, we may be required to re-evaluate our growth strategy. We may incur substantial expenses and devote significant management time and resources to complete acquisitions that may not generate the financial results we planned to achieve. We may also choose to close or divest certain sectors or divisions of acquired companies, which could require us to record losses and/or spend cash relating to such closures or divestitures.

We continue to experience significant risks associated with the acquisition of Electro Scientific Industries, Inc. (the “ESI Merger”), which we completed in 2019. These risks include our ability to retain key personnel and to realize the anticipated growth in net revenues from the acquired business, as well as the potential to incur or record significant cash or non-cash charges or write down the carrying value of intangible assets and goodwill obtained in the ESI Merger, which could adversely impact our cash flow or lower our earnings in the period or periods for which we incur such charges or write down such assets.

In addition, we could use substantial portions of our available cash for all or a portion of the purchase price of future acquisitions. We could also issue additional securities as consideration for or to finance these acquisitions, which could cause significant stockholder dilution, or obtain additional debt financing, which would increase our costs, reduce our future cash flow and subject us to covenants and other restrictions that may impede our ability to manage our operations, without achieving the desired accretion to our business.

As a result of our previous acquisitions, we presently have several different decentralized operating and accounting systems. We will need to continue to modify our accounting policies, internal controls, procedures and compliance programs to provide consistency across all of our operations. In order to increase efficiency and operating effectiveness and improve corporate visibility into our decentralized operations, we continue to review opportunities to integrate enterprise resource planning systems where practical. Any future implementations may risk potential disruption of our operations during the conversion periods and the implementations could require significantly more management time and higher implementation costs than currently estimated.

Financial Risks

Our consolidated indebtedness has increased substantially as a result of the Atotech Acquisition. This increased level of indebtedness could adversely affect us, including by increasing our interest expense and decreasing our business flexibility.

As of December 31, 2022, we had approximately \$5.1 billion of principal indebtedness outstanding under a senior secured term loan facility (the “New Term Loan Facility”) comprised of three tranches: a \$1.0 billion loan (the “USD Tranche A”), a \$3.6 billion loan (the “USD Tranche B”) and a EUR 600 million loan (the “Euro Tranche B”). We also have \$500 million of available borrowing capacity under a senior secured revolving credit facility (the “New Revolving Facility” and, together with the New Term Loan Facility, the “New Credit Facilities”). This level of indebtedness could have the effect, among other things, of reducing our flexibility to respond to changing business, industry and economic conditions, limiting our ability to obtain financing in the future and increasing interest expense.

We also have incurred and will continue to incur various costs and expenses associated with our indebtedness. The amount of cash required to pay interest on our increased indebtedness levels following completion of the Atotech Acquisition, and the demands on our cash resources that come from that debt, are significantly greater than the amount of cash flows required to service the levels of indebtedness we incurred prior to the Atotech Acquisition. Our increased levels of indebtedness following completion of the Atotech Acquisition could also reduce funds available for working capital, capital expenditures, acquisitions and other general corporate purposes and may create competitive disadvantages relative to other companies with lower debt levels. If we do not achieve the expected benefits and cost savings from the Atotech Acquisition, or if the financial performance of the combined company does not meet current expectations, then our ability to service our indebtedness may be adversely impacted.

Despite our current level of indebtedness, we and our subsidiaries may still be able to incur more indebtedness. Although our debt agreements contain restrictions on the incurrence of additional indebtedness, these restrictions are subject to certain qualifications and exceptions, and thus, additional indebtedness may be incurred in compliance with these restrictions. This could further exacerbate the risks we describe.

Moreover, we may be required to raise substantial additional financing to fund working capital, capital expenditures, acquisitions or other general corporate requirements. Our ability to arrange additional financing or refinancing will depend on, among other factors, our financial position and performance, as well as prevailing market conditions and other factors beyond our control. There can be no assurance that we will be able to obtain additional financing or refinancing on terms acceptable to us or at all.

The terms of our New Term Loan Facility and New Revolving Facility impose significant financial obligations and risks upon us, limit our ability to take certain actions, and could discourage a change in control.

As of December 31, 2022, the total principal balance of our USD Tranche A was \$889 million, the total principal balance of our USD Tranche B was \$3,591 million and the total principal balance of our Euro Tranche B was EUR 585 million. Our New Revolving Facility provides us with a senior secured revolving credit facility of up to \$500 million. We have not borrowed against our New Revolving Facility as of December 31, 2022.

All amounts outstanding under the New Term Loan Facility and the New Revolving Facility bear interest at a variable interest rate. Although we hedge some of the variable interest rate exposure, if interest rates increase, variable rate debt will create higher debt service requirements, which would adversely affect our cash flows. In addition, changes in our credit ratings could affect the cost and availability of future borrowings and, accordingly, our cost of capital. The ratings of our indebtedness reflect each nationally recognized statistical rating organization's opinion of our financial strength, operating performance and ability to meet our debt obligations. We cannot make any assurances that we will achieve or maintain a particular rating in the future.

Our New Term Loan Facility and New Revolving Facility contain several negative covenants that, among other things and subject to certain exceptions, restrict our ability and/or our subsidiaries' ability to:

- Incur additional indebtedness;
- Pay certain dividends on our capital stock or redeem, repurchase or retire certain capital stock or certain other indebtedness;
- Make certain investments, loans and acquisitions;
- Engage in certain transactions with our affiliates;
- Sell assets, including capital stock of our subsidiaries;
- Materially alter the business we conduct;
- Consolidate or merge;
- Incur liens; and
- Engage in sale-leaseback transactions.

In addition, the USD Tranche A and the New Revolving Facility require that we meet certain financial covenants based on a consolidated leverage ratio test. Under the USD Tranche A and the New Revolving Facility, so long as any loans under the USD Tranche A (or commitments in respect thereof) are outstanding, our total net leverage ratio cannot exceed 5.50 to 1.00, with an annual step-down of 0.25:1.00 and subject to a step-up of 0.50:1.00 for the four full fiscal quarter period following any material acquisition, not to exceed 5.50 to 1.00. In addition, whenever there are no loans under the USD Tranche A (or commitments in respect thereof) outstanding and the aggregate amount of loans outstanding under the New Revolving Facility (net of (a) all letters of credit (whether cash collateralized or not) and (b) unrestricted cash of us and our restricted subsidiaries) exceeds 35% of the aggregate commitments under the New Revolving Facility, our first lien net leverage ratio cannot exceed 6.00 to 1.00.

Our ability to comply with these provisions may be affected by events beyond our control, including prevailing economic, financial and industry conditions. These restrictions on our ability to engage in or benefit from these actions may also limit our flexibility in planning for, or reacting to, changes in and opportunities for our business, such as limiting our ability to engage in mergers and acquisitions. This could place us at a competitive disadvantage. If the matters described in our other risk factors result in a material adverse effect on our business, financial condition or operating results, we may be unable to comply with the terms of our credit facilities or experience an event of default.

Our New Term Loan Facility and New Revolving Facility contain customary events of default, including:

- Failure to make required payments;
- Failure to comply with certain agreements or covenants;
- Materially breaching any representation or warranty;
- Failure to pay, or cause acceleration of, certain other indebtedness;
- Certain events of bankruptcy and insolvency;
- Failure to pay certain judgments; and
- A change in control of us.

The amount of cash available to us for repayment of amounts owed under these credit facilities will depend on our usage of our existing cash balances and our operating performance and ability to generate cash flows from operations, which will be subject to financial, business and other factors affecting our operations, many of which are beyond our control. We cannot provide any assurances that we will generate sufficient cash flows from operations to service our debt obligations. Any failure to repay these obligations as they become due would result in an event of default under the credit facilities.

If an event of default occurs, the lenders may end their obligation to make loans to us under the credit facilities and may declare any outstanding indebtedness under these credit facilities immediately due and payable. In such case, we would need to obtain additional financing or significantly deplete our available cash, or both, to repay this indebtedness. Any additional financing may not be available on reasonable terms or at all, and significant depletion of our available cash would harm our ability to fund our operations or execute our broader corporate objectives. If we were unable to repay outstanding indebtedness following an event of default, then in addition to other available rights and remedies, the lenders could initiate foreclosure proceedings on substantially all of our assets. Any such foreclosure proceedings or other rights and remedies successfully implemented by the lenders in an event of default would have a material adverse effect on our business, financial condition and operating results.

Further, because a change in control of us constitutes an event of default under these credit facilities, this may be a deterrent to some potential acquirers, as it would likely require an acquirer to repay any outstanding borrowings under these credit facilities.

A material amount of our assets represents goodwill and intangible assets, and our net income would be reduced if our goodwill or intangible assets become impaired.

As of December 31, 2022, our goodwill and intangible assets, net, represented approximately \$7.5 billion, or 65% of our total assets. Goodwill is generated in our acquisitions when the cost of an acquisition exceeds the fair value of the net tangible and identifiable intangible assets we acquire. For example, as a result of the Atotech Acquisition, we added significant additional goodwill and intangible assets. Goodwill and indefinite-lived intangible assets are subject to an impairment analysis at least annually based on the fair value of the reporting unit. Intangible assets relate primarily to the developed technologies, customer relationships, trade names and trademarks acquired by us as part of our acquisitions of other companies and are subject to an impairment analysis whenever events or changes in circumstances exist that indicate that the carrying value of the intangible asset might not be recoverable. We will continue to monitor and evaluate the carrying value of goodwill and intangible assets. If market and economic conditions or business performance deteriorate, the likelihood that we would record an impairment charge would increase, which impairment charge could materially and adversely affect our financial condition and operating results.

Risks Related to Cybersecurity, Data Privacy and Intellectual Property Protection

We are exposed to risks related to cybersecurity and data privacy threats and incidents, including the ransomware event we identified on February 3, 2023, and we are subject to restrictions and changes in laws and regulations governing data privacy and data protection, any of which could have a material adverse effect on our business.

We rely on various information technology networks and systems, some of which are managed by third parties, to process, transmit and store electronic information and to carry out and support a variety of business activities, including, among others, finance and accounting, order management, human resources, communications, manufacturing, research and development, intellectual property, supply chain management, sales and information technology, including critical functions such as internet connectivity, network communications, and email. Some of these activities are processed via Software-as-a-Service (“SaaS”) products provided by third parties and hosted on their own networks and servers, or third-party networks and servers. The data on such various information technology networks and systems includes confidential information, personally identifiable information, transactional information and intellectual property belonging to us and our employees, customers, suppliers and other business partners.

We are subject to ongoing cybersecurity threats, including ransomware or other malware, hacking, phishing, denial of service attacks, and other attacks. These threats may range from employee error or misuse to sophisticated and targeted attempts by bad actors to gain unauthorized access to information systems. We and our third-party administrators and vendors have experienced, and expect to continue to be subject to, cybersecurity threats and incidents, including industry-wide vulnerabilities, and we cannot guarantee that these threats and incidents will not have an adverse impact on our business, financial condition or results of operations. For example, on February 3, 2023, we identified that we had become subject to a ransomware event. Based on our investigation, we concluded ransomware actors encrypted certain of our systems by deploying malware. This incident required us to temporarily suspend operations at certain of our facilities and has had a material impact in the first quarter of 2023 on the Company’s ability to process orders, ship products and provide service to our Vacuum Solutions Division (“VSD”) and Photonics Solutions Division (“PSD”) customers. We expect this incident will have a negative impact on our revenue for the first quarter of 2023 of at least \$200 million. As a result of the incident, our relationship with our customers may be negatively impacted and we may be subject to subsequent investigations, claims or actions, in addition to other costs, fines, penalties, or other obligations related to impacted data, whether or not such data is misused. For additional information regarding this incident, please refer to “Management’s Discussion and Analysis of Financial Condition and Results of Operations—Overview—Recent Events—Ransomware Event” in Part II, Item 7 of this Annual Report on Form 10-K.

Despite the implementation of a variety of security controls and measures, as well as those of our third-party administrators and vendors, there is no assurance that such actions will be sufficient to prevent another cybersecurity incident, whether due to

ransomware or other malware, attacks by hackers, employee error or malfeasance, computer viruses, telecommunication failures, systems failures, natural disasters, or other catastrophic events. We also face the challenge of supporting our older systems and implementing necessary upgrades. Further, as we transition to using more cloud-based solutions that are dependent on the internet or other networks to operate, we expose ourselves to additional or different cyber and other data security threats, whether directly or through our third-party administrators and vendors. As cyber threats continue to rapidly evolve and become increasingly more difficult to detect and defend against, our current security controls and measures may not be effective in preventing cybersecurity incidents and we may not have the capabilities to detect certain vulnerabilities. These risks may be further amplified by the increased reliance on remote access to information technology systems as a result of the use of SaaS software, cloud and remote services, and employees working remotely. Additionally, our merger, acquisition and divestiture activity may also require updates to security protocols or transitions to or from, and the integration of, various information management systems. Those systems that we acquire or that are used by acquired entities or businesses may also pose security risks of which we are unaware or unable to mitigate, particularly during the transition of these systems.

While we continue to assess and address the implications of existing and new domestic and foreign regulations relating to data privacy, the evolving regulatory landscape presents a number of legal and operational challenges, and our efforts to comply with these regulations may be unsuccessful. For example, regulations in the European Union (the “EU”) and China have established a prohibition on the transfer of personally identifiable information from their respective countries to other countries whose laws do not protect personal data to an adequate level of privacy or security. While we have utilized certain permitted approaches for transferring personally identifiable information from these countries to the United States, these approaches may be reviewed and invalidated by courts or regulatory bodies and we may be required to ascertain an alternative legal basis for such transfers. Additionally, based on our investigation of the ransomware event we identified in February 2023, we became aware on February 13, 2023, that the ransomware actors may have exfiltrated personal information from our systems. We provided notifications to individuals and to regulators, in accordance with applicable laws, and we may be required to provide additional notifications in the future. On March 3, 2023, we became subject to a class action lawsuit filed in the Orange County Superior Court of the State of California seeking unspecified monetary damages, costs and attorneys’ fees arising out of the ransomware event. See “—We are exposed to various risks related to legal proceedings, including, for example, product liability claims, intellectual property infringement claims, contractual claims and security class action litigation, which if successful, could have a material adverse effect on our commercial relationships, business, financial condition and operating results.” below for more information regarding legal risks associated with privacy-related matters.

A failure to comply with the ever-changing regulatory landscape, or a breach of our operational or security systems or infrastructure, or those of our customers, suppliers and other business partners, could disrupt our business, including business operations and manufacturing processes; result in the disclosure, misuse, corruption or loss of confidential or other valuable business information, including intellectual property, personally identifiable information and other critical data of ours and our employees, customers, suppliers and other business partners; result in competitive disadvantages to the extent the information is competitively sensitive; damage our reputation; negatively affect our relationships with our employees, customers, suppliers and other business partners, including loss of confidence, which could lead to loss of or reduction in orders; divert the attention of management; cause losses; result in litigation, investigations or liability under contracts; require notifications to regulatory authorities and impacted individuals; result in significant penalties and/or fines from regulatory bodies, including pursuant to privacy laws and export control laws; add to the complexity of our compliance obligations; increase our cybersecurity protection costs; and result in the incurrence of remediation costs. These adverse effects would likely be amplified in the event a breach of operational or security systems remains undetected for an extended period of time.

The costs of compliance with, and other burdens imposed by, privacy, cybersecurity, data protection and data localization laws, regulations and policies, including restrictions on marketing activities, could have a material adverse effect on our business, financial condition and operating results. For example, as a result of the ransomware event described above, we have incurred costs, and we expect to continue to incur costs, which may be significant, in connection with efforts to investigate the incident, assess the impact of the incident, recover our systems, enhance our data security and protect against unauthorized access to, or manipulation of, our systems and data. Despite incurring these costs, we may not have identified and may not be able to remediate all of the potential causes of the incident, and similar incidents may occur in the future. Further, customers and third-party providers increasingly demand rigorous contractual provisions regarding privacy, cybersecurity, data protection, confidentiality, and intellectual property, which may also increase our overall compliance burden.

Although we maintain insurance related to cybersecurity risks, all of these costs, expenses, liability and other matters may not be covered adequately by insurance and may result in an increase in our costs for insurance or insurance not being available to us on economically feasible terms, or at all. Insurers may also deny us coverage as to any future claim. Any of these results could harm our business, financial condition and reputation.

Our proprietary technology is important to the continued success of our business. Our failure to protect this proprietary technology may significantly impair our competitive position.

Our success and ability to compete depend in large part upon protecting our proprietary technology. We rely on a combination of patent, trademark and trade secret protection and other agreements, such as nondisclosure agreements and other contractual agreements with our employees and third parties, to protect our proprietary rights. The steps we have taken may not be sufficient to prevent the misappropriation of our intellectual property, particularly in countries and regions outside, for example, the United States and Europe, where laws may not protect our proprietary rights as fully. For example, the patent prosecution and enforcement systems within China and India, where we have a significant customer base and manufacturing presence, both of which have considerably increased following the completion of the Atotech Acquisition, are less robust than these systems in certain other jurisdictions and as a result, we may be limited in our ability to enforce our intellectual property rights there. We may also be at a disadvantage in any enforcement proceeding in China and India as a foreign entity seeking protection against a locally headquartered company. Patent and trademark laws and trade secret protection may not be adequate to deter third party infringement or misappropriation of our patents, trademarks, trade secrets and similar proprietary rights. In addition, patents issued to us may be challenged, invalidated or circumvented. The loss or expiration of any of our key patents could lead to a significant loss of sales of certain of our products and could materially affect our future operating results. We have in the past and may in the future be subject to or may initiate interference proceedings, validity challenges or opposition proceedings in the U.S. Patent and Trademark Office, the European Patent Office, or similar agencies, which can demand significant financial and management resources. The process of seeking patent protection can be time consuming and expensive and patents may not be issued from currently pending or future applications. Moreover, our existing patents or any new patents that may be issued may not be sufficient in scope or strength to provide meaningful protection or any commercial advantage to us. We may initiate claims, enforcement actions or litigation against third parties for infringement of our proprietary rights in order to determine the scope and validity of our proprietary rights or the proprietary rights of our competitors, which claims could result in costly litigation, the diversion of our technical and management personnel and the assertion of counterclaims by defendants, including counterclaims asserting invalidity of our patents. We will take such actions where we believe that they are of sufficient strategic or economic importance to us to justify the cost.

Risks Related to Our Operations

Supply chain disruptions and other manufacturing interruptions or delays have affected our ability to meet customer demand and have led to higher costs, while the failure to estimate customer demand accurately has resulted in excess or obsolete inventory, all of which has negatively impacted, and we expect will continue to impact, our business.

Our business depends on the timely supply of products and services that meet the rapidly changing technical and volume requirements of our customers, which depends in part on the timely delivery of raw materials, parts, components and subassemblies from suppliers, including contract manufacturers. For example, since the first quarter of 2021, we have experienced significant constraints due to global supply chain disruptions, including procuring electronic components, which have negatively impacted, and continue to impact, our sales, costs and margins, and our ability to produce timely products to meet customer demand. Supply constraints and potential for shortages have caused us to increase safety stock levels, which has increased the amount of inventory we hold. Cyclical industry conditions and volatility of demand for our products increase capital, technical, operational and other risks for us and for companies throughout our supply chain. We have experienced, and we expect to continue to experience, significant disruptions in our supply chain, interruptions of our manufacturing operations, delays in our ability to deliver products or services, increased costs, price volatility, and customer order cancellations, which have been, or may in the future be, as a result of:

- Volatility in the availability and cost of materials, including electronic components, whether due to interruptions in production by suppliers, allocations of products to other purchasers, fluctuations in foreign currency exchange rates, changes in worldwide price levels, whether as a result of inflationary pressures or otherwise, environmental limitations, geopolitical issues or other factors;
- Pandemics such as COVID-19, natural disasters or other events beyond our control (such as earthquakes at our facilities in California or Oregon, floods or storms, wildfires, power outages, such as rolling blackouts previously experienced in China, regional economic downturns, social unrest, political instability, terrorism, or acts of war), particularly where we or our suppliers, subcontractors and contract manufacturers conduct manufacturing;
- Global logistics network challenges, such as limited availability of and constraints on freight capacity;
- Information technology or infrastructure failures; and
- New laws or regulations.

For example, our Materials Solutions Division (“MSD”) uses certain raw materials derived from petrochemical based feedstocks, the prices of which have historically been subject to periods of rapid and significant upward and downward movement. We may not always be able to pass on price increases in raw materials, or price increases by our suppliers, to our customers due to competitive pricing pressure, and, even when we are able to do so, there may be a delay between price increases in raw materials and our ability to increase the prices of our products.

In addition, if we need to rapidly increase our business and manufacturing capacity to meet increases in demand or expedited shipment schedules, this may exacerbate any interruptions in our manufacturing operations and supply chain and the associated effect on our working capital. Moreover, if actual demand for our products is different than expected, we may purchase more/fewer parts than necessary or incur costs for canceling, postponing or expediting delivery of parts. If we purchase inventory in anticipation of customer demand that does not materialize, or if our customers reduce or delay orders, we may incur excess inventory charges. Any of these factors could materially and adversely affect our business, financial condition and operating results.

Our dependence on sole and limited source suppliers and international suppliers has negatively impacted, and could continue to impact, our ability to manufacture products and systems.

We rely on sole and limited source suppliers and international suppliers for some of our raw materials, components, subassemblies and software that are critical to manufacturing our products and/or our testing and operations processes due to unique properties or component designs as well as specialized quality and performance requirements. For example, MSD relies on a local basis on single principal suppliers of palladium, its most significant raw material input by value. Our reliance on sole and limited source suppliers and international suppliers involves a number of risks, including:

- The inability to obtain an adequate supply of required raw materials or components, including if our suppliers cannot scale their manufacturing output to meet our demands;
- Quality and reliability problems with raw materials or components, which in turn adversely affects our products' quality and reliability;
- Prohibitively higher raw material or component prices due to the imposition of tariffs;
- Supply chain disruptions, including as a result of the relocation of our low-cost and sole and limited source suppliers to less-developed countries, such as the movement of some suppliers from China to the Philippines or Vietnam;
- Reduced control over pricing and timing of delivery of raw materials and components;
- The inability of our suppliers to develop technologically advanced products to support our growth and development of new products;
- The unavailability of service and/or spare parts for critical capital equipment; and
- The inability or unwillingness of our suppliers to continue to offer supplies or services on commercially acceptable terms.

At times, we have not been able to, and in the future, we may not be able to, obtain and qualify alternative sources of these components on favorable terms, on a timely basis, or at all, whether because there are a limited number of suppliers or because we have entered into supply agreements with certain suppliers that contain certain minimum purchase requirements. The use of alternative sources could also require us to redesign our products, resulting in increased costs, likely shipping delays and the potential need to requalify products with customers, particularly those who have “copy exact” requirements. Any inability to redesign our products could result in further costs and shipping delays. Increased costs would decrease our profit margins if we could not pass the costs to our customers. Further, shipping delays damage, and may continue to damage, our relationships with customers and have a material adverse effect on our business and operating results.

Our failure to successfully manage the transition of certain of our products to other manufacturing locations and/or to contract manufacturers and the transition of certain functions to centralized locations would likely harm our business, financial condition and operating results.

As part of our continuous cost-reduction and business continuity efforts, we continue to relocate the manufacturing of certain of our existing product lines and subassemblies to, and initiate the manufacturing of certain new products in, our facilities in China, Israel, Mexico, Romania and Singapore, as well as to our significant subcontracted operations in Mexico and selected contract manufacturers in Asia. In addition, we have relocated certain segments of other functions to centralized locations, including certain procurement activity to Mexico and certain research and development activity to India. In the future, we may expand the level of functions that we move to other global locations to take advantage of cost efficiencies available to us in those

locations or for business continuity purposes. However, we may not achieve the significant cost savings or other benefits that we anticipate from moving these operations and functions, and costs may increase as development and manufacturing expense increase and labor, material, shipping and facility-related costs rise, as we have seen in our manufacturing locations in China. If these costs increase to the extent that we no longer realize the cost savings we anticipated, we may need to relocate these operations and functions to other lower-cost regions. Additionally, if we are unable to successfully manage the relocation, initiation or oversight of these operations and functions, including identifying, training and retaining skilled labor, our business, financial condition and operating results would be harmed.

In particular, transferring product lines to other manufacturing locations and/or to our contract manufacturers' facilities often requires us to transplant complex manufacturing equipment and processes across a large geographical distance and to train a completely new workforce concerning the use of this equipment and these processes. In addition, certain of our customers may require the requalification of products supplied to them in connection with the relocation of manufacturing operations. If we are unable to manage these transfers and training smoothly and comprehensively, or if we are unable to requalify products in a timely manner, we could suffer manufacturing and supply chain delays, excessive product defects, harm to our operating results and our reputation with our customers, and loss of customers. Further, the utilization of overseas manufacturing locations and contract manufacturers may require additional transportation and shipping providers, customs tariffs or export licenses, which may be difficult or costly to obtain.

Additionally, qualifying contract manufacturers and commencing volume production is expensive and time-consuming, and there is no guarantee we will continue to do so successfully. Further, our reliance on contract manufacturers reduces our control over compliance, the assembly process, quality assurance, production costs and material and component supply for our products. If we fail to manage our relationships with our contract manufacturers, or if any of our contract manufacturers violate laws or regulations or experience financial difficulty, delays, disruptions, capacity constraints or quality control problems in their operations, our ability to ship products to our customers could be impaired and our competitive position and reputation could be harmed. Further, if we or our contract manufacturers are unable to negotiate with suppliers for reduced material or component costs, our operating results could be harmed.

In addition, our contract manufacturers may terminate our agreements with them upon prior notice to us or immediately for reasons such as if we become insolvent, or if we fail to perform a material obligation under the agreements. If we are required to change contract manufacturers or assume internal manufacturing operations for any reason, including the termination of one of our contract manufacturing contracts, we will likely suffer manufacturing and shipping delays, lost sales, increased costs and damage to our customer relationships, any of which would harm our business, financial condition and operating results.

Our products could contain defects, which would increase our costs and seriously harm our business, financial condition, operating results and customer relationships.

Many of our products are inherently complex in design and, in some cases, require extensive customization and/or ongoing regular maintenance. Further, the manufacturing of these products often involves a highly complex and precise process and the utilization of specially qualified materials or components that conform to stringent specifications. Many of our products also require highly skilled labor. As a result of the technical complexity of these products, design defects, skilled labor turnover, changes in our or our suppliers' manufacturing processes or the inadvertent use of defective or nonconforming materials by us or our suppliers could adversely affect our manufacturing yields and product reliability. This could in turn harm our business, operating results, financial condition and customer relationships.

We provide warranties for our products, and we accrue allowances for estimated warranty costs at the time we recognize revenue for the sale of the products. The determination of such allowances requires us to make estimates of product return rates and expected costs to repair or replace the products under warranty. We establish warranty reserves based on historical warranty costs for our products. If actual return rates or repair and replacement costs differ significantly from our estimates, our operating results would be negatively impacted.

Our customers may discover defects in our products after the products have been fully deployed and operated under peak stress conditions. In addition, some of our products are combined with products from other suppliers, which may contain defects. Further, some of our customers use our products in ways other than their intended purpose. As a result, should problems occur, it may be difficult to identify the source of the problem. If we are unable to promptly identify and fix defects or other problems, we could experience, among other things:

- Loss of customers;
- Increased costs of product returns and warranty expenses;
- Increased costs required to analyze and mitigate the defects or problems;
- Damage to our reputation;

- Failure to attract new customers or achieve market acceptance;
- Diversion of development, engineering and service resources; and/or
- Legal action by our customers or their customers.

The occurrence of any of these factors could seriously harm our business, financial condition and operating results.

Chemical manufacturing is inherently hazardous and could result in accidents that disrupt our operations or expose us to significant losses or liabilities.

The hazards associated with chemical manufacturing and the related storage and transportation of chemical raw materials, products and wastes are inherent in operating MSD. These hazards could lead to an interruption or suspension of operations and have a material adverse effect on the productivity and profitability of a particular manufacturing facility or on our business as a whole. Potential risks include storage tank leaks and ruptures, explosions and fires, and chemical spills and other discharges or releases of toxic or hazardous substances or gases. These risks could be caused or exacerbated by mechanical failures, unscheduled downtime, labor difficulties, transportation interruptions, inclement weather, natural disasters, cybersecurity breaches or terrorist attacks. These hazards may result in personal injury and loss of life, damage to property, and contamination of the environment, which may result in a suspension of operations and the imposition of civil or criminal fines, penalties and other sanctions, cleanup costs, and claims by our employees, governmental entities or third parties. We are dependent on the continued operation of our production facilities, and the loss or shutdown of operations at any of our major operating facilities could have a material adverse effect on our business, financial condition and operating results.

We outsource a number of services to third-party service providers, which decreases our control over the performance of these functions. Disruptions or delays at our third-party service providers could adversely impact our operations.

We outsource a number of services, including certain information technology systems and systems management, logistics functions, contract manufacturing, payroll and tax functions, to third-party service providers. While outsourcing arrangements may lower our cost of operations, they also reduce our direct control over the services rendered. This diminished control may have an adverse effect on the quality or quantity of services rendered, on our ability to quickly respond to changing market conditions, or on our ability to ensure compliance with all applicable domestic and foreign laws and regulations. If we do not effectively develop and manage our outsourcing strategies, if required export and other governmental approvals are not timely obtained, if our third-party service providers do not perform as anticipated, or do not adequately protect our data from cyber-related security breaches, or if there are delays or difficulties in enhancing business processes, we may experience operational difficulties (such as limitations on our ability to pay suppliers in a timely manner), increased costs, manufacturing or service interruptions or delays, loss of intellectual property rights or other sensitive data, quality and compliance issues, and challenges in managing our product inventory or recording and reporting financial and management information, any of which could materially and adversely affect our business, financial condition and operating results.

The loss of net revenues from any one of our major customers would likely have a material adverse effect on us.

Our top ten customers accounted for approximately 42%, 46% and 44% of our net revenues for 2022, 2021 and 2020, respectively. Our top two customers, Lam Research Corporation and Applied Materials, Inc., together accounted for approximately 24%, 27% and 24% of net revenues for 2022, 2021 and 2020, respectively. In any one reporting period, a single customer or several customers may contribute an even larger percentage of our consolidated net revenues. Further, our equipment solutions business (“ESB”), a component of PSD, also depends on a few significant customers for a large portion of its revenue in any given quarter. While the Atotech Acquisition has mitigated our reliance on these customers to some degree, the loss of any of these customers or any significant reduction in orders by these customers, including reductions due to economic, market or competitive conditions or regulatory requirements, would likely still have a material adverse effect on our business, financial condition and operating results. None of our significant customers has entered into an agreement with us requiring it to purchase any minimum quantity of our products.

Attempts to lessen the adverse effect of any loss or reduction of net revenues through the rapid addition of new customers would be difficult because a relatively small number of companies dominate the semiconductor and electronics manufacturing industries. Further, prospective customers typically require lengthy qualification periods prior to placing volume orders with a new supplier. Our future success will continue to depend upon:

- Our ability to maintain relationships with existing key customers;
- Our ability to attract new customers and satisfy any required qualification periods;
- Our ability to introduce new products in a timely manner for existing and new customers;

- The successes of our original equipment manufacturer (“OEM”) customers in creating demand for their capital equipment products that incorporate our products; and
- Our ability to gain significant customers in new, emerging segments of our markets.

Key personnel have been, and may continue to be, difficult to attract and retain.

Our ability to maintain and grow our business is directly related to the service of our employees in each area of our business, as we consider talent to be a significant asset. Our performance is directly tied to our ability to hire, train, motivate and retain qualified personnel, including highly skilled technical, financial, managerial, and sales and marketing personnel. There is significant competition for personnel in the technology and sciences marketplace, particularly in certain geographies where we are located, including the Boston area, the Orange County, California area, the San Francisco Bay area, China, Germany, Japan and Singapore. Also, employees in our industries are increasingly able to work remotely, which could increase employee mobility and turnover, making it more difficult for us to attract and retain employees. In addition, many of our product manufacturing processes and product services require deep technical expertise, and it can be particularly challenging to identify and attract candidates and retain employees possessing such expertise. We have experienced, and may continue to experience, attrition in certain key positions. A related challenge is that a significant portion of our technical talent is nearing retirement age, and we may have difficulty attracting a sufficient number of employees with the necessary skills to replace them. If we are unable to hire sufficient numbers of qualified employees or retain and motivate existing employees, including our employees from the Atotech Acquisition, our business and operating results would be harmed.

Risks Related to Our Industries and Markets

The semiconductor, electronics manufacturing and automotive industries we serve are characterized by periodic fluctuations in business activity that may cause a reduction in demand for our products.

Our business has depended upon the capital expenditures of semiconductor device manufacturers (which in turn depends upon the demand for semiconductors) and the capital expenditures for electronics manufacturing. As a result of the Atotech Acquisition, we also expect to experience increased dependence on the automotive industry. All of these industries have historically experienced cyclical variations in product supply and demand. For example, while our sales to semiconductor capital equipment manufacturers and semiconductor device manufacturers sequentially increased 12% in 2022, we anticipate that our semiconductor revenue could decrease in 2023, as a result of expected softening in the market. These sometimes sudden and severe cycles can result from many factors, including overall consumer and industrial spending and demand for electronic products that drive manufacturer production. These cycles can also result from manufacturers' capacity utilization, timing of new product introductions, demand for customers' products, inventory levels relative to demand, access to affordable capital, labor conditions, prices of commodities and energy costs. The timing, severity and duration of these cycles are difficult to predict, and we may not be able to respond effectively to these cycles.

During downturns in the semiconductor and electronics manufacturing industries, periods of overcapacity have resulted in rapid and significantly reduced demand for our products, which may result in lower gross margins due to reduced absorption of manufacturing overhead, as our ability to reduce our cost structure rapidly and effectively in response to such downturns is limited by the fixed nature of many of our expenses in the near term. During downturns in the automotive industry, we would expect a similar effect on the gross margins of MSD. Further, our ability to reduce our long-term expenses is constrained by our need to continue investment in next-generation product technology and to support and service our products. In addition, due to the relatively long manufacturing lead times for some of the products we sell to these industries, we may incur expenditures or purchase raw materials or components for products we are unable to sell. As a result, downturns in these industries may materially harm our business, financial condition and operating results. Conversely, during upturns in these industries, we may have difficulty rapidly and effectively increasing our manufacturing capacity to meet sudden increases in customer demand. If we fail to do so, we may lose business to our competitors and our relationships with our customers may be harmed.

Many of the markets and industries we serve are highly competitive, are subject to rapid technological advancement, and have narrow design windows, and if we fail to introduce new and innovative products or improve our existing products, or if our products or the applications we invest in do not achieve widespread adoption, our business, financial condition and operating results will be harmed.

We operate in highly competitive markets characterized by rapid technological advances, frequent product introductions and enhancements, changing customer requirements, evolving industry standards, substantial capital investment and increasing price pressure. Our success depends upon our ability to continuously develop, market and support superior products, processes and solutions. Factors that could harm our competitive position include:

- Our failure to anticipate demand for and internally develop or acquire new, improved and disruptive technologies;
- Our investment in emerging applications that do not achieve widespread adoption or significant growth;
- Delays in introducing new, enhanced and differentiated products, many of which are difficult to design and manufacture because of their sophistication and complexity;
- Reduced manufacturing capabilities, customer service or support;
- Our inability to have semiconductor device manufacturers direct semiconductor capital equipment manufacturers to use our products at their semiconductor fabrication facilities;
- Our inability to have global electronics OEMs specify our products in their manufacturing processes for the rigid printed circuit board manufacturers they use;
- Failure of customers to achieve market demand for their products that incorporate our technologies;
- Efforts of customers to internally develop products that compete with our technologies or to engage subcontract manufacturers or system integrators to manufacture competitive products on their behalf;
- Competitors that develop products that offer superior performance or technological features;
- Competitors with greater financial, technical, marketing and other resources, including ownership by or affiliations with members of government, political entities or larger, multinational businesses, which may offer a number of competitive advantages, such as the ability to incur lower costs due to control over sources of components and raw materials or exclusive agreements with suppliers thereof;
- Competitors with greater recognition and stronger presences in specific product niches and/or regions, including in the specialty chemicals industry;
- Competitors, particularly in China, that are able to develop low-cost competitive products;
- Difficulties in displacing competitors' products that are designed into customers' products;
- Pricing pressure from customers and competitors, particularly new competitors that offer aggressive price and payment terms in an attempt to gain market share, and especially during cyclical downturns in our markets, when end-markets become more sensitive to costs and competitors are more likely to seek to maintain or increase market share, reduce inventory or introduce more technologically advanced or lower-cost products;
- Industry consolidation among competitors, which could exacerbate certain of these factors; and
- Regulatory changes that prevent or make it difficult to supply our products and services to a particular industry, market or country.

Certain of these factors could cause customers to defer or cancel orders for our products and/or place orders for our competitors' products. This is particularly significant to us, as our success depends on many of our products being designed into new generations of equipment and manufacturing processes. Certain markets in which we operate, such as the semiconductor capital equipment market and the mobile phone market, which is part of our industrial technologies market, experience cyclical and unevenness in capital spending. If we are unable to introduce new products in a timely manner or are otherwise unsuccessful in making sales to customers, we may miss market upturns or fail to have our products or subsystems designed into our customers' products. For example, new products designed by capital equipment manufacturers historically have had a lifespan of five to fifteen years. We must develop products that are technologically advanced in a timely manner so that they are positioned to be chosen for use in each successive generation of capital equipment.

These factors could also prompt us to agree to pricing concessions or extended payment terms with our customers, in an effort to expand into new markets, gain volume orders or improve customer cost of ownership in highly competitive applications. In other cases, we may discontinue selling certain products if we cannot offset price erosion through shifts in operations.

Finally, these factors could render the portfolios of products or lines of business from which we generate significant net revenues obsolete. For example, MSD has lost business to customers who identify alternative materials or processes and therefore no longer require as much or any specialty chemicals. If our customers or the industries we serve shift to other technologies, our business, financial condition and operating results would be harmed.

We offer products for multiple markets and must face the challenges of supporting the distinct needs of each of the markets we serve.

We offer products for very diverse markets, the scope and number of which expanded as a result of the Atotech Acquisition. Because we operate in multiple markets, we must work constantly to understand the needs, standards and technical requirements of many different applications within these markets, and must devote significant resources to developing different products for these markets. Product development is costly and time consuming. We must anticipate trends in our customers' industries and develop products before our customers' products and processes are commercialized. If we do not anticipate our customers' needs and future activities, we may invest substantial resources in developing products that do not achieve broad market acceptance. Our growth prospects rely in part on successful entry into new markets, which depends on displacing competitors who are more familiar with these markets and better known to customers. In many cases, we are attempting to enter or expand our presence in these new markets with newly introduced products that are not yet proven in the industry. Our decision to continue to offer products to a given market or to penetrate new markets is based in part on our judgment of the size, growth rate, profitability and other factors that contribute to the attractiveness of a particular market. If our product offerings in any particular market are not competitive, our analyses of a market are incorrect or our sales and marketing approach for a market is ineffective, we may not achieve anticipated growth rates in this market, and our business, financial condition and operating results would be harmed.

Further, serving diverse markets requires an understanding of different sales cycles and customer types, and the development and maintenance of a complex global sales team and sales channels to support the markets' differing needs. It also requires dynamic operations that can support both complex, customized product builds as well as quick turn-around for commercial off-the-shelf sales. If we fail to provide sales and operational support for our diverse markets, our business, financial condition and operating results would be harmed.

Risks Related to Operating a Global Business

We face significant risks associated with doing business internationally.

We face significant risks from our substantial operations in, sales to, and purchases from international markets, which has considerably increased following the completion of the Atotech Acquisition. Our presence and operations in international markets, and the risks associated with doing business internationally, may continue to change and will likely increase if our business grows. These risks, many of which we have experienced, include:

- Adverse changes or instability in political or economic conditions in countries or regions where we and our customers and suppliers are located, including currency devaluations, debt defaults, lack of liquidity and recessions;
- Challenges of administering our diverse business and product lines globally;
- Actions of government regulatory authorities, including embargoes, sanctions (including “anti-blocking” rules), executive orders, import, export, and reexport restrictions, antiboycott laws, tariffs (including anti-dumping and countervailing duties), currency controls, trade restrictions and trade barriers (including retaliatory actions), license requirements (including license-specific restrictions and provisos), citizenship requirements, nationality restrictions, environmental requirements and other rules and regulations (including extraterritorial rules and regulations) applicable to the manufacture, import, export, reexport or end-use of our products, all of which may be complicated and conflicting, require significant investments in cost, time and resources for compliance, negatively impact revenues and margins, and impose strict and severe penalties for noncompliance;
- Political and social attitudes, laws, rules, regulations and policies within countries that favor domestic companies over non-domestic companies, including customer- or government-supported efforts to promote the development and growth of local competitors;
- Greater risk of violations of U.S. and international laws and regulations, including anti-corruption and trade laws, and our code of conduct, by our employees, sales representatives, distributors or other agents;
- Ambiguous or vague laws that make collecting payments or seeking recourse difficult;
- Increased credit risk and differing financial conditions of customers and distributors, resulting in longer accounts receivable collection periods and payment cycles, increased bad debt write-offs and additions to reserves;
- Overlapping, burdensome and differing tax structures and laws;
- Potential for certain tax benefits to be revoked or reclaimed;

- Reduced, inconsistent or differing protection of intellectual property, including unequal recognition and treatment of multi-national corporations' rights by hostile or indifferent governments;
- Increasingly stringent privacy, security, consumer and data protection laws, such as the E.U. General Data Protection Regulation, the Data Security Law of China and the China Personal Information Protection Law;
- Shipping, logistics and other supply chain complications or cargo security requirements, including forced-labor mitigation rules and inflationary rates of shipping costs;
- Adverse currency exchange rate fluctuations;
- Restrictions on currency conversion or the transfer of funds, including restrictions on certain financial institutions themselves;
- Compliance costs, withholding taxes and legal and contractual restrictions associated with repatriating overseas earnings;
- Increased risk of exposure to significant health concerns (such as Monkeypox, COVID-19, Sudden Acute Respiratory Syndrome, Avian Influenza and the H7N9, Ebola or Zika viruses);
- Differences in business practices, culture, language and management style;
- Complex, burdensome and differing labor and employment laws and practices;
- Changing labor conditions and difficulties staffing, managing, and rationalizing our foreign operations, including, rising wages and other labor costs, retention of employees, the formation of labor unions and works councils and the maintenance of defined benefit pension plans;
- Nationalization or other expropriation of private enterprises or land;
- Involuntary geopolitical annexations or accessions through military force or otherwise; and
- Increased risk of exposure to civil unrest, terrorism, government sanctioned and non-government sanctioned acts of violence, and military activities.

If we experience any of the risks associated with doing business internationally, our business, financial condition and operating results could be significantly harmed.

We have significant facilities and operations and a considerable number of employees in Israel. A number of our products are manufactured in facilities located in Israel. The Middle East remains a volatile region, and the future of peace efforts between Israel and neighboring countries remains extremely uncertain. Any armed conflicts or significant political instability in the region is likely to negatively affect business conditions and could significantly disrupt our operations in Israel. Further, many of our employees in Israel may be called for active military duty under emergency circumstances. If a military conflict or war arises, our operations in Israel could be disrupted by the absence of one or more key employees or a significant number of other employees. Any such disruptions could adversely affect our business.

MSD has limited operations and employees in Belarus and recently ceased operations in Russia. Historically, we have made immaterial sales into Russia and Belarus. As a result of the ongoing military conflict between Russia and Ukraine, including the imposition of sanctions on Russia, Belarus and related parties, our sales operations in Russia and our sales into Belarus and Russia have ceased. Any additional disruptions, including the expansion of sanctions in connection with the conflict, could adversely affect our business.

The U.S. government continues to take action against certain of our customers, particularly our customers located in Asia, including indictments for various criminal charges, and in some cases, restrictions on doing business with these customers (or restrictions on third parties from engaging designated entities), including the suspension of our ability to fill outstanding orders. These actions have caused us, and will in the future cause us, to lose anticipated revenue from product sales, the amount of which could be significant. In addition, these or other customers could elect to purchase products from unaffected non-U.S. competitors, even when trade restrictions are not in place, jeopardizing our long-term relationship with them. Further, compliance with regulatory restrictions may cause us to breach contractual obligations, which could result in costs, penalties and litigation.

Additionally, potential customers in certain countries, particularly in Asia, have a strong preference for technology and products developed by suppliers based in their home countries. The trade dispute between the U.S. government and the Chinese government has reinforced and broadened this preference, as potential and existing customers seek to avoid the uncertainty related to the trade dispute. While we have attempted to mitigate these issues by establishing a significant local presence in many of these countries, companies like us that are based elsewhere remain at a disadvantage.

We face significant risks associated with doing increased business in China in particular.

The Atotech Acquisition significantly increased our operations and assets in China. As a result of our presence in China, we are subject to the following significant risks:

- Adverse changes in Chinese political, economic or social conditions or Chinese laws, regulations or policies, including the imposition of unexpected or confiscatory taxation, restrictions on currency conversion, imports and sources of supply, devaluations of currency, the nationalization or other expropriation of private enterprises, or the reversal of economic reform policies that encourage private economic activity, foreign investments and greater economic decentralization;
- Restrictions or limitations on our ability to repatriate funds from our Chinese operations, including penalties for non-compliance with applicable Chinese law;
- Differing economic practices compared to most developed countries, including with respect to the amount of government involvement, control of foreign exchange and allocation of resources;
- Uncertainties presented by the Chinese legal system, which is not fully integrated and continues to rapidly evolve, impeding our ability to interpret certain Chinese laws and regulations, predict and evaluate the outcome of administrative and court proceedings and the level of legal protection in China and enforce contracts we have entered into in China; and
- Chinese controls on the convertibility of Renminbi into foreign currencies and, in certain cases, the remittance of currency out of China, restricting our ability to remit sufficient foreign currency to pay dividends or make other payments to us, or otherwise satisfy foreign currency-denominated obligations.

If we experience any of the risks associated with doing business in China, our business, financial condition and operating results could be significantly harmed.

Unfavorable currency exchange rate fluctuations may lead to lower operating results or may cause us to change customer pricing, which could result in reduced sales and losses.

Although we report our financial position and operating results in U.S. dollars, a significant portion of our net revenues are from customers in international markets where we invoice in currencies other than the U.S. dollar, and we have facilities where costs are incurred in currencies other than the U.S. dollar. In addition, we carry certain assets and liabilities in currencies other than the U.S. dollar. The indebtedness we incurred in connection with the Atotech Acquisition includes a Euro tranche of EUR 600 million. Currency exchange rate fluctuations could have an adverse effect on our assets, liabilities, net revenues, expenses and operating results and we could experience losses with respect to our hedging activities. Unfavorable exchange rate fluctuations could require us to increase or decrease prices to customers, which could result in lower net revenues from such customers. Alternatively, if we do not adjust the prices for our products in response to unfavorable currency fluctuations, our operating results could be adversely affected by declining net revenues or profit margins for our products. Such exchange rate fluctuations could also increase the costs and expenses of our non-U.S. operations when translated into U.S. dollars or require us to modify our current business practices. In addition, most sales made by our foreign subsidiaries are denominated in the currency of the country in which these products are sold and the currency they receive in payment for such sales could be less valuable on a U.S. dollar basis at the time of receipt as a result of exchange rate fluctuations. We enter into foreign exchange forward contracts to reduce a portion of our currency exposure arising from intercompany sales of inventory as well as intercompany accounts receivable and intercompany loans. However, we cannot be certain that our efforts will be adequate to protect us from significant exchange rate fluctuations or that such efforts will not expose us to additional exchange rate risks.

Legal, Tax, Regulatory and Compliance Risks

We have identified a material weakness in our internal control over financial reporting and that weakness has led to a conclusion that our internal control over financial reporting and disclosure controls and procedures were not effective as of December 31, 2022. Our inability to remediate the material weakness, our discovery of additional weaknesses, and our inability to achieve and maintain effective disclosure controls and procedures and internal control over financial reporting could adversely affect our results of operations, our stock price and investor confidence in our Company.

Section 404 of the Sarbanes-Oxley Act of 2002 requires that companies evaluate and report on the effectiveness of their internal control over financial reporting. In addition to the Company's evaluation, our independent registered public accounting firm provides an opinion regarding the effectiveness of our internal control over financial reporting. As disclosed in more detail in Part II, Item 9A, "Controls and Procedures" below, following the ransomware incident we identified on February 3, 2023, we

identified a material weakness as of December 31, 2022 in our internal control over financial reporting. Our assessment was we did not maintain sufficient information technology (“IT”) controls to prevent or detect, on a timely basis, unauthorized access to our financial reporting systems. Specifically, we did not design or maintain effective controls with respect to our financial reporting systems related to access authentication, intrusion detection and response capability, and backup and restoration such that recovery from a cybersecurity incident could be performed in a more timely manner.

Internal controls related to our financial reporting systems are important to accurately reflect our financial position and results of operations in our financial reports. Due to the material weakness in our internal control over financial reporting, we have also concluded our disclosure controls and procedures were not effective as of December 31, 2022.

Failure to have effective internal control over financial reporting and disclosure controls and procedures can impair our ability to produce accurate financial statements on a timely basis and could lead to a restatement of our financial statements. If, as a result of the ineffectiveness of our internal control over financial reporting and disclosure controls and procedures, we cannot provide reliable financial statements, our business decision processes may be adversely affected, our business and results of operations could be harmed, investors could lose confidence in our reported financial information and our ability to obtain additional financing, or additional financing on favorable terms, could be adversely affected.

Our management has taken action to begin remediating the material weakness; however, certain remedial actions have only recently commenced and other remedial actions have not yet started, and while we expect to continue to implement our remediation plans, we cannot be certain as to when remediation will be fully completed or if our remediation efforts will be successful. Additional details regarding the initial remediation efforts are disclosed in more detail in Part II, Item 9A, “Controls and Procedures” below. In addition, we could in the future identify additional internal control deficiencies that could rise to the level of a significant deficiency or material weakness or uncover other errors in financial reporting. During the course of our evaluation, we may identify areas requiring improvement and may be required to design additional enhanced processes and controls to address issues identified through this review. In addition, there can be no assurance that such remediation efforts will be successful, that our internal control over financial reporting will be effective as a result of these efforts or that any such future significant deficiencies identified may not be material weaknesses that would be required to be reported in future periods. In addition, we cannot provide assurance that our independent registered public accounting firm will be able to attest that such internal controls are effective when they are required to do so.

If we fail to remediate the material weakness and maintain effective disclosure controls and procedures or internal control over financial reporting, our ability to accurately record, process, and report financial information and, consequently, our ability to prepare financial statements within required time periods could be adversely affected. Failure to maintain effective internal controls could result in a failure to comply with SEC rules and regulations, stock exchange listing requirements, and the covenants under our debt agreements, subject us to litigation, investigations or enforcement actions, negatively affect investor confidence in our financial statements, and adversely impact our stock price and ability to access capital markets. The defense of any such claims, investigations or enforcement actions could cause the diversion of the Company’s attention and resources and could cause us to incur significant legal and other expenses even if the matters are resolved in our favor.

If significant trade restrictions or tariffs on our products or components that are imported from or exported to China continue or are increased, our business, financial condition and operating results may be materially harmed.

Trade tensions between the United States and China have increased substantially in recent years, resulting in significant trade restrictions that have significantly harmed our business. These regulations include tariff increases, additional sanctions against specified entities, and the broadening of restrictions and license requirements for specified end-uses of those of our products that are subject to these restrictions, including restrictions surrounding specific product groups, applications and/or end uses. U.S. Government concerns relate to, among other things, national security concerns and the concept of 'military/civil fusion' in China - a national strategy in which military technologies are developed or produced alongside commercial, non-military items, often by private or quasi-government companies. In addition to targeted comprehensive sanctions against specific firms, in recent years, “Entity List” designations and “military end-user” controls have been significantly modified, as were some rules relating to items produced outside the United States that incorporate more than de minimis levels of U.S. controlled content or derived from (i.e., the “direct product” of) U.S. origin technologies. Most recently, in October 2022, the U.S. Department of Commerce’s Bureau of Industry and Security (“BIS”) published regulations that introduce new and novel restrictions related to end-uses in semiconductor, semiconductor manufacturing, supercomputer, and advanced computing, along with certain equipment used to develop and produce them, as well as controls around the activities of U.S. persons (the “New BIS Rules”). These regulations have resulted in, and may in the future result in, loss of business, both directly to China end-customers, and indirectly through our OEM customers, as well as additional export license requirements on shipments of our products, parts and supplies, and associated increased administrative burdens. The extraordinary complexity and evolving nature of these rules also significantly increases our risk of non-compliance, which could result in fines and penalties. While we continue to adjust our policies and practices to ensure compliance with these regulations, and we will seek to mitigate their impact, there can be no assurances that current or future regulations and tariffs will not have a material adverse effect on our business.

Since the beginning of 2019, the pace at which regulatory changes have been implemented has been extraordinarily high, which increases the resources needed to monitor and comply with regulations, while heightening the risk of non-compliance. Such regulatory changes include the addition by BIS of China-based Huawei Technologies Co., Ltd. (“Huawei”), Semiconductor Manufacturing International Corporation (“SMIC”), Yangtze Memory Technologies Corp (“YMTC”) and many of their respective affiliates onto its Entity List. Accordingly, we have implemented additional monitoring processes and suspended orders from Huawei, SMIC, YMTC and certain other designated Chinese-based customers, where those orders are subject to U.S. jurisdiction. We have also been negatively impacted by the cancellation of orders from customers who are suppliers to these firms. BIS has also modified the Foreign Direct Product and “military end-use” rules, expanded the scope of products and technologies that would require licenses for military end-uses, primarily in China, and expanded the list of “military end users,” mostly in China. In October 2022, the New BIS Rules imposed new restrictions on our ability to sell, ship, service and support certain equipment and otherwise conduct business with certain counterparties, primarily China-based companies involved in semiconductor manufacturing, which has negatively impacted, and we expect will continue to negatively impact, our revenues. At the same time, BIS also added numerous China-based companies, including companies with which we do business, to its “Unverified List.” Placement on the Unverified List may be an indication of additional future restrictions by BIS, as was the case with YMTC, which was added to the Unverified List in October 2022 and was then added to the Entity List in December 2022.

Increased restrictions on China may lead to regulatory retaliation by the Chinese government and possibly further escalate geopolitical tensions between China and Taiwan. China has adopted, and announced its intention to further adopt, new regulations, which could have an adverse effect on our operations. For example, in response to the imposition of U.S. tariffs in 2018 and 2019, China imposed its own retaliatory tariffs. In May 2019, China's Ministry of Commerce announced an “unreliable entity list” under which non-Chinese entities that cut off supply to Chinese companies may be subject to government action. In September 2020, it disclosed potential enforcement mechanisms in the form of an “Unreliable Entity List.” This regulation has yet to be implemented, and its effects are unknown at this time.

The ongoing geopolitical tensions and economic uncertainty between the United States and China caused by recent tariffs, Entity List and “military end user” designations, foreign-made product rules and the New BIS Rules, and the unknown impact of current and future Chinese trade regulations, may continue to cause increased costs, as well as restrictions on our ability to sell, or a decreased demand from customers to purchase, our products, directly and indirectly, which could materially harm our business, financial condition and operating results. This trade uncertainty has caused, and may continue to cause, customers to delay or cancel orders, as they mitigate their own supply chain and cost exposure by sourcing from locally-based suppliers or suppliers based in other countries. Such delays and cancellations could have a material impact on our business, financial condition and operating results. It is possible that additional restrictions on trade will be imposed, and that existing tariffs will be increased on imports of our products or the components used in our products and/or that our business will be impacted by additional retaliatory tariffs or restrictions imposed and/or increased by China or other countries in response to existing or future tariffs, causing us to potentially lose additional sales and customers, incur increased costs and lower margins, seek alternative suppliers, raise prices or make changes to our operations, any of which could materially harm our business, financial condition and operating results.

We are subject to international trade compliance regulations, and violations of those regulations could result in fines or trade restrictions, which could have a material adverse effect on us.

We are subject to trade compliance laws in both the United States and other jurisdictions where we operate. For example, exports of our products and technology developed or manufactured in the United States are subject to export controls imposed by the U.S. Government and administered by the U.S. Departments of Commerce and, to a lesser extent, State and Treasury. Export regulations govern exports of our products and technology developed or manufactured in other countries, including, for example, Austria, China, France, Germany, Israel, Romania and Singapore. In certain instances, these regulations may require obtaining licenses from the administering agency prior to exporting products or technology to international locations or foreign nationals, including foreign nationals employed by us in the United States and abroad. For products and technology subject to the U.S. Export Administration Regulations administered by BIS, the requirement for a license is dependent on the type and end use of the product and technology, the final destination and the identity and nationality of the end user. Virtually all exports from the United States of defense articles subject to the International Traffic in Arms Regulations, administered by the Department of State's Directorate of Defense Trade Controls, require a license. The Israeli Ministry of Economy and the Defense Export Control Agency of the Israeli Ministry of Defense administer similar export regulations and license requirements, which apply to many of our products and technology developed or manufactured in Israel. In addition, the Romanian Ministry of Foreign Affairs and the Department for Export Controls administer similar export regulations and license requirements, which apply to many of our products and technology developed or manufactured in Romania. Obtaining export licenses can be difficult and time-consuming, and we may not be successful in obtaining them. Failure to obtain export licenses to enable product and technology exports could reduce our net revenues, harm our relationships with our customers and could adversely affect our business, financial condition and operating results. Compliance with export regulations may also subject us to additional fees and costs. The absence of comparable export restrictions on competitors, whether due to technical specifications or the competitor's geography, may adversely affect our competitive position. In addition, if we or our international representatives or distributors fail to comply with

any of these export regulations, we or they could be subject to civil and criminal and monetary and non-monetary penalties and costly consent decrees, and we could experience disruptions to our business, restrictions on our ability to export products and technology, damage to our reputation and significant harm to our business and operating results. While we have implemented policies and procedures to comply with these laws, we cannot be certain that our employees, contractors, suppliers or agents will not violate such laws or our policies.

Changes in tax rates or tax regulation or the termination of tax incentives could affect our operating results.

As a global company, we are subject to taxation in the United States and various other countries. Significant judgment is required to determine and estimate worldwide tax liabilities. Our future annual and quarterly effective tax rates could be affected by numerous factors, including changes in the applicable tax laws; composition of pre-tax income in countries with differing tax rates; our determinations of tax liabilities; and/or valuation of our deferred tax assets and liabilities.

The enactment of the Tax Cuts and Jobs Act (the “TCJA”) in December 2017 significantly affected U.S. tax law by changing how the United States imposes tax on multinational corporations. The U.S. Department of Treasury has broad authority under the TCJA to issue regulations and interpretive guidance. Some of the proposed and final regulations that have been issued regarding the TCJA have been challenged in court. We have applied available guidance to estimate our tax obligations, but new guidance issued by the U.S. Treasury Department may cause us to adjust our tax estimates in future periods. The ultimate impact of the TCJA on our U.S. tax liabilities is based upon our understanding and interpretation of the regulatory guidance that has been issued regarding the TCJA.

On October 4, 2021, 136 members of the Organisation for Economic Co-operation and Development (“OECD”) agreed to a global minimum tax rate of 15%. On December 20, 2021, OECD published its model rules on the agreed minimum tax known as the Global Anti-Base Erosion (“GloBE”) rules. The GloBE rules provide a framework for a coordinated multi-country system of taxation intended to ensure large multinational enterprise groups pay a minimum level of tax on the income arising in each of the jurisdictions where they operate. On December 14, 2022, the European Council approved its directive to implement Pillar Two of the GloBE rules regarding a 15% global minimum tax rate. Many EU countries have already indicated they plan to enact certain provisions of this directive as of January 1, 2024. In addition, many G20 nations have indicated their plan to follow the OECD guidance as early as January 1, 2024. Pillar Two may materially increase our future effective tax rate.

We are subject to regular examination by the U.S. Internal Revenue Service and state, local and foreign tax authorities. We regularly assess the likelihood of favorable or unfavorable outcomes resulting from these examinations to determine the adequacy of our provision for income taxes. Although we believe our tax estimates are reasonable, we can make no assurances that any final determination of tax liability will not be materially different from the treatment reflected in our historical income tax provisions and accruals, which could materially and adversely affect our financial condition and operating results.

We qualify for tax incentives based on our ability to meet, on a continuing basis, various tests relating to our employment levels, research and development expenditures and other qualification requirements in a particular jurisdiction. While we intend to operate in such a manner to maintain and maximize our tax incentives, we can make no assurances that we have so qualified or that we will so qualify for any particular year or jurisdiction. If we fail to qualify or remain qualified for certain tax incentives, the tax incentives we previously received may be terminated and/or retroactively revoked, requiring repayment of past tax benefits, and we would be subject to an increase in our effective tax rate, which would adversely impact our financial results.

Many of our products and customers are subject to numerous laws regulating the production and use of chemical substances, and some of our products may need to be reformulated or discontinued to comply with these laws and regulations.

As MSD manufactures specialty chemicals, we are subject to chemicals approvals, registrations and regulations around the world, including European Union Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (“EU REACH”), the Toxic Substances Control Act (“TSCA”) in the United States, and similar laws and regulations in certain other jurisdictions in which we and our customers operate. In recent years, changes to existing laws and regulations and the adoption of new laws and regulations have imposed new obligations, including restrictions and prohibitions on highly hazardous substances, could also force us to reformulate or discontinue certain of our products.

Governmental, regulatory, and societal demands for increasing levels of product safety and environmental protection are resulting in increased pressure for more stringent regulatory control with respect to the chemical industry, including with respect to manufacturing, importing and using chemicals. For example, the EU REACH imposes comprehensive compliance obligations and establishes mechanisms to identify and restrict high-concern chemicals, and comparable regulatory requirements have now been adopted in several other countries. As another example, in the United States, the core provisions of the TSCA were amended in June 2016 for the first time in nearly 40 years. Among the more significant changes, the amended TSCA mandates risk evaluation of existing “high priority” chemicals. In addition, the U.S. Environmental Protection Agency (the “EPA”) must make a no “unreasonable risk” finding before a new chemical can be fully commercialized. These laws and regulations generally create

uncertainty about whether existing chemicals important to our business may be designated for restriction and whether the approval process for new chemicals may become more difficult and costly. These changes could adversely impact our ability to supply certain products to our customers and could also result in compliance obligations, fines, ongoing monitoring and other future business activity restrictions, which could have a material adverse effect on our business, financial condition and operating results.

Perfluorooctanesulfonic acid and other per- and polyfluoroalkyl substances (“PFAS”) are chemical agents that have been targeted for risk assessment, restriction, regulation and high-priority remediation and are the subject of litigation and governmental investigations in the United States and other countries. While we have developed a suite of products that do not require any PFAS chemicals and, when adopted by the industry, will obviate the need for PFAS-containing mist suppressants and wetting agents, we continue to sell a limited number of products that contain permissible levels of PFAS. We have been named as a defendant in a lawsuit related to PFAS and we have received a request for information from, and responded to, a state agency.

International environmental protection requirements, including chemical regulation requirements, and enforcement of these requirements, may become more stringent in the future and could result in material costs relating to regulatory compliance, liabilities, litigation proceedings, or other impacts, such as restrictions or prohibitions on our products. Future regulatory or other developments could also restrict or eliminate the use of, or require us to make modifications to, our products, packaging, manufacturing processes, transportation methods, and technology, which could have a material adverse effect on our business, financial condition, and operating results. Our production facilities require permits, such as environmental, operating, and product-related permits and import/export permits, which are subject to renewal and, in some circumstances, revocation. We may not obtain the necessary permits, existing permits may be discontinued, and any newly issued permits may contain significant and costly new requirements. If a permit for a production facility would not be renewed or would be revoked, the facility may need to be closed temporarily or permanently, which may have a material adverse effect on our business, financial condition and operating results. Failure to obtain or maintain permits for our facilities or other failure to comply with applicable environmental regulations could result in the shutdown of, or suspension of operations at, our plants.

Many of our customers are subject to the same or similar environmental regulations. The impact of these regulations on our customers and our customers' ability to comply with these regulations is outside of our control. However, noncompliance by our customers could have an indirect negative effect on our business. We must monitor relevant chemical regulatory developments in order to limit the associated risks of new developments by triggering countermeasures, such as alternative products and phase-outs, at the right time.

We are subject to environmental regulations. If we fail to comply with these regulations, our business could be harmed.

Our operations are subject to various federal, state, local and international laws and regulations relating to environmental protection, including those governing discharges of pollutants into the air, water and land, the reporting, generation, use, handling, storage, transportation, treatment and disposal of hazardous substances, waste and other materials and the cleanup of contaminated sites. In the United States, we are subject to the federal regulation and control of the EPA, and we are subject to regulations and controls of comparable authorities in other countries. Some of our operations, including our chemical operations, require environmental permits and controls to prevent and reduce air and water pollution, and these permits are subject to modification, renewal and revocation by issuing authorities. Future developments, administrative actions or liabilities relating to environmental matters, including sanctions such as capital expenditure obligations, clean-up and removal costs, long-term monitoring and maintenance costs, costs of waste disposal, natural resource damages and payments for property damage and personal injury, could have a material adverse effect on our business, financial condition or operating results.

Although we believe that our safety procedures for using, handling, storing and disposing of such materials comply with the standards required by applicable federal, state, local and international laws and regulations, we cannot completely eliminate the risk of accidental contamination or injury from these materials, including risks related to our chemical products, which are inherently hazardous. We have been, and may in the future be, subject to claims by employees or third parties alleging contamination or injury, and could be liable for damages, which liability could exceed the amount of our liability insurance coverage (if any) and the resources of our business.

Certain portions of the soil at the former facility of our Spectra-Physics lasers business, located in Mountain View, California, and certain portions of the aquifer surrounding the facility, through which contaminated groundwater flows, are part of an EPA-designated Superfund site and are subject to a cleanup and abatement order from the California Regional Water Quality Control Board. Spectra-Physics, which we acquired as part of the Newport acquisition in April 2016 and which had been acquired by Newport in 2004, along with other entities with facilities located near the Mountain View, California facility, were identified as responsible parties with respect to this Superfund site, due to releases of hazardous substances during the 1960s, 1970s and 1980s. Spectra-Physics and the other responsible parties entered into cost-sharing agreements covering the costs of remediating the off-site groundwater impact. The site is mature, and investigations, monitoring and remediation efforts by the responsible parties have been ongoing for approximately 30 years. We have certain ongoing costs related to investigation, monitoring and remediation of the site that have not been material to us as a whole in the recent past. However, while we benefitted from the indemnification of

certain costs by a third party in the past, that indemnification is now in a transition period, and we will become subject to a greater portion of costs of remediation going forward. Our ultimate costs of remediation and other potential liabilities are difficult to predict. In the event that the EPA and the California Regional Water Quality Control Board determine that the site cleanup requires additional measures to ensure that it meets current standards for environmental contamination, or if they enhance any of the applicable required standards, we will likely become subject to additional remediation obligations in the future. In addition to our investigation, monitoring and remediation obligations, we may be liable for property damage or personal injury claims relating to this site. While we are not aware of any material claims at this time, such claims could be made against us in the future. If significant costs or other liability relating to this site arise in the future, our business, financial condition and operating results would be adversely affected.

In addition, some of MSD's manufacturing facilities and former facilities have an extended history of chemical manufacturing operations or other industrial activities, and contaminants have been detected at some of those sites. We or our predecessors have in the past been, and are currently, required to remediate contamination at several of these current and former sites, and there remains some risk that further investigation and remediation might be necessary.

The environmental regulations that we are subject to include a variety of federal, state, local and international regulations that restrict the use and disposal of materials used in the manufacture of our products or require design changes or recycling of our products. If we fail to comply with any present or future regulations, we could be subject to future liabilities, the suspension of manufacturing or a prohibition on the sale of products we manufacture. In addition, these regulations could restrict our ability to equip our facilities or could require us to acquire costly equipment, or to incur other significant expenses to comply with environmental regulations, including expenses associated with the recall of any non-compliant product and the management of historical waste. For example, in addition to EU REACH, which regulates the use of certain hazardous substances in certain products, the EU has enacted the Waste Electrical and Electronic Equipment Directive, which requires the collection, reuse and recycling of waste from certain products. Compliance with such laws requires significant resources. These regulations may require us to redesign our products or source alternative components to ensure compliance with applicable requirements, for example by mandating the use of different types of materials in certain components. Any such redesign or alternative sourcing may increase the cost of our products, adversely impact the performance of our products, add greater testing lead-times for product introductions, or in some cases limit the markets for certain products. Further, such environmental laws are frequently amended, which increases the cost and complexity of compliance. For example, such amendments have in the past, and may in the future, result in certain of our products falling in the scope of a directive, even if they were initially exempt. In addition, certain of our customers, particularly OEM customers whose end products may be subject to these directives, may require that the products we supply to them comply with these directives, even if not mandated by law. Because certain directives, for example, those issued from the EU, are implemented in individual member states, compliance is particularly challenging. Our failure to comply with any of such regulatory requirements or contractual obligations could result in our being directly or indirectly liable for costs, fines or penalties and third-party claims, and could jeopardize our ability to conduct business in certain countries.

We are exposed to various risks related to legal proceedings, including, for example, product liability claims, intellectual property infringement claims, contractual claims and securities class action litigation, which if successful, could have a material adverse effect on our commercial relationships, business, financial condition and operating results.

From time to time, we may be involved in legal proceedings, enforcement actions or claims regarding product performance, product warranty, product certification, product liability, patent infringement, misappropriation of trade secrets, other intellectual property rights, data privacy, antitrust, environmental regulations, trade regulations, securities, contracts, unfair competition, employment, workplace safety, and other matters. We can provide no assurance of the outcome of these legal proceedings, enforcement actions or claims or that the insurance we maintain will be adequate to cover them.

For example, some of our products, such as certain ultrafast lasers, are used in medical and scientific research applications where malfunctions could result in serious injury. Certain of our products may be hazardous if not operated properly or if defective. Other products of ours, including our chemicals products and laser systems, are inherently hazardous and must be used with particular care. We are exposed to significant risks for product liability claims in the event of a significant line down situation or if death, personal injury or property damage results from the handling, use or storage of our products, including our chemical products and laser systems. We may experience material product liability losses in the future. We currently maintain insurance for certain product liability claims. However, our insurance coverage may not continue to be available on acceptable terms, if at all. This insurance coverage also may not adequately cover liabilities that we incur. Further, if our products are defective, we may be required to recall or redesign these products. A successful claim against us that exceeds our insurance coverage level or that is not covered by insurance, or any product recall, could have a material adverse effect on our commercial relationships, business, financial condition and operating results.

In addition, securities class action lawsuits and derivative lawsuits are often brought against companies who have entered into business combinations and acquisitions. We were previously involved in securities class action litigation in connection with the acquisitions of Newport and ESI. In each case, the plaintiffs alleged, among other things, that the then-current directors of the

acquired company breached their fiduciary duties to their respective shareholders by agreeing to sell the company through an inadequate and unfair process, leading to inadequate and unfair consideration, by agreeing to unfair deal protection devices, and by omitting material information from the proxy statement. We, or the companies we acquire, may be subject to additional securities class action litigation in connection with other recently completed or future business combinations and acquisitions.

Regardless of the outcome, securities class action litigation such as this can be time-consuming, result in significant expense to us and divert attention and resources of our management and other key employees. Costs and expenses, or an unfavorable outcome in such cases, could exceed applicable insurance coverage, if any. Any such unfavorable outcome could have a material adverse effect on our business, financial condition, operating results and cash flows.

With respect to data privacy and intellectual property, as a result of the ransomware event described under “Risks Related to Cybersecurity, Data Privacy and Intellectual Property Protection” above, and under “Management’s Discussion and Analysis of Financial Condition and Results of Operations—Ransomware Event” below, we are subject to litigation, investigations or liability under contracts. For example, on March 3, 2023, we became subject to a class action lawsuit filed in the Orange County Superior Court of the State of California seeking unspecified monetary damages, costs and attorneys’ fees arising out of the ransomware event. We are unable to predict at this time the potential timing and outcome of the claim and whether we may be subject to further private litigation or inquiries and proceedings by various government agencies, law enforcement and other governmental authorities. While we intend to vigorously defend this lawsuit, and any additional such lawsuits, in light of the inherent uncertainties involved in such proceedings, we may incur losses associated with any such proceedings. Additionally, ongoing legal and other costs related to this lawsuit, as well as any potential future proceedings and inquiries, may be substantial, and losses associated with any adverse judgments, settlements, penalties or other resolutions of such proceedings and inquiries could be significant and have a material adverse impact on our business, reputation, financial condition, cash flows and operating results.

In addition, we have from time to time received claims from third parties alleging that we are infringing certain trademarks, patents or other intellectual property rights held by them. Such infringement claims have in the past and may in the future result in litigation, settlement or enforcement action. Any such action could be protracted and costly, and we could become subject to damages for infringement, or to an injunction preventing us from making, selling or using certain of our products or services, or using certain of our trademarks. Such claims could also result in the necessity of obtaining a license or paying damages relating to one or more of our products, services or current or future technologies, which may not be available on commercially reasonable terms or at all. Any intellectual property action and the failure to obtain necessary licenses or other rights or develop substitute technology may divert management's attention from other matters and could have a material adverse effect on our business, financial condition and operating results. In addition, the terms of some of our customer contracts require us to indemnify the customer for any claim of infringement brought by a third party based on our products. Claims of this kind may have a material adverse effect on our commercial relationships, business, financial condition or operating results.

Although our standard commercial documentation sets forth the terms and conditions that we intend to apply to commercial transactions with our business partners, counterparties to these transactions may not explicitly agree to our terms and conditions. In situations where we engage in business with a third party without an explicit written agreement regarding the applicable terms and conditions, or where the commercial documentation applicable to the transaction is subject to interpretation, we may have disputes with those third parties regarding the applicable terms and conditions of our transaction with them. These disputes could result in deterioration of commercial relationships, costly and time-consuming litigation or additional concessions or obligations being offered by us to resolve these disputes, or could impact our net revenue or cost recognition. Any of these outcomes could materially and adversely affect our business, financial condition and operating results.

In addition, from time to time in the normal course of business we indemnify parties with whom we enter into contractual relationships, including customers, suppliers, consultants and lessors, with respect to certain matters. We have agreed, under certain conditions, to hold these parties harmless against losses, such as those arising from a breach of representations or covenants, negligence or willful misconduct, and other third-party claims that our products and/or technologies infringe intellectual property rights. We may be compelled to enter into or accrue for probable settlements of alleged indemnification obligations, or we may be subject to potential liability arising from our customers' involvement in legal disputes. In addition, notwithstanding the provisions related to limitations on our liability that we seek to include in our business agreements, the counterparties to such agreements may dispute our interpretation or application of such provisions, and a court of law may not interpret or apply such provisions in our favor, any of which could result in an obligation for us to pay significant additional damages and engage in costly legal proceedings. It is difficult to determine the maximum potential amount of liability under any indemnification obligations, whether or not asserted, due to the unique facts and circumstances likely to be involved in any particular claim. Our business, financial condition and operating results in a reported fiscal period could be materially and adversely affected if we expend significant amounts in defending or settling any asserted claims, regardless of their merit or outcomes.

Legal proceedings, enforcement actions and claims, whether with or without merit, and associated internal investigations, may be time-consuming and expensive to prosecute, defend or conduct; divert management's attention and other resources; inhibit our ability to sell our products or services; result in adverse judgments for damages, injunctive relief, penalties and fines; and

negatively affect our business. We can make no assurances regarding the outcome of current or future legal proceedings, enforcement actions, claims or investigations or that the insurance we maintain will be adequate to cover them.

Risks Related to the COVID-19 Pandemic and other Widespread Health Crises

The continued effects of the COVID-19 pandemic or the emergence of other widespread health crises may have an adverse effect on our business, financial condition and operating results.

The COVID-19 pandemic subjected, and the continued effects of the COVID-19 pandemic or the emergence of other widespread health crises may continue to subject, our business, financial condition and operating results to a number of risks, including:

- Supply chain disruptions and other operational challenges, including shortages of and significant price increases and increased lead times for raw materials, components and subassemblies, in particular where we rely on sole and limited source suppliers, increased employee turnover, increased health and safety measures, site closures, and other restrictions on the movement of people, goods and raw materials, which could reduce our ability to obtain materials from suppliers and meet customer demand, in each case on favorable terms, on a timely basis, or at all, harming our relationships with customers, creating opportunities for competitors and exposing us to contractual disputes or liability;
- The implementation of government mandates and other regulatory actions, including periodic business shutdowns, manufacturing restrictions, and quarantines, which could reduce or halt our operations or the operations of our customers and suppliers, carry into the future for an extended or unknown duration, and contain complex requirements that make compliance difficult;
- Decreased employee productivity or availability, whether due to illnesses or due to the measures we or government authorities may take to mitigate their spread and effects, including site closures, restrictions on travel and vaccine mandates, which could lead to employee attrition; and
- A decline in industry and global economic conditions that reduces demand from and weakens the financial health of our customers, resulting in delayed or canceled orders, requests for payment deferrals or other contract modifications, and, if we do not anticipate significant or sudden decreases in order patterns, excess inventory.

These risks may be heightened in certain geographies, segments and markets. For example, some of our general metal finishing customers were negatively impacted by disruptions associated with COVID-19 in China in the fourth quarter of 2022. In addition, the continued effects of the COVID-19 pandemic and the emergence of other widespread health crises could exacerbate the other risks described here and in our future filings with the SEC.

Risks Related to Owning Our Common Stock

Our quarterly operating results have fluctuated, and are likely to continue to vary significantly, which may result in volatility in the market price of our common stock.

A substantial portion of our shipments occurs shortly after an order is received, and therefore we generally operate with a relatively low level of backlog. As a result, a decrease in demand for our products from one or more customers could occur with limited advance notice and could have a significant adverse effect on our operating results in any particular period. Further, we often recognize a significant portion of the revenue of certain of our business lines in the last month of each fiscal quarter, due in part to the tendency of some customers to wait until late in a quarter to commit to purchase our products as a result of capital expenditure approvals and budgeting constraints occurring at the end of a quarter, or the hope of obtaining more favorable pricing from a competitor. Thus, variations in timing of sales can cause significant fluctuations in our quarterly sales, gross margin and profitability. In addition, orders expected to ship in one period could shift to another period due to changes in the timing of our customers' purchase decisions, requests for rescheduled delivery dates, material shortages, manufacturing capacity constraints or logistics delays. Our orders are generally subject to rescheduling without penalty or cancellation without penalty other than reimbursement in certain cases for certain labor and material costs. Our operating results for a particular period may be adversely affected if our customers, particularly our largest customers, cancel or reschedule orders, or if we cannot fill orders in time due to material shortages, capacity constraints or unexpected delays in manufacturing, testing, shipping, delivery or product acceptance. Also, we base our manufacturing plans on our forecasted product mix. If the actual product mix varies significantly from our forecast, we may not be able to fill some orders, which would result in delays in the shipment of our products and could shift sales to a subsequent period. Moreover, a significant percentage of our expenses are fixed and based in part on expectations of net revenues. Our inability to adjust spending quickly enough to compensate for any shortfall would magnify the adverse impact of a shortfall in net revenues on our operating results.

Customers of our high-value, more complex products often require substantial time to qualify our products and make purchase decisions. In addition, some of our sales to defense and security customers are under major defense programs that involve lengthy competitive bidding and qualification processes. These customers often perform, or require us to perform, extensive configuration, testing and evaluation of our products before committing to purchasing them, which can require a significant upfront investment in time and resources. The sales cycle for these products from initial contact through shipment varies significantly, is difficult to predict and can last more than a year. If we fail to anticipate the likelihood of, or the costs or timing associated with, sales of these products, or the cancellation or rescheduling of orders for these products, our business and operating results would be harmed.

Our worldwide sales to customers in the research and defense markets rely to a large extent on government funding for research and defense-related programs. Any decline in government funding as a result of reduced budgets in connection with fiscal austerity measures, revised budget priorities or other causes would likely result in reduced sales of our products that are purchased either directly or indirectly with government funding, which would have an adverse impact on our operating results. Concerns regarding the global availability of credit may also make it more difficult for our customers to raise capital, whether debt or equity, to finance their projects and purchases of capital equipment, which would adversely affect sales of our products and therefore harm our business and operating results.

Market seasonality also causes fluctuations in our operating results. MSD has generally experienced its strongest revenue in the second half of the fiscal year, mostly driven by consumption trends during the holiday season, and its lowest revenue in the first quarter of the fiscal year, mostly driven by the slowdown in production in China as a result of the Chinese New Year. In addition, we typically experience our strongest revenue in the research market in the fourth quarter of our fiscal year as a result of government spending patterns, and our highest revenue in the electronics manufacturing market in the second half of our fiscal year as a result of consumer spending during the holiday season.

Other factors that could cause fluctuations in our financial results include:

- A worldwide economic slowdown or disruption in the global financial markets;
- Fluctuations in our customers' capital spending, industry cyclicality (particularly in the semiconductor, electronics manufacturing and automotive industries), levels of government funding available to our customers (particularly in the life and health sciences, and research and defense markets) and other economic conditions within the markets we serve;
- The timing of the receipt of orders within a given period;
- Demand for our products and the products sold by our customers;
- Disruption in sources of supply;
- Production capacity constraints;
- Regulatory and trade restrictions in the countries we source from, manufacture or sell our products;
- Specific features requested by customers;
- Natural disasters or other events beyond our control (such as earthquakes, floods or storms, regional economic downturns, pandemics, social unrest, political instability, terrorism, or acts of war);
- The timing of product shipments and revenue recognition within a given quarter;
- Changes in our pricing practices or in the pricing practices of our competitors or suppliers, including as a result of inflationary pressures;
- Our and our competitors' timing in introducing new products;
- Engineering and development investments relating to new product introductions, and significant changes to our manufacturing and outsourcing operations;
- Market acceptance of any new or enhanced versions of our products;
- The timing and level of inventory obsolescence, scrap and warranty expenses;
- The availability, quality and cost of components and raw materials we use to manufacture our products;
- Changes in our effective tax rates;
- Changes in our capital structure, including cash, marketable securities and debt balances, and changes in interest rates;

- Changes in bad debt expense based on the collectability of our accounts receivable;
- The timing, type and size of acquisitions and divestitures, and related expenses and charges;
- Fluctuations in currency exchange rates;
- Our expense levels;
- Impairment of goodwill and amortization of intangible assets; and
- Fees, expenses and settlement costs or judgments against us relating to litigation or regulatory compliance.
- As a result of these factors, among others, we may experience quarterly or annual fluctuations in our operating results, and our operating results for any period may fall below our expectations or the expectations of public market analysts or investors. In any such event, the price of our common stock could fluctuate or decline significantly. Consequently, we believe that quarter-to-quarter and year-to-year comparisons of our operating results, or any other similar period-to-period comparisons, may not be reliable indicators of our future performance.

The future exercise of registration rights may adversely affect the market price of our common stock.

In connection with the Atotech Acquisition, we entered into an agreement (the “Investor Rights Agreement”) with Carlyle Partners VI Cayman Holdings L.P., CEP IV Participations S.A.R.L. Sicar and Gamma Holding Company Limited (collectively, the “Carlyle Shareholders”) to grant the Carlyle Shareholders certain registration rights with respect to the shares of our common stock they received upon consummation of the Atotech Acquisition (the “Company Shares”). As of December 31, 2022, the Carlyle Shareholders beneficially owned approximately 13% of our outstanding common stock. Pursuant to the Investor Rights Agreement, the Carlyle Shareholders have registration rights for the Company Shares, and we filed a resale “shelf” registration statement to register such Company Shares and are obligated to use commercially reasonable efforts to keep such registration statement effective thereafter.

In addition, and alternatively, shares of common stock that are owned by the Carlyle Shareholders are eligible for sale in the public market to the extent permitted by the provisions of Rule 144 and Rule 701 under the Securities Act of 1933, as amended. If these additional shares of common stock are sold, or if it is perceived that they will be sold, in the public market, the trading price of our common stock could decline.

Sales of a substantial number of shares of our common stock pursuant to the resale registration statement in the public market could occur at any time the registration statement remains effective. In addition, the Carlyle Shareholders can request underwritten offerings to sell their securities. These sales, or the perception in the market that the holders of a large number of shares intend to sell shares, could reduce the market price of our common stock.

The market price of our common stock has fluctuated and may continue to fluctuate for reasons over which we have no control.

The stock market has from time to time experienced, and is likely to continue to experience, extreme price and volume fluctuations. For example, the closing price of our common stock ranged from a high of \$180.69 to a low of \$65.09 between January 1, 2022 and December 31, 2022. Prices of securities of technology companies have been especially volatile and have often fluctuated for reasons that are unrelated to the operating performance of the companies. Historically, the market price of shares of our common stock has fluctuated greatly and could continue to fluctuate due to a variety of factors. In the past, companies that have experienced volatility in the market price of their stock have been the objects of securities class action litigation. If we become the subject of securities class action litigation, it could result in substantial costs and a diversion of our management's attention and resources.

We may not pay dividends on our common stock.

Holders of our common stock are only entitled to receive dividends when and if they are declared by our Board of Directors. Our credit facilities restrict our ability to pay dividends on our capital stock under certain circumstances. Although we have declared cash dividends on our common stock since 2011, and occasionally increased the dividends from prior quarters, we are not required to do so, and we may reduce or eliminate our cash dividend in the future. This could adversely affect the market price of our common stock.

Some provisions of our restated articles of organization, as amended, our amended and restated by-laws and Massachusetts law could discourage potential acquisition proposals and could delay or prevent a change in control.

Anti-takeover provisions could diminish opportunities for stockholders to participate in tender offers, including tender offers at a price above the then-current market price of our common stock. Such provisions may also inhibit increases in the market price of our common stock that could result from takeover attempts. For example, while we have no present plans to issue any preferred stock, our Board of Directors, without further stockholder approval, may issue preferred stock that could have the effect of delaying, deterring or preventing a change in control of us. The issuance of preferred stock could adversely affect the voting power of the holders of our common stock, including the loss of voting control to others. In addition, our amended and restated by-laws provide for a classified Board of Directors consisting of three classes. Our classified board could also have the effect of delaying or deterring a change in control of our Company.

Item 1B. Unresolved Staff Comments

None.

Item 2. Properties

The following table provides information concerning MKS' principal and certain other owned and leased facilities as of December 31, 2022:

Country	City	Sq. Ft.	Activity	Reportable Segment	Owned/Leased
China	Guangzhou	794,000	Manufacturing, Warehouse, Sales and Research and Development	MSD	Owned and Leased
	Shenzhen	302,000	Manufacturing and Service	VSD and PSD	Leased
	Yangzhou	156,000	Manufacturing, Warehouse, and Office	MSD	Owned and Leased
Germany	Berlin	271,000	Manufacturing, Office, Research and Development	MSD	Leased
	Feucht	445,000	Manufacturing, Warehouse, Office and Research and Development	MSD	Owned
	Neuruppin	216,000	Manufacturing, Warehouse, Office and Research and Development	MSD	Owned
	Trebur	101,000	Research and Development	MSD	Owned and Leased
India	Manesar	189,000	Manufacturing, and Research and Development	MSD	Owned
Israel	Jerusalem	120,000	Manufacturing, Sales and Research and Development	PSD	Owned and Leased
Italy	Milan	135,000	Warehouse	MSD	Leased
Malaysia	Penang	109,000	Manufacturing, Warehouse, Sales, Office and Research and Development	MSD	Owned
Mexico	Nogales	248,000	Manufacturing and Service	VSD and PSD	Leased
	Queretaro	172,000	Manufacturing, Warehouse, Sales, and Office	MSD	Owned
Romania	Oradea	104,000	Warehouse	MSD	Leased
South Korea	Hwasung	107,000	Manufacturing, Sales, and Office	MSD	Owned and Leased
United States	Andover, MA	158,000	Corporate Headquarters, Manufacturing, and Research and Development	VSD	Owned and Leased
	Beaverton, OR	113,000	Manufacturing, Office and Warehouse	PSD	Leased
	Broomfield, CO	107,000	Manufacturing, and Research and Development	VSD	Leased
	Irvine, CA	233,000	Manufacturing, and Research and Development	PSD	Leased
	Milpitas, CA	103,000	Manufacturing, Sales, Customer Support, Service and Research and Development	PSD	Leased
	Rochester, NY	156,000	Manufacturing, Sales, Customer Support, Service and Research and Development	VSD	Owned
	Rock Hill, SC	200,000	Manufacturing, Warehouse, Office and Research and Development	MSD	Owned
	Wilmington, MA	118,000	Manufacturing, Customer Support, Service and Research and Development	VSD	Owned

In addition to the significant facilities listed above, MKS also has manufacturing, sales and marketing, customer support and services operations in various other leased and owned facilities throughout the world. See “Business—Sales and Marketing” and “Business—Reportable Segments, and Product and Service Offerings” in Part I, Item 1 of this Annual Report on Form 10-K. We believe that our current facilities are suitable and adequate to meet our needs.

Item 3. Legal Proceedings

We are subject to various legal proceedings and claims, which have arisen in the ordinary course of business. In the opinion of management, the ultimate disposition of these matters will not have a material adverse effect on our results of operations, financial condition or cash flows.

Item 4. Mine Safety Disclosures

Not applicable.

PART II

Item 5. Market for the Registrant's Common Equity, Related Stockholder Matters and Issuer Purchases of Equity Securities

Common Stock

Our common stock is traded on the Nasdaq Global Select Market under the symbol MKSI.

As of March 6, 2023, we had 80 stockholders of record.

Dividend Policy and Cash Dividends

Holders of our common stock are entitled to receive dividends when and if they are declared by our Board of Directors. During 2022, our Board of Directors declared a cash dividend of \$0.22 per share during each quarter of the year, which totaled \$52 million or \$0.88 per share. During 2021, our Board of Directors declared a cash dividend of \$0.20 per share during the first quarter and \$0.22 per share during each of the second, third and fourth quarters, which totaled \$47 million or \$0.86 per share.

On February 6, 2023, our Board of Directors declared a quarterly cash dividend of \$0.22 per share that was paid on March 10, 2023 to shareholders of record as of February 27, 2023.

Future dividend declarations, if any, as well as the record and payment dates for such dividends, are subject to the final determination of our Board of Directors. The Board of Directors intends to declare and pay cash dividends on our common stock based on our financial conditions and results of operations of the Company, although it has no obligation to do so. Our credit facilities contain covenants that restrict our ability to grant cash dividends in certain circumstances.

Share Repurchase Program

On July 25, 2011, our Board of Directors approved, and on July 27, 2011, we publicly announced a share repurchase program for the repurchase of up to an aggregate of \$200 million of our outstanding common stock from time to time in open market purchases, privately negotiated transactions or through other appropriate means. The timing and quantity of any shares repurchased depends upon a variety of factors, including business conditions, stock market conditions and business development activities, including, but not limited to, merger and acquisition opportunities. These repurchases may be commenced, suspended or discontinued at any time without prior notice.

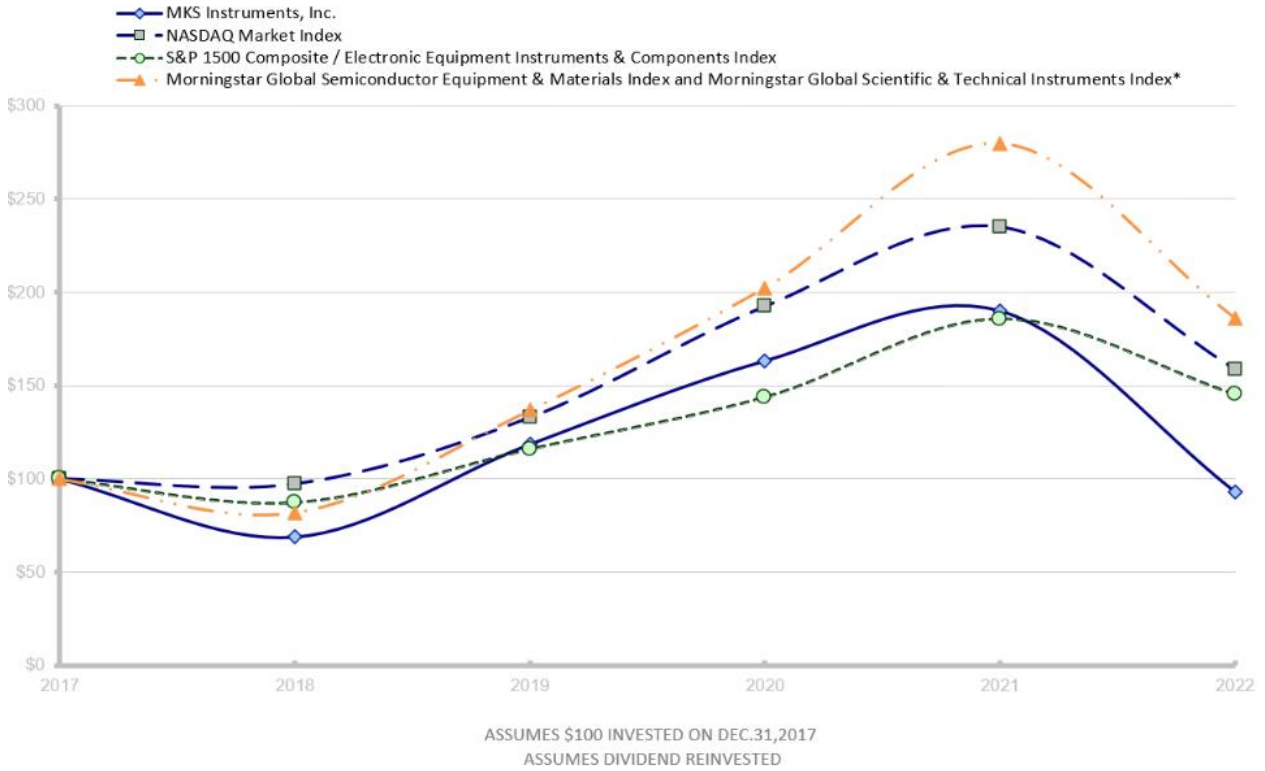
During 2022 and 2021, the Company did not repurchase any shares of common stock. We have repurchased approximately 2.6 million shares of common stock for approximately \$127 million pursuant to the program since its adoption.

Comparative Stock Performance

The following graph compares the cumulative total shareholder return (assuming reinvestment of dividends) from investing \$100 on December 31, 2017, and plotted at the last trading day of each of the fiscal years ended December 31, 2018, 2019, 2020, 2021 and 2022 of MKS' common stock; a peer group index representing all companies comprising the S&P 1500 Composite Electronic Equipment Instruments & Components Index, which we believe more accurately represents the industries we serve following the Atotech Acquisition; and the Nasdaq Market Index. The S&P Composite 1500 Electronic Equipment, Instruments & Components Index replaces the blended peer group indices we included in our Annual Report on Form 10-K for the period ended December 31, 2021, comprised of the Morningstar Global Semiconductor Equipment & Materials Index and Morningstar Global Scientific & Technical Instruments Index, with each index weighted equally. We have included our former blended peer group index in the graph below for comparative purposes. The stock price performance in the graph below is not necessarily indicative of future price performance.

Performance Graph

COMPARISON OF CUMULATIVE TOTAL RETURN



	2017	2018	2019	2020	2021	2022
MKS Instruments, Inc.	\$ 100.00	\$ 68.93	\$ 118.49	\$ 163.16	\$ 189.85	\$ 93.07
Nasdaq Market Index	\$ 100.00	\$ 97.16	\$ 132.81	\$ 192.47	\$ 235.15	\$ 158.65
S&P 1500 Composite / Electronic Equipment, Instruments & Components Index	\$ 100.00	\$ 87.48	\$ 116.05	\$ 143.73	\$ 185.67	\$ 145.24
Morningstar Global Semiconductor Equipment & Materials Index and Morningstar Global Scientific & Technical Instruments Index*	\$ 100.00	\$ 82.04	\$ 136.89	\$ 202.42	\$ 279.81	\$ 186.17

* Morningstar Global Semiconductor Equipment & Materials and Morningstar Global Scientific & Technical Instruments indices weighted equally.

Item 6. Reserved.

Item 7. Management's Discussion and Analysis of Financial Condition and Results of Operations

The Management's Discussion and Analysis of Financial Condition and Results of Operations ("MD&A"), describes principal factors affecting the results of our operations, financial condition, cash flows and liquidity, as well as our critical accounting policies and estimates that require significant judgment and thus have the most significant potential impact on our Consolidated Financial Statements, and is intended to better allow investors to view the Company from management's perspective. This section focuses on material events and uncertainties known to management that are reasonably likely to cause reported financial information not to be necessarily indicative of our future operating results or of our future financial condition. This section provides an analysis of our financial results for the year ended December 31, 2022 compared to the year ended December 31, 2021. For the discussion and analysis covering the year ended December 31, 2021 compared to the year ended December 31, 2020, please refer to "Management's Discussion and Analysis of Financial Condition and Results of Operations" in Part II, Item 7 of our Annual Report on Form 10-K for the year ended December 31, 2021, as filed with the SEC on February 28, 2022.

Overview

We enable technologies that transform our world. We deliver foundational technology solutions to leading edge semiconductor manufacturing, electronics and packaging, and specialty industrial applications. We apply our broad science and engineering capabilities to create instruments, subsystems, systems, process control solutions and specialty chemicals technology that improve process performance, optimize productivity and enable unique innovations for many of the world's leading technology and industrial companies. Our solutions are critical to addressing the challenges of miniaturization and complexity in advanced device manufacturing by enabling increased power, speed, feature enhancement and optimized connectivity. Our solutions are also critical to addressing ever-increasing performance requirements across a wide array of specialty industrial applications.

Recent Events

Atotech Acquisition

On August 17, 2022 (the "Effective Date"), we completed the acquisition of Atotech Limited ("Atotech") through the acquisition of the entire issued share capital of Atotech (the "Atotech Acquisition") by Atotech Manufacturing, Inc. ("Bidco"), a Delaware corporation and indirect wholly owned subsidiary of the Company. The Atotech Acquisition was implemented by means of a scheme of arrangement under the laws of Jersey (the "Scheme") pursuant to the definitive agreement entered into by us and Atotech on July 1, 2021, as amended by the Letter Agreement dated October 29, 2021 by and among us, Atotech and Bidco, and as further amended by the Amendment to the Implementation Agreement dated April 1, 2022 by and among us, Atotech and Bidco (together, the "Implementation Agreement").

Atotech, which we operate as our Materials Solutions Division, develops leading process and manufacturing technologies for advanced surface modification, electroless and electrolytic plating, and surface finishing. Applying a comprehensive systems-and-solutions approach, Atotech's portfolio includes chemistry, equipment, software, and services for innovative and high-technology applications in a wide variety of end markets. Atotech further broadens our capabilities by bringing leadership in critical chemistry solutions for electronics and packaging and specialty industrial applications.

On the Effective Date, pursuant to the Scheme and in accordance with the terms and conditions of the Implementation Agreement, Bidco acquired each issued and outstanding ordinary share of Atotech in exchange for per share consideration of \$16.20 in cash and 0.0552 of a share of Company common stock. The total net purchase price, including cash consideration, net of cash acquired, value of MKS shares issued, repayment of Atotech debt and settlement of certain Atotech share-based awards, totaled \$5.7 billion. We funded the payment of the aggregate cash consideration with a combination of cash on hand and the proceeds from the New Term Loan Facility, as defined below. As a result of the Atotech Acquisition, we issued an aggregate of 10.7 million shares of our common stock to the former Atotech shareholders.

Ransomware Event

On February 3, 2023, we identified that we had become subject to a ransomware event and took immediate action to activate our incident response and business continuity protocols to contain the incident. We took immediate action to contain the incident and engaged appropriate incident response professionals and notified law enforcement authorities. We then initiated the recovery phase, contained the incident, and have since made substantial progress by completing restoration of many of our information technology systems, including our enterprise resource planning systems, and reopening certain of our affected manufacturing and service operations.

Based on our investigation, we concluded ransomware actors encrypted certain of our systems by deploying malware. This incident required us to temporarily suspend operations at certain of our facilities and has had a material impact in the first quarter of 2023 on our ability to process orders, ship products and provide service to our Vacuum Solutions Division and Photonics Solutions Division customers. The incident did not impact the operations of our Materials Solutions Division. We expect this incident will have a negative impact on our revenue for the first quarter of 2023 of at least \$200 million.

We have engaged security specialists to assist in the review, assessment and remediation of our information technologies controls, are strengthening access requirements and unauthorized access detection and are implementing procedures to facilitate more timely restoration of our financial reporting systems.

We have incurred costs in the first quarter of 2023 and expect to continue to incur costs, which may be significant, in connection with this incident. In the first quarter of 2023, these costs have been primarily comprised of various third-party consulting services, including forensic experts, restoration experts, legal counsel, and other information technology and accounting professional expenses, enhancements to our cybersecurity measures, costs to restore our systems and access our data, and employee-related expenses, including with respect to increased overtime. We expect to incur these and other costs related to this incident in the future. As a result of the incident, our relationship with our customers may be negatively impacted and we may be subject to subsequent investigations, claims or actions, in addition to other costs, fines, penalties, or other obligations related to impacted data, whether or not such data is misused. In addition, we are subject to a class action lawsuit arising from this ransomware event. We are unable to predict at this time the potential timing and outcome of the claim and whether we may be subject to further private litigation or inquiries and proceedings by various government agencies, law enforcement and other governmental authorities. For additional information on the risks we face related to this incident and other cybersecurity incidents, refer to “Risk Factors—Risks Related to Cybersecurity, Data Privacy and Intellectual Property Protection” and “Risk Factors—Legal, Tax, Regulatory and Compliance Risks” in Part I, Item 1A of this Annual Report on Form 10-K.

Segments and Markets

In the first quarter of 2022, we updated the names of our then-three divisions in order to simplify our naming convention. These divisions, formerly known as the Vacuum & Analysis Division, the Light & Motion Division and the Equipment & Solutions Division, were renamed the Vacuum Solutions Division (“VSD”), the Photonics Solutions Division (“PSD”) and the Equipment Solutions Division (“ESD”), respectively. Following the Atotech Acquisition, we refer to Atotech as our Materials Solutions Division (“MSD”). During the third quarter of 2022, we consolidated our equipment solutions business, previously ESD, into PSD, with prior periods recast to reflect this change. Our reportable segments now consist of our three divisions: VSD, PSD and MSD.

VSD delivers foundational technology solutions to leading edge semiconductor manufacturing, electronics and packaging and specialty industrial applications. VSD products are derived from our core competencies in pressure measurement and control, flow measurement and control, gas and vapor delivery, gas composition analysis, electronic control technology, reactive gas generation and delivery, power generation and delivery, and vacuum technology.

PSD provides a full range of solutions including lasers, beam measurement and profiling, precision motion control, vibration isolation systems, photonics instruments, temperature sensing, opto-mechanical components, optical elements, laser-based systems for flexible printed circuit board (“PCB”) processing, laser-based systems for high density interconnect PCB and package manufacturing, and high-speed multi-layer ceramic testing.

MSD develops leading process and manufacturing technologies for advanced surface modification, electroless and electrolytic plating, and surface finishing. Atotech is a brand within MSD. Applying a comprehensive systems-and-solutions approach, MSD's portfolio includes chemistry, equipment, software, and services for innovative and high-technology applications in a wide variety of end-markets.

Semiconductor Market

MKS is a critical solutions provider for semiconductor manufacturing. Our products are used in major semiconductor processing steps, such as depositing thin films of material onto silicon wafer substrates, etching, cleaning, lithography, metrology and inspection. The semiconductor industry continually faces new challenges as products become smaller, more powerful and highly mobile. Ultra-thin layers, smaller critical dimensions, new materials, 3D structures, and the ongoing need for higher yield and productivity drive the need for tighter process measurement and control, all of which MKS supports. We believe we are the broadest critical subsystem provider in the wafer fabrication equipment (“WFE”) ecosystem and address over 85% of the market.

Approximately 58% and 62% of our net revenues for 2022 and 2021, respectively, were from sales to customers in the semiconductor market. We estimate global spending on WFE was approximately \$97 billion in 2022 compared to approximately \$89 billion in 2021, driven by increases in memory and logic and reflective of strong secular demand trends increasing semiconductor demand, such as robust data growth, 5G, Internet-of-Things, artificial intelligence, and autonomous vehicles. We anticipate that the semiconductor market will continue to account for a substantial portion of our sales. Following the Atotech Acquisition, our end-market exposure has become more diversified and in the fourth quarter of 2022, revenue from the semiconductor market was 46% of total net revenues.

Net revenues in our semiconductor market increased by \$216 million, or 12%, in 2022, compared to 2021, due to increases in net revenues in VSD and PSD. VSD net revenues in our semiconductor market increased \$114 million due to broad-based increases in demand and volume increases for VSD products. PSD net revenues in our semiconductor market increased \$102 million, driven by demand for our photonics solutions in lithography, metrology and inspection, as well as contributions from our acquisition of Photon Control Inc. (“Photon Control”) in July 2021. Foreign exchange rates had a negative effect of approximately \$82 million on net revenues in our semiconductor market, as the U.S. dollar strengthened against most foreign currencies in 2022.

The semiconductor capital equipment industry is subject to rapid demand shifts, which are difficult to predict, and we cannot be certain as to the timing or extent of future demand or any future weakness in the semiconductor capital equipment industry. We anticipate that our semiconductor market revenue could decrease in 2023 as a result of expected softening in the semiconductor market following three years of significant growth.

In 2022, we experienced continued supply chain disruptions, component shortages and significant price increases for certain components in our semiconductor market due to global capacity constraints compounded by increasing global demand and the COVID-19 pandemic. We expect these disruptions and shortages to continue for at least the near-term.

In October 2022, the U.S. Department of Commerce’s Bureau of Industry and Security (“BIS”) published regulations that introduce new and novel restrictions related to end-uses in semiconductor, semiconductor manufacturing, supercomputer, and advanced computing, along with certain equipment used to develop and produce them (the “New BIS Rules”). The New BIS Rules restrict our direct and indirect sales to China and primarily impact our semiconductor market. As a result of the New BIS Rules, we expect an overall annualized reduction of net revenues in the range of \$250 million to \$350 million. While we continue to adjust our policies and practices to ensure compliance with these regulations, and we will seek to mitigate their impact, there can be no assurances that the New BIS Rules will not have an effect on our business that exceeds our expectations.

Electronics and Packaging

MKS is a foundational solutions provider for the electronics and packaging market. Our portfolio includes photonics components, laser drilling systems, electronics chemistries and plating equipment, that are critical for the manufacturing of PCBs and package substrates, as well as in wafer level packaging (“WLP”) applications. Similar to the semiconductor industry, the PCB, package substrate and WLP industries demand smaller features, greater density, and better performance. We characterize our complementary offering of laser systems and chemistry solutions as Optimize the Interconnect, to reflect the unique technology enablement we provide at the Interconnect level within PCBs, package substrates and WLPs.

In addition, this end-market also includes sales of our vacuum and photonics solutions for display manufacturing applications.

Approximately 15% and 12% of our net revenues for 2022 and 2021, respectively, were from sales to customers in our electronic and packaging market.

Net revenues from customers in our electronics and packaging market increased by \$197 million, or 57%, in 2022 compared to 2021. This increase was driven primarily by the Atotech Acquisition, with MSD net revenues of \$334 million in 2022, mainly from customers in PCB manufacturing. This increase was offset by a decrease of \$134 million in PSD net revenues, in part due to decreased industry demand for flexible PCB via drilling systems as customers have temporarily slowed capacity expansion. In addition, demand for flexible PCB via drilling systems, which are a part of PSD, and demand for chemistry solutions, which are a part of MSD, have softened due to a decline in end market demand for electronics, such as smartphones and personal computers.

In addition, foreign exchange rates had a negative effect of approximately \$14 million on net revenues in our electronics and packaging market, as the dollar strengthened against most foreign currencies in 2022.

Specialty Industrial

MKS' strategy in specialty industrial is to leverage our domain expertise and proprietary technologies across a broad array of applications in industrial technologies, life and health sciences, and research and defense markets.

Industrial Technologies

Industrial technologies encompasses a wide range of diverse applications, including chemistries for functional coatings, surface finishing and wear resistance in the automobile industry, vacuum solutions for synthetic diamond manufacturing and photonics for solar manufacturing. Other applications include, but are not limited to, vacuum and photonics solutions for light emitting diode and laser diode manufacturing.

Life and Health Sciences

Our products for life and health sciences are used in a diverse array of applications, including bioimaging, medical instrument sterilization, medical device manufacturing, analytical, diagnostic and surgical instrumentation, consumable medical supply manufacturing and pharmaceutical production.

Research and Defense

Our products for research and defense are sold to government, university and industrial laboratories for applications involving research and development in materials science, physical chemistry, photonics, optics and electronics materials. Our products are also sold for monitoring and defense applications, including surveillance, imaging and infrastructure protection.

Approximately 27% and 26% of our net revenues for 2022 and 2021, respectively, were from customers in our specialty industrial market.

Net revenues from customers in our specialty industrial market increased by \$184 million, or 24%, in 2022, compared to 2021. This increase was driven primarily by the Atotech Acquisition with MSD net revenues of \$183 million in 2022. Though demand across our specialty industrial market remained relatively stable, our general metal finishing business, which is part of MSD, continues to be impacted by supply chain constraints in the automotive market. Foreign exchange rates had a negative effect of approximately \$31 million on net revenues in our specialty industrial market, as the U.S. dollar strengthened against most foreign currencies in 2022.

International Markets

A significant portion of our net revenues is from sales to customers in international markets. International net revenues accounted for approximately 58% and 57% of our total net revenues in 2022 and 2021, respectively. A significant portion of our international net revenues was from customers in China, Germany and South Korea. We expect that international revenues will continue to account for a significant percentage of total net revenues for the foreseeable future as a result of the Atotech Acquisition. Long-lived assets located outside of the United States accounted for approximately 57% and 28% of our total long-lived assets at December 31, 2022 and 2021, respectively. The increase as of December 31, 2022, compared to December 31, 2021, primarily related to the Atotech Acquisition. Long-lived assets include, property, plant and equipment, net, right-of-use assets, and certain other assets and exclude goodwill, intangible assets and long-term tax-related accounts.

Critical Accounting Policies and Estimates

MD&A discusses our Consolidated Financial Statements, which have been prepared in accordance with accounting principles generally accepted in the United States ("U.S. GAAP"). The preparation of these financial statements requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities and the disclosure of contingent liabilities at the date of the financial statements and the reported amounts of revenues and expenses during the reporting period. On an ongoing basis, we evaluate our estimates and judgments, including those related to revenue recognition, inventory, warranty costs, pension plan valuations, stock-based compensation expense, intangible assets, goodwill and other long-lived assets and income taxes. We base our estimates and judgments on historical experience and on various other factors that are believed to be reasonable under the circumstances, the results of which form the basis for making judgments about the carrying values of

assets and liabilities that are not readily apparent from other sources. Actual results may differ from these estimates under different assumptions or conditions.

We believe the following critical accounting policies affect the most significant judgments, assumptions and estimates we use in preparing our Consolidated Financial Statements:

Revenue Recognition. We account for revenue using Accounting Standards Codification 606, “Revenue from Contracts with Customers” (“ASC Topic 606”). We apply ASC Topic 606 using the following steps:

- Identify the contract with a customer
- Identify the performance obligations in the contract
- Determine the transaction price
- Allocate the transaction price to performance obligations in the contract
- Recognize revenue when or as we satisfy a performance obligation

Revenue is recognized when or as obligations under the terms of a contract with our customer has been satisfied and control has transferred to the customer. The majority of our performance obligations, and associated revenue, are transferred to customers at a point in time, generally upon shipment of a product to the customer or receipt of the product by the customer and without significant judgments. We recognize revenue over time for contracts relating to the manufacturing, modifications and retrofits of our plating equipment, as the equipment is built to customer specification, and we have an enforceable right to payment for the performance completed to date. For these sales, we use the cost-to-cost input method to measure progress. In cases, where cost-to-cost is not proportionate to our progress in satisfying the performance obligation because of uninstalled materials, we adjust the measure of progress and recognize revenue to the extent of cost incurred to satisfy the performance obligation under the contract. Revenue from customized products with no alternative future use to us, and that have an enforceable right to payment for performance completed to date, are also recorded over time. We consider this to be a faithful depiction of the transfer to the customer of revenue over time as the work is performed or service is delivered. Adjustments for custom products were not material for 2022 or 2021.

Installation services, other than those related to our plating equipment, are not significant, are usually completed in a short period of time and, therefore, are recorded at a point in time when the installation services are completed, rather than over time, as they are not material. Extended warranty, service contracts, and repair services, which are transferred to the customer over time, are recorded as revenue as the services are performed. For repair services, we make an accrual at each quarter end based upon historical repair times within our product groups to record revenue based upon the estimated number of days completed to date, which is consistent with ratable recognition.

Revenue is measured as the amount of consideration we expect to receive in exchange for transferring goods or providing services. Performance obligations promised in a contract are identified based on the products or services that will be transferred to the customer that are both capable of being distinct, whereby the customer can benefit from the product or service either on its own or together with other resources that are readily available from third parties or from us, and are distinct in the context of the contract, whereby the transfer of the product or service is separately identifiable from other promises in the contract. Sales, value add, and other taxes we collect concurrent with revenue-producing activities are excluded from revenue. Our normal payment terms are 30 to 60 days but vary by the type and location of our customers and the products or services offered. The time between invoicing and when payment is due is not significant. For certain products and services and customer types, we require payment before the products or services are delivered to, or performed for, the customer. None of our contracts in each of the periods presented contained a significant financing component.

We periodically enter into contracts with our customers in which a customer may purchase a combination of goods and or services, such as products with installation services or extended warranties. These contracts include multiple deliverables that we evaluate to determine if the deliverables are separate performance obligations. Once we determine the performance obligations, we then determine the transaction price, which includes estimating the amount of variable consideration to be included in the transaction price, if any. To the extent the transaction price includes variable consideration, we estimate the amount of variable consideration that should be included in the transaction price utilizing either the expected value method or the most likely amount method, depending on the method we expect to better predict the amount of consideration to which we will be entitled. There are no constraints on the variable consideration recorded. We then allocate the transaction price to each performance obligation in the contract based on a relative stand-alone selling price charged separately to customers or using an expected cost-plus margin method. The corresponding revenues are recognized when or as the related performance obligations are satisfied, which are noted above. The impact of variable consideration was immaterial in each of the periods presented.

We sell separately priced service contracts and extended warranty contracts related to certain of our products, in particular related to our plating and laser-based products. These separately priced contracts generally range from 12 to 60 months. We

recognize revenue over the term of the contract in proportion to the costs expected to be incurred in satisfying the obligations under the contract.

We monitor and track the amount of product returns, provide for sales return allowances and reduce revenue at the time of shipment for the estimated amount of such future returns, based on historical experience. While product returns have historically been within our expectations and established provisions, there is no assurance that we will continue to experience the same return rates that we have in the past. Any significant increase in product return rates could have a material adverse impact on our operating results for the period in which such returns materialize.

While we maintain a credit approval process, significant judgments are made by management in connection with assessing our customers' ability to pay at the time of shipment. Despite this assessment, from time to time, our customers are unable to meet their payment obligations. We continuously monitor our customers' creditworthiness and use our judgment in establishing a provision for estimated credit losses based upon our historical experience and any specific customer collection issues that we have identified. While such credit losses have historically been within our expectations and the provisions established, there is no assurance that we will continue to experience the same credit loss rates that we have in the past. A significant change in the liquidity or financial position of our customers could have a material adverse impact on the collectability of accounts receivable and our future operating results. Bad debt expense was immaterial in 2022 and 2021.

Inventory. We value our inventory at the lower of cost or net realizable value, cost being determined using a standard costing system that approximates actual costs, based on a first-in, first-out method. We regularly review inventory quantities on hand and record a provision to write-down excess and obsolete inventory to its estimated net realizable value, if less than cost, based primarily on our estimated forecast of product demand. Once our inventory value is written-down and a new cost basis has been established, the inventory value is not increased due to demand increases. Demand for our products can fluctuate significantly. A significant increase in the demand for our products could result in a short-term increase in the cost of inventory purchases as a result of supply shortages or a decrease in the cost of inventory purchases as a result of volume discounts, while a significant decrease in demand could result in an increase in the charges for excess inventory quantities on hand. In addition, our industry is subject to technological change, new product development and product technological obsolescence that could result in an increase in the amount of obsolete inventory quantities on hand. Therefore, any significant unanticipated changes in demand or technological developments could have a significant impact on the value of our inventory and our reported operating results. Excess and obsolete expense was \$21 million and \$16 million for 2022 and 2021, respectively.

Warranty Costs. We provide for the estimated costs to fulfill customer warranty obligations upon the recognition of the related revenue. We provide warranty coverage for our products for periods ranging from 12 to 36 months, with the majority of our products for periods ranging from 12 to 24 months. Short-term accrued warranty obligations, which expire within one year, are included in other current liabilities and long-term accrued warranty obligations are included in other liabilities in the consolidated balance sheets. We estimate the anticipated costs of repairing our products under such warranties based on the historical costs of the repairs and any known specific product issues. The assumptions we use to estimate warranty accruals are re-evaluated periodically in light of actual experience and, when appropriate, the accruals are adjusted. Our determination of the appropriate level of warranty accrual is based upon estimates. Should product failure rates differ from our estimates, actual costs could vary significantly from our expectations. Defective products will be either repaired or replaced, generally at our option, upon meeting certain criteria.

Pension Plans. Several of our non-U.S. subsidiaries have defined benefit pension plans covering employees of those subsidiaries. Some of the plans are unfunded, as permitted under the plans and applicable laws. For financial reporting purposes, we obtained actuarial reports supporting the calculation of net periodic pension costs that used a number of actuarial assumptions, including a discount rate for plan obligations, an assumed rate of return on pension plan assets and an assumed rate of compensation increase for employees covered by the various plans. We reviewed these actuarial assumptions and concluded they were reasonable based upon our judgment, considering known trends and uncertainties. Actual results that differ from these assumptions would impact future expense recognition and the cash funding requirements of our pension plans.

Stock-Based Compensation Expense. We record compensation expense for all stock-based compensation awards to employees and directors based upon the estimated fair market value of the underlying instrument. Accordingly, stock-based compensation cost is measured at the grant date, based upon the fair value of the award.

We typically issue restricted stock units ("RSUs") as stock-based compensation. We also provide certain employees the opportunity to purchase our shares through an Employee Stock Purchase Plan ("ESPP"). For RSUs, the fair value is the closing market price of the stock on the date of grant. We estimate the fair value of shares issued under our ESPP using the Black-Scholes pricing model, which incorporates a number of complex and subjective variables, including expected stock price volatility over the term of the awards, expected life, risk free interest rate and expected dividends. Management determined that blended stock-based compensation, a combination of historical and implied volatility, is more reflective of market conditions and a better indicator of expected volatility than historical or implied volatility alone.

Certain RSUs involve stock to be issued upon the achievement of performance conditions (“performance shares”) under our stock incentive plan. Such performance shares become available, subject to time-based vesting conditions if, and to the extent that, financial performance criteria for the applicable period are achieved. Accordingly, the number of performance shares earned will vary based on the level of achievement of financial performance objectives for the applicable period. Until such time that our financial performance can ultimately be determined, each quarter we estimate the number of performance shares to be earned based on an evaluation of the probability of achieving the financial performance objectives. Such estimates are revised, if necessary, in subsequent periods when the underlying factors change our evaluation of the probability of achieving the financial performance objectives. Accordingly, share-based compensation expense associated with performance shares may differ significantly from the amount recorded in the current period.

The assumptions used in calculating the fair value of share-based compensation awards represents management’s best estimates, but these estimates involve inherent uncertainties and the application of management’s judgment. As a result, if factors change and we use different assumptions, our stock-based compensation expense could be materially different in the future.

Intangible Assets, Goodwill and Other Long-Lived Assets. As a result of our acquisitions, we have identified intangible assets and generated significant goodwill. Definite-lived intangible assets are valued based on estimates of future cash flows and amortized over their estimated useful life. Determining fair value requires the exercise of significant judgment, including assumptions about appropriate discount rates as well as forecasted revenue, gross profit and operating expenses.

Goodwill and indefinite-lived intangible assets are subject to annual impairment testing as well as testing upon the occurrence of any event that indicates a potential impairment. Intangible assets and other long-lived assets are also subject to an impairment test if there is an indicator of impairment. If our expectations of future results and cash flows are significantly diminished, intangible assets and goodwill may be impaired and the resulting charge to operations may be material. When we determine that the carrying value of intangibles or other long-lived assets may not be recoverable based upon the existence of one or more indicators of impairment, we use the projected undiscounted cash flow method to determine whether an impairment exists, and then measure the impairment using discounted cash flows. To measure impairment for goodwill, we compare the fair value of our reporting units by measuring discounted cash flows to the book value of the reporting units. Goodwill would be impaired if the resulting implied fair value was less than the recorded book value of the goodwill.

The estimation of useful lives and expected cash flows require us to make significant judgments regarding future periods that are subject to some factors outside of our control. Changes in these estimates can result in significant revisions to the carrying value of these assets and may result in material charges to the results of operations.

We have elected to perform our annual goodwill impairment test as of October 31 of each year, or more often if events or circumstances indicate that there may be impairment. Goodwill is the amount by which the cost of acquired net assets exceeded the fair value of those net assets on the date of acquisition. We allocate goodwill to reporting units at the time of acquisition or when there is a change in the reporting structure and base that allocation on which reporting units will benefit from the acquired assets and liabilities. Reporting units are defined as operating segments or one level below an operating segment, referred to as a component. The estimated fair value of our reporting units was based on discounted cash flow models derived from internal earnings and internal and external market forecasts. Determining fair value requires the exercise of significant judgment, including assumptions about appropriate discount and perpetual growth rates, as well as forecasted revenue growth rates and gross profit and operating expenses. Discount rates are based on a weighted average cost of capital (“WACC”), which represents the average rate a business must pay its providers of debt and equity. The WACC used to test goodwill is derived from a group of comparable companies. Assumptions in estimating future cash flows are subject to a high degree of judgment and complexity. We make every effort to forecast these future cash flows as accurately as possible with the information available at the time the forecast is developed.

During the quarter ended June 30, 2022, following softening industry demand for flexible PCB via drilling equipment and declines in projected operating results for the equipment solutions business (“ESB”) reporting unit, we evaluated the carrying values of goodwill, purchased intangible assets and other long-lived assets assigned to ESB and determined the carrying values were recoverable. We performed our analysis using the income approach and key underlying assumptions included forecasted revenue, gross profit and operating expenses as well as discount rate. Fair value estimates are based on complex series of judgments about future events and uncertainties and rely heavily on estimates and assumptions that we have been deemed reasonable. There are inherent uncertainties and management judgment required in these determinations. In our quantitative assessment of ESB, we estimated the fair value exceeded carrying value by 10%. There were no other triggering events that required an impairment assessment in 2022.

In performing our annual goodwill impairment test, we are permitted to first assess qualitative factors to determine whether it is more likely than not that the fair value of our reporting unit is less than its carrying amount, including goodwill. In performing the qualitative assessment, we consider certain events and circumstances specific to the reporting unit and to the entity as a whole, such as macroeconomic conditions, industry and market considerations, overall financial performance and cost factors when evaluating whether it is more likely than not that the fair value of the reporting unit is less than its carrying amount. We are also

permitted to bypass the qualitative assessment and proceed directly to the quantitative test. If we choose to undertake the qualitative assessment and we conclude that it is more likely than not that the fair value of the reporting unit is less than its carrying amount, we would then proceed to the quantitative impairment test. In the quantitative assessment, we compare the fair value of the reporting unit to its carrying amount, which includes goodwill. If the fair value exceeds the carrying value, no impairment loss exists. If the fair value is less than the carrying amount, a goodwill impairment loss is measured and recorded.

As of October 31, 2022, we performed our annual impairment assessment of goodwill using a qualitative assessment for all of our reporting units. We determined that it was more likely than not that the fair values were more than the carrying values for each of the reporting units.

We will continue to monitor and evaluate the carrying value of goodwill. If market and economic conditions or business performance deteriorate, this could increase the likelihood of us recording an impairment charge.

Income Taxes. We evaluate the realizability of our net deferred tax assets and assess the need for a valuation allowance on a quarterly basis. The future benefit to be derived from our deferred tax assets is dependent upon our ability to generate sufficient future taxable income in each jurisdiction of the right type to realize the assets. We record a valuation allowance to reduce our net deferred tax assets to the amount that is expected to be realized. To the extent we establish a valuation allowance an expense is recorded within the provision for income taxes line in the consolidated statements of operations and comprehensive income.

Accounting for income taxes requires a two-step approach to recognize and measure uncertain tax positions. The first step is to evaluate the tax position for recognition by determining if, based on the technical merits, it is more likely than not that the position will be sustained upon audit, including resolutions of related appeals or litigation processes, if any. The second step is to measure the tax benefit as the largest amount that is more than 50% likely of being realized upon ultimate settlement. We re-evaluate these uncertain tax positions on a quarterly basis. This evaluation is based on factors including, but not limited to, changes in facts or circumstances, changes in tax law, effectively settled issues under audit and new audit activity. Any change in these factors could result in the recognition of a tax benefit or an additional charge to the tax provision.

Derivatives. As a result of our global operating activities and variable interest rate borrowings, we are exposed to market risks from changes in foreign currency exchange rates and interest rates, which may adversely affect our operating results and financial position. We enter into derivative instruments for risk management purposes only, including derivatives designated as hedging instruments and those utilized as economic hedges. We do not enter into derivative instruments for trading or speculative purposes.

We have used derivative instruments, such as foreign exchange forward contracts and options, to manage certain foreign currency exposure, and interest rate swaps and interest rate caps to manage interest rate exposure. Changes in fair value of derivative instruments are recognized in the consolidated statement of operations or, if hedge accounting is applied, in other comprehensive income for the effective portion of the changes in fair value. The cash flows resulting from foreign exchange forward contracts are classified in the consolidated statements of cash flows as part of cash flows from operating activities. All derivatives are stated at fair value in the balance sheet.

Accounting principles for qualifying hedges require detailed documentation that describes the relationship between the hedging instrument and the hedged item, including, but not limited to, the risk management objectives and hedging strategy and the methods to assess the effectiveness of the hedging relationship. We assess the hedging relationships, both at the inception of the hedge and on an ongoing basis, using either the critical terms matching approach or a regression analysis approach to determine whether the designated hedging instrument is highly effective in offsetting changes in the value of the hedged item.

By nature, all financial instruments involve market and credit risks. We enter into derivative instruments with major investment grade financial institutions, for which no collateral is required. We have policies to monitor the credit risk of these counterparties. While there can be no assurance, we do not anticipate any material non-performance by any of these counterparties.

Results of Operations

The following table sets forth, for the periods indicated, the percentage of total net revenues of certain line items included in our consolidated statements of operations and comprehensive income data:

	Years Ended December 31,	
	2022	2021
Net revenues:		
Products	87.9%	87.4%
Services	12.1	12.6
Total net revenues	100.0	100.0
Cost of revenues:		
Products	50.0	46.5
Services	6.4	6.7
Total cost of revenues (exclusive of amortization shown separately below)	56.4	53.2
Gross profit	43.6	46.8
Research and development	6.8	6.8
Selling, general and administrative	13.7	13.1
Acquisition and integration costs	1.5	1.0
Restructuring and other	0.3	0.4
Amortization of intangible assets	4.1	1.9
Gain on sale of long-lived assets	(0.2)	—
Income from operations	17.4	23.7
Interest income	(0.1)	—
Interest expense	5.0	0.8
Other expense, net	0.3	0.3
Income before income taxes	12.1	22.5
Provision for income taxes	2.7	3.9
Net income	9.4%	18.7%

Year Ended December 31, 2022 compared to 2021

Net Revenues

<i>(Dollars in millions)</i>	Years Ended December 31,	
	2022	2021
Products	\$ 3,119	\$ 2,579
Services	428	371
Total net revenues	\$ 3,547	\$ 2,950

Net product revenues increased \$540 million in 2022, compared to 2021, primarily due to the Atotech Acquisition with MSD net product revenues of \$486 million in 2022. Additional increases were primarily due to volume increases in sales to our semiconductor market in VSD and PSD, partially offset by decreases in sales to our electronics and packaging market, primarily in PSD due to decreased industry demand for flexible PCB via drilling systems and other products for the consumer electronics markets.

Net service revenues consisted mainly of fees for services related to the maintenance and repair of our products, sales of spare parts, and installation and training. Net service revenues increased \$57 million in 2022, compared to 2021, primarily due to the Atotech Acquisition with MSD net service revenues of \$31 million in 2022. Additional increases were primarily due to increases in VSD and PSD from increases in sales to our semiconductor and electronics and packaging markets.

Total international net revenues, including product and service, were \$2.1 billion in 2022, compared to \$1.7 billion in 2021. The increase in 2022 was primarily driven by the Atotech Acquisition. The increase in international net revenues was primarily from increases in sales to customers in China, Germany, Israel and Japan.

The following table sets forth our net revenues by reportable segment:

Net Revenues

<i>(Dollars in millions)</i>	Years Ended December 31,	
	2022	2021
Vacuum Solutions Division	\$ 1,966	\$ 1,862
Photonics Solutions Division	1,064	1,088
Materials Solutions Division	517	—
Total net revenues	<u>\$ 3,547</u>	<u>\$ 2,950</u>

Net revenues for our VSD segment increased \$104 million in 2022, compared to 2021, primarily due to volume increases in the semiconductor market.

Net revenues for our PSD segment decreased \$24 million in 2022, compared to 2021, primarily due to decreases in our electronics and packaging market resulting from decreased industry demand for flexible PCB via drilling systems and other products for the consumer electronics market, offset by volume increases in the semiconductor market.

Net revenues for our MSD segment in 2022 consist of revenues from the Atotech Acquisition.

The following table sets forth gross profit as a percentage of net revenues by product and service:

Gross Profit

<i>(As a percentage of net revenues)</i>	Years Ended December 31,		% Points Change
	2022	2021	
Products	43.1 %	46.8 %	(3.7)%
Services	47.4	46.5	0.9
Total gross profit percentage	<u>43.6 %</u>	<u>46.8 %</u>	<u>(3.2)%</u>

Gross profit as a percentage of net product revenues decreased by 3.7 percentage points in 2022, compared to 2021, primarily due to higher materials costs reflective of global component shortages, higher logistics costs and unfavorable overhead absorption arising from the effect of component shortages on manufacturing efficiencies. Additionally, as a result of the Atotech Acquisition, we incurred a \$52 million step-up to fair value adjustment on acquired inventory, which was fully amortized during the year ended December 31, 2022 and negatively impacted our gross margin. These decreases were partially offset by higher revenue volumes and favorable product mix.

Gross profit as a percentage of net service revenues increased by 0.9 percentage points in 2022, compared to 2021, which was reflective of our efforts to transition customers to higher-value offerings, such as service contracts, and the mix of products serviced. The increase was partially offset by unfavorable overhead efficiency on service-related parts.

The following table sets forth gross profit as a percentage of net revenues by reportable segment:

Gross Profit

<i>(As a percentage of net revenues)</i>	Years Ended December 31,		% Points Change
	2022	2021	
Vacuum Solutions Division	43.5 %	46.6 %	(3.1)%
Photonics Solutions Division	46.9	47.1	(0.2)
Materials Solutions Division	37.1	—	37.1
Total gross profit percentage	<u>43.6 %</u>	<u>46.8 %</u>	<u>(3.2)%</u>

Gross profit as a percentage of net revenues for our VSD segment decreased primarily due to higher material costs reflective of global component shortages, higher logistics costs and unfavorable absorption. These decreases were partially offset by favorable product mix and higher revenue volumes.

Gross profit as a percentage of net revenues for our PSD segment decreased primarily due to higher material costs reflective of global component shortages, higher logistics costs and unfavorable absorption. These decreases were partially offset by favorable product mix.

Gross profit as a percentage of net revenues for our MSD segment was 37.1% for the year ended December 31, 2022 and included a charge of \$52 million of inventory step-up amortization related to the Atotech Acquisition.

Research and Development

<i>(Dollars in millions)</i>	Years Ended December 31,	
	2022	2021
Research and development	\$ 241	\$ 200

Research and development expenses increased \$41 million in 2022, compared to 2021, primarily due to an increase of \$31 million resulting from the Atotech Acquisition. The remaining increase of \$10 million was primarily due to increases of \$6 million in compensation-related costs, \$2 million in project materials and \$2 million in occupancy costs.

Our research and development efforts are primarily focused on developing and improving our instruments, components, chemistry, subsystems, systems and process control solutions to improve process performance and productivity. We have thousands of products, and our research and development efforts primarily consist of a large number of projects related to these products, none of which is individually material to us. Projects typically have a duration of 3 to 36 months but may be extended for development of new products.

We continue to make product advancements to meet our customers' evolving needs. We have developed, and continue to develop, new products to address industry trends, such as the shrinking of integrated circuit critical dimensions and technology inflections, and, in the flat panel display and solar markets, the transition to larger substrate sizes, which require more advanced processing and process control technology, the continuing drive toward more complex and accurate components and devices within the handset and tablet market, the transition to 5G for both devices and infrastructure, the growth in units and via counts in the high density interconnect PCB drilling market, and the industry transition to electric cars in the automotive market. In addition, we have developed, and continue to develop, products that support the migration to new classes of materials, ultra-thin layers, and 3D structures that are used in small geometry manufacturing. In our chemistry and equipment plating businesses, a majority of our research and development investment supports existing customers' product improvement needs and their short-term research and development goals, which enables us to pioneer new high-value solutions while limiting commercial risk. Research and development expenses consist primarily of salaries and related expenses for personnel engaged in research and development, fees paid to consultants, material costs for prototypes and other expenses related to the design, development, testing and enhancement of our products.

We believe that the continued investment in research and development and ongoing development of new products are essential to the expansion of our markets. We expect to continue to make significant investment in research and development activities. We are subject to risks from products not being developed in a timely manner, as well as from rapidly changing customer requirements and competitive threats from other companies and technologies. Our success primarily depends on our products being designed into new generations of equipment for the semiconductor, electronics and packaging, and specialty industrial markets. We develop products that are technologically advanced so that they are positioned to be chosen for use in each successive generation of semiconductor capital equipment and advanced markets applications. If our products are not chosen to be designed into our customers' products, our net revenues may be reduced during the lifespan of those products.

Selling, General and Administrative

<i>(Dollars in millions)</i>	Years Ended December 31,	
	2022	2021
Selling, general and administrative	\$ 488	\$ 385

Selling, general and administrative expenses increased \$103 million during 2022, compared to 2021, primarily due to an increase of \$101 million resulting from the Atotech Acquisition. Excluding the Atotech Acquisition, VSD and PSD selling, general and administrative expenses increased by \$2 million primarily due to \$2 million in information technology costs and \$2 million in travel related expenses offset by a decrease of \$2 million in compensation related costs.

Acquisition and Integration Costs

<i>(Dollars in millions)</i>	Years Ended December 31,	
	2022	2021
Acquisition and integration costs	\$ 52	\$ 30

Acquisition and integration costs incurred during 2022 were primarily related to consulting and professional fees related to the Atotech Acquisition. Acquisition and integration costs incurred during 2021 primarily related to consulting and professional fees in connection with our acquisition of Photon Control, our then-pending Atotech Acquisition and a proposed acquisition that was not consummated.

Restructuring and Other

<i>(Dollars in millions)</i>	Years Ended December 31,	
	2022	2021
Restructuring and other	\$ 10	\$ 11

Restructuring and other costs incurred in 2022 primarily related to executive payments related to the Atotech Acquisition, severance costs due to a global cost-saving initiative, the closure of two facilities in Europe and movement of certain products to low-cost regions. Restructuring and other costs incurred in 2021 primarily related to duplicate facility costs attributed to entering into new facility leases, severance costs due to a global cost-saving initiative, costs related to the closure of two facilities in Europe and the movement of certain products to low-cost regions.

Amortization of Intangible Assets

<i>(Dollars in millions)</i>	Years Ended December 31,	
	2022	2021
Amortization of intangible assets	\$ 146	\$ 55

Amortization of intangible assets increased \$91 million in 2022, compared to 2021, due primarily to amortization of intangible assets from the Atotech Acquisition.

Gain on Sale of Long-Lived Assets

<i>(Dollars in millions)</i>	Years Ended December 31,	
	2022	2021
Gain on sale of long-lived assets	\$ (7)	\$ —

We recorded a gain from the sale of a minority interest investment in a private company in 2022.

Interest Expense, Net

<i>(Dollars in millions)</i>	Years Ended December 31,	
	2022	2021
Interest expense, net	\$ 173	\$ 25

Interest expense, net, increased by \$148 million in 2022, compared to 2021, primarily due to borrowings on the New Term Loan Facility we entered into in connection with the Atotech Acquisition.

Other Expense, Net

<i>(Dollars in millions)</i>	Years Ended December 31,	
	2022	2021
Other expense, net	\$ 11	\$ 9

Other expense, net, for 2022 and 2021 primarily related to changes in foreign exchange rates.

Provision for Income Taxes

<i>(Dollars in millions)</i>	Years Ended December 31,	
	2022	2021
Provision for income taxes	\$ 100	\$ 114

Our effective tax rates for 2022 and 2021 were 23.1% and 17.1%, respectively. Our effective tax rate for 2022 was higher than the U.S. statutory tax rate, mainly due to additional withholding taxes related to the change of indefinite reinvestment assertion, the U.S. global intangible low-taxed income (“GILTI”) inclusion, offset by the U.S. deduction for foreign derived intangible income (“FDII”) and the geographic mix of income earned by our international subsidiaries being taxed at rates lower than the U.S. statutory tax rate.

Our effective tax rate for 2021 was lower than the U.S. statutory tax rate, mainly due to the geographic mix of income earned by our international subsidiaries being taxed at rates lower than the U.S. statutory tax rate, the U.S. deduction for FDII and research credits offset by the tax effects of non-deductible executive compensation and the GILTI inclusion.

As of December 31, 2022, total gross unrecognized tax benefits, which excludes interest and penalties, was \$83 million. As of December 31, 2021, total gross unrecognized tax benefits, which excludes interest and penalties, was \$43 million. The net increase was primarily attributable to the addition of historical gross unrecognized tax benefits as a result of the Atotech Acquisition.

We accrue interest and, if applicable, penalties for any uncertain tax positions. Interest and penalties are classified as a component of income tax expense. As of December 31, 2022 and 2021, we accrued interest on unrecognized tax benefits of approximately \$6 million and \$1 million, respectively.

Over the next 12 months, it is reasonably possible that we may recognize approximately \$3 million of previously net unrecognized tax benefits, excluding interest and penalties, related to various U.S. federal, state and foreign tax positions, primarily due to the expiration of statutes of limitations.

We are subject to examination by U.S. federal, state and foreign tax authorities. The U.S. federal statute of limitations remains open for tax years 2018 through the present. The statute of limitations for our tax filings in other jurisdictions varies between fiscal years 2015 through the present. We also have certain federal credit carryforwards and state tax loss and credit carryforwards that are open to examination for tax years 2002 through the present. In addition, the 2017 transition tax remains open for examination.

In 2022, we recorded a net benefit to income tax expense of \$4 million, due to the closure of a tax audit and expiration of certain statutes of limitations. In 2021, we recorded a net benefit to income tax expense of \$4 million, excluding interest and penalties, due to reserve releases related to the expiration of certain statutes of limitations for previously open tax years.

Our future effective tax rate depends on various factors, including the impact of tax legislation, further interpretations and guidance from U.S. federal and state governments on the impact of proposed regulations issued by the IRS, as well as the geographic composition of our pre-tax income and changes in income tax reserves for unrecognized tax benefits. The Organisation for Economic Co-operation and Development (“OECD”) Pillar Two Model Rules (Pillar Two) for a global 15% minimum tax are in the process of being adopted by a number of jurisdictions in which we operate. Pillar Two may materially increase our future effective tax rate. We cannot be certain regarding the amount of the effective tax rate increase until all jurisdictions in which we operate adopt legislation and implement a version of Pillar Two. We monitor these factors and timely adjust our estimates of the effective tax rate accordingly. We expect the geographic mix of pre-tax income will continue to have a favorable impact on our effective tax rate. However, the geographic mix of pre-tax income can change based on multiple factors including the Atotech Acquisition, resulting in changes to the effective tax rate in future periods. While we believe we have adequately provided for all tax positions, amounts asserted by taxing authorities could materially differ from our accrued positions as a result of uncertain and complex application of tax law and regulations. Additionally, the recognition and measurement of certain tax benefits include estimates and judgment by management. Accordingly, we could record additional provisions or benefits for U.S. federal, state, and foreign tax matters in future periods as new information becomes available.

Liquidity and Capital Resources

Cash, cash equivalents and short-term marketable investments at December 31, 2022 and December 31, 2021 totaled \$910 million and \$1.0 billion, respectively. The decrease primarily related to the use of cash to fund the payment of a portion of the purchase price for the Atotech Acquisition. The primary driver in our current and anticipated future cash flows is, and we expect will continue to be, cash generated from operations, consisting primarily of our net income, excluding non-cash charges and changes in operating assets and liabilities.

Our total cash and cash equivalents and short-term marketable investments at December 31, 2022 consisted of \$173 million held in the United States and \$737 million held by our foreign subsidiaries. We believe that our current cash and investments position and available borrowing capacity, together with the cash anticipated to be generated from our operations, will be sufficient to satisfy our estimated working capital, planned capital expenditure requirements, payments of debt, and any future cash dividends declared by our Board of Directors or share repurchases through at least the next 12 months and the foreseeable future.

In periods when our sales are growing, higher sales to customers will result in increased trade receivables, and inventories will generally increase as we build products for future sales. This may result in lower cash generated from operations. Conversely, in periods when our sales are declining, our trade accounts receivable and inventory balances will generally decrease, resulting in increased cash from operations.

Net cash provided by operating activities was \$529 million for 2022 and resulted from net income of \$333 million, which included non-cash charges of \$353 million, offset by a net increase in working capital of \$157 million. The net increase in working capital was primarily due to increases in inventory of \$236 million, as a result of increased business levels, and a decrease of \$31 million in accrued compensation, resulting from the payment of variable compensation. These increases in working capital were partially offset by a decrease in other current and non-current assets of \$28 million, an increase in accounts payable of \$61 million and an increase in income taxes payable of \$19 million.

Net cash provided by operating activities was \$640 million for 2021 and resulted from net income of \$551 million, which included non-cash net charges of \$161 million, offset by an increase in working capital of \$72 million. The increase in working capital consisted of an increase in inventories of \$92 million and an increase in trade accounts receivable of \$53 million, both of which were the result of increased business levels, offset by an increase in accounts payable of \$56 million from increased business levels and an increase in current and non-current accrued compensation of \$17 million.

Net cash used in investing activities was \$4.6 billion for 2022, primarily due to \$4.5 billion used for the Atotech Acquisition, net of cash and cash equivalents acquired, and \$164 million in capital expenditures, partially offset by \$76 million in net maturities of investments.

Net cash used in investing activities was \$205 million for 2021, reflecting the purchase of Photon Control for \$268 million, net of cash and cash equivalents acquired, and \$87 million in capital expenditures, primarily for production-related equipment, offset by the net sales of short-term investments of \$150 million.

Net cash provided by financing activities was \$4.0 billion for 2022, primarily due to \$5.0 billion in net proceeds from our New Term Loan Facility offset by \$962 million of payments on borrowings, primarily related to payment of the Prior Term Loan Facility (as defined below), a \$100 million optional pre-payment and \$22 million regularly scheduled payment on the New Term Loan Facility and \$52 million in dividend payments.

Net cash used in financing activities was \$65 million for 2021, primarily due to dividend payments of \$47 million and net payments of short and long-term borrowings of \$15 million.

For the year ended December 31, 2022, we paid cash dividends of \$52 million in the aggregate or \$0.88 per share. For the year ended December 31, 2021, we paid cash dividends of \$47 million in the aggregate or \$0.86 per share. Future dividend declarations, if any, as well as the record and payment dates for such dividends, are subject to the final determination of our Board of Directors. Holders of our common stock are entitled to receive dividends when and if they are declared by our Board of Directors. Under the terms of our New Term Loan Facility and New Revolving Facility, each as defined and described further below, we may be restricted from paying dividends under certain circumstances.

On February 6, 2023, our Board of Directors declared a quarterly cash dividend of \$0.22 per share that was paid on March 10, 2023 to shareholders of record as of February 27, 2023.

Atotech Acquisition

On August 17, 2022, we completed the Atotech Acquisition. The total net purchase price, including cash consideration, net of cash acquired, value of MKS shares issued, repayment of Atotech debt and settlement of share-based awards totaled \$5.7 billion. We funded the payment of the aggregate cash consideration with a combination of cash on hand and the proceeds from the New Term Loan Facility, as defined below. As a result of the Atotech Acquisition, we issued an aggregate of 10.7 million shares of our common stock to the former Atotech shareholders. Additional information regarding the funding of the Atotech Acquisition, the entry into the New Term Loan Facility, and the New Revolving Facility and the replacement of the Prior Term Loan Facility and the Prior ABL Credit Facility, is discussed under “Recent Events - Atotech Acquisition” above and in Note 14 to the Notes to Consolidated Financial Statements.

In connection with the completion of the Atotech Acquisition, we entered into a credit agreement with JPMorgan Chase Bank, N.A., as administrative agent and collateral agent, Barclays Bank PLC, and the lenders from time to time party thereto (the “New Credit Agreement”). The New Credit Agreement provides for (i) a senior secured term loan facility (the “New Term Loan Facility”) comprised of three tranches: a USD 1 billion loan (the “USD Tranche A”), a USD 3.6 billion loan (the “USD Tranche B”) and a EUR 600 million loan (the “Euro Tranche B”), each of which were borrowed in full on the Effective Date, and (ii) a senior secured revolving credit facility of USD 500 million (the “New Revolving Facility”) and, together with the New Term Loan Facility, the “New Credit Facilities”), with the commitments under each of the foregoing facilities subject to increase from time to time subject to certain conditions.

Borrowings under the New Credit Facilities bear interest at a rate per annum equal to, at our option, any of the following, plus, in each case, an applicable margin: (a) with respect to the USD Tranche A, the USD Tranche B and the New Revolving Facility, (x) a base rate determined by reference to the highest of (1) the federal funds effective rate plus 0.50%, (2) the prime rate quoted in The Wall Street Journal, or (3) a forward-looking term rate based on the secured overnight financing rate (“Term SOFR”) (plus an applicable credit spread adjustment) for an interest period of one month, plus 1.00%; and (y) a Term SOFR rate (plus an applicable credit spread adjustment) for the interest period relevant to such borrowing, subject to a rate floor of (I) with respect to the USD Tranche B, 0.50% and (II) with respect to the USD Tranche A and the New Revolving Facility, 0.0%; and (b) with respect to the Euro Tranche B, a EURIBOR rate determined by reference to the costs of funds for Euro deposits for the interest period relevant to such borrowing adjusted for certain additional costs, subject to a EURIBOR rate floor of 0.0%. The USD Tranche A was issued with original issue discount of 0.25% of the principal amount thereof. The USD Tranche B and the Euro Tranche B were issued with original issue discount of 2.00% of the principal amount thereof. The applicable margin for

borrowings under the USD Tranche A is 1.50% with respect to base rate borrowings and 2.50% with respect to Term SOFR borrowings. The applicable margin for borrowings under the USD Tranche B is 1.75% with respect to base rate borrowings and 2.75% with respect to Term SOFR borrowings. The applicable margin for borrowings under the Euro Tranche B is 3.00%. The initial applicable margin for borrowings under the New Revolving Facility is 1.50% with respect to base rate borrowings and 2.50% with respect to Term SOFR borrowings. Commencing with the delivery of financial statements with respect to the first quarter ending after the closing of the New Credit Agreement, the applicable margin for borrowings under the New Revolving Facility is subject to adjustment each fiscal quarter, based on our first lien net leverage ratio as of the end of the preceding quarter.

In addition to paying interest on outstanding principal under the New Credit Facilities, we are required to pay a commitment fee in respect of the unutilized commitments under the New Revolving Facility. The initial commitment fee is 0.375% per annum. Commencing with the delivery of financial statements with respect to the first quarter ending after the closing of the New Credit Agreement, the commitment fee is subject to downward adjustment based on our first lien net leverage ratio as of the end of the preceding quarter. We must also pay customary letter of credit fees and agency fees.

We incurred \$242 million of deferred financing fees and original issue discount fees related to the term loans under the New Term Loan Facility, which are included in long-term debt in the accompanying consolidated balance sheets and are being amortized to interest expense over the estimated life of the term loans using the effective interest method. As of December 31, 2022, the remaining balance of deferred financing fees and original issue discount of the New Term Loan Facility was \$195 million. A portion of the deferred financing fees and original issue discount has been accelerated in connection with the debt prepayment and extinguishment of the Prior Term Loan Facility (as defined below).

Under the New Credit Agreement, we are required to prepay outstanding term loans, subject to certain exceptions, with portions of our annual excess cash flow as well as with the net cash proceeds of certain of our asset sales, certain casualty and condemnation events and the incurrences or issuances of certain debt.

If at any time the aggregate amount of outstanding loans, unreimbursed letter of credit drawings and undrawn letters of credit under the New Revolving Facility exceeds the aggregate commitments under the New Revolving Facility, we are required to repay outstanding loans and/or cash collateralize letters of credit, with no reduction of the commitment amount.

We may voluntarily prepay outstanding loans under the New Credit Facilities from time to time, subject to certain conditions, without premium or penalty other than customary "breakage" costs with respect to Term SOFR or EURIBOR loans; provided, however, that subject to certain exceptions, if on or prior to the date that is twelve months after the closing date of the New Term Loan Facility, we prepay any loans under the USD Tranche B or the Euro Tranche B in connection with a repricing transaction, we must pay a prepayment premium of 1.00% of the aggregate principal amount of the loans so prepaid. Additionally, we may voluntarily reduce the unutilized portion of the commitment amount under the New Revolving Facility.

We are required to make scheduled quarterly payments each equal to 1.25% of the original principal amount of the USD Tranche A (increasing to 1.875% in years 3 and 4 and 2.50% in year 5) and 0.25% of the original principal amount of the USD Tranche B and the Euro Tranche B, beginning with the fiscal quarter ending December 31, 2022, with the balance due thereunder on the fifth anniversary of the closing date in the case of the USD Tranche A and the seventh anniversary of the closing date in the case of the USD Tranche B and the Euro Tranche B.

There is no scheduled amortization under the New Revolving Facility. Any principal amount outstanding under the New Revolving Facility is due and payable in full on the fifth anniversary of the closing date.

We incurred \$7 million of costs in connection with the New Revolving Facility, which were capitalized and included in other assets in the accompanying consolidated balance sheet and are being amortized to interest expense over the estimated life of four years. As a result of our Prior ABL Credit Facility (as defined below) being terminated concurrently with our entry into the New Revolving Facility, we wrote off an immaterial amount of previously capitalized debt issuance costs.

All obligations under the New Credit Facilities are guaranteed by certain of our wholly-owned domestic subsidiaries and are required to be guaranteed by certain of our future wholly-owned domestic subsidiaries and are secured by substantially all of our assets and the assets of such subsidiaries, subject to certain exceptions and exclusions.

Under the New Credit Agreement, we have the ability to incur additional incremental debt facilities in an amount up to (x) the greater of (1) \$1.01 billion and (2) 75% of consolidated EBITDA, plus (y) an amount equal to the sum of all voluntary prepayments of term loans under the New Term Loan Facility, plus (z) an additional unlimited amount subject to pro forma compliance with certain leverage ratio tests (based on the security and priority of such incremental debt).

Under the USD Tranche A and the New Revolving Facility, so long as any USD Tranche A loans (or commitments in respect thereof) are outstanding as of the end of any fiscal quarter, we may not allow our total net leverage ratio as of the end of such fiscal quarter to be greater than 5.50 to 1.00, with an annual step-down of 0.25:1.00 and subject to a step-up of 0.50:1.00 for the four full fiscal quarter period following any material acquisition, not to exceed 5.50 to 1.00.

In addition, in the event there are no loans outstanding under the USD Tranche A, as of the end of any fiscal quarter of ours when the aggregate amount of loans outstanding under the New Revolving Facility (net of (a) all letters of credit (whether cash collateralized or not) and (b) unrestricted cash of ours and our restricted subsidiaries) exceeds 35% of the aggregate amount of all commitments under the New Revolving Facility in effect as of such date, we may not allow our first lien net leverage ratio as of the end of each such fiscal quarter to be greater than 6.00 to 1.00.

The USD Tranche B and the Euro Tranche B are not subject to financial maintenance covenants.

The New Credit Agreement contains a number of negative covenants that, among other things and subject to certain exceptions, restrict our ability and each of our subsidiaries to incur additional indebtedness; pay dividends on our capital stock or redeem, repurchase or retire our capital stock or our subordinated indebtedness; make investments, loans and acquisitions; create restrictions on the payment of dividends or other amounts to us from our restricted subsidiaries or restrictions on the ability of our restricted subsidiaries to incur liens; engage in transactions with our affiliates; sell assets, including capital stock of our subsidiaries; materially alter the business it conducts; consolidate or merge; incur liens; and engage in sale-leaseback transactions.

The New Credit Agreement also contains customary representations and warranties, affirmative covenants and provisions relating to events of default. If an event of default occurs, the lenders under the New Credit Facilities will be entitled to take various actions, including the acceleration of amounts due under the New Credit Facilities and all actions permitted to be taken by a secured creditor. At December 31, 2022, we were in compliance with all covenants under the New Credit Agreement.

The proceeds of the New Term Loan Facility were used on the Effective Date, among other things, to fund a portion of the consideration payable in connection with the Atotech Acquisition and to refinance the Prior Term Loan Facility, the Prior ABL Credit Facility and certain indebtedness of Atotech. We also paid certain customary fees and expenses of JPMorgan Chase Bank, N.A., Barclays Bank PLC, BofA Securities Inc., Citigroup Global Markets Inc., HSBC Securities (USA) Inc. and Mizuho Bank, Ltd. in their respective capacities as lead arrangers and bookrunners in connection with the New Credit Facilities.

On the Effective Date, in connection with the entry into the New Credit Agreement described above, we terminated and prepaid the prior term loan credit facility under that certain Term Loan Credit Agreement, dated as of April 29, 2016, by and among us, Barclays Bank PLC and the other financial institutions from time to time party thereto (as amended, the "Prior Term Loan Credit Agreement" and the term loan credit facility thereunder, the "Prior Term Loan Facility") and terminated the prior revolving credit facility under that certain ABL Credit Agreement, dated as of February 1, 2019, by and among the us, Barclays Bank PLC and the other financial institutions from time to time party thereto (as amended, the "Prior ABL Credit Agreement" and the revolving credit facility thereunder, the "Prior ABL Credit Facility"). At the time of termination, there were approximately \$820 million in borrowings outstanding under the Prior Term Loan Facility that were prepaid and no borrowings outstanding under the Prior ABL Credit Facility. We have determined the termination to be a full extinguishment of debt and have written off to expense the immaterial remaining balance of deferred finance costs and debt issuance costs related to the Prior Term Loan Facility and Prior ABL Credit Facility.

As of December 31, 2022, the outstanding principal amount of the New Term Loan Facility was \$5.1 billion and the weighted average interest rate was 6.8%. As of December 31, 2022, there were no borrowings under the New Revolving Facility.

Lines of Credit and Borrowing Arrangements

Certain of our Japanese subsidiaries have lines of credit and a financing facility with various financial institutions, many of which generally expire and are renewed at three-month intervals, with the remaining having no expiration date. The lines of credit and financing facility provided for aggregate borrowings as of December 31, 2022 and December 31, 2021 of up to an equivalent of \$27 million and \$29 million, respectively. There were no borrowings outstanding under these arrangements at December 31, 2022 or December 31, 2021.

Derivatives

We enter into derivative instruments for risk management purposes only, including derivatives designated as hedging instruments and those utilized as economic hedges. We operate internationally, and in the normal course of business, are exposed to fluctuations in interest rates and foreign exchange rates. These fluctuations can increase the costs of financing, investing and operating the business. We have used derivative instruments, such as foreign exchange forward contracts and options, to manage certain foreign currency exposure, and interest rate swaps and caps to manage interest rate exposure.

By nature, all financial instruments involve market and credit risks. We enter into derivative instruments with major investment grade financial institutions and no collateral is required. We have policies to monitor the credit risk of these counterparties. While there can be no assurance, we do not anticipate any material non-performance by any of these counterparties.

Interest Rate Swap and Interest Rate Cap Agreements

We have various interest rate swap agreements, as described further in Note 8 to the Notes to Consolidated Financial Statements, that exchange the variable Term SOFR rate to a fixed rate in order to manage the exposure to interest rate fluctuations associated with the variable Term SOFR rate paid on the outstanding balance of the New Term Loan Facility. We acquired USD London Interbank Offered Rate (“LIBOR”) interest rate cap agreements as a result of the Atotech Acquisition and we are utilizing these agreements to offset the variable Term SOFR rate on our New Term Loan Facility. Our USD LIBOR-based swaps and USD LIBOR-based interest rate caps will convert to Term SOFR after LIBOR’s termination in June 2023, according to the terms of each instrument.

Effective Date	Maturity	Fixed Rate	Notional Amount at Effective Date	Notional Amount at December 31, 2022	As of December 31,	
					2022	2021
					Fair Value Asset (Liability)	Fair Value Asset (Liability)
April 5, 2019	March 31, 2023	2.309 %	\$ 300	\$ 200	\$ 1	\$ (5)
October 26, 2021	February 28, 2025	0.485 %	200	200	16	4
March 31, 2022	February 28, 2025	0.623 %	100	100	22	5
September 30, 2022	September 30, 2026	3.156 %	350	350	8	—
January 2, 2024	January 31, 2028	2.841 %	250	—	5	—
September 30, 2022	September 30, 2027	3.198 %	350	350	8	—
January 2, 2024	January 31, 2029	2.986 %	250	—	4	—
September 30, 2022	September 30, 2026	3.358 %	600	600	10	—
			2,400	1,800	74	4
March 31, 2020	January 31, 2024	1.000 %	350	350	15	—
March 31, 2020	January 31, 2024	1.000 %	350	350	15	—
			700	700	30	—
Total			\$ 3,100	\$ 2,500	\$ 104	\$ 4

The interest rate swaps and caps are recorded at fair value on the balance sheet and changes in the fair value are recognized in Accumulated Other Comprehensive Income. To the extent that these arrangements are no longer an effective hedge, any ineffectiveness measured in the hedging relationships is recorded immediately in earnings in the period it occurs. The fair value of the interest rate swaps and caps is classified in other assets or non-current liabilities, accordingly, in the consolidated balance sheet.

Foreign Exchange Contracts

We hedge a portion of our forecasted foreign currency denominated intercompany sales of inventory, over a maximum period of eighteen months, using foreign exchange forward contracts accounted for as cash-flow hedges related to British, Euro, Japanese, South Korean and Taiwanese currencies. To the extent these derivatives are effective in offsetting the variability of the hedged cash flows, and otherwise meet the hedge accounting criteria, changes in the derivatives’ fair value are not included in current earnings but are included in accumulated other comprehensive income in stockholders’ equity. These changes in fair value will subsequently be reclassified into earnings, as applicable, when the forecasted transaction occurs. To the extent that a previously designated hedging transaction is no longer an effective hedge, any ineffectiveness measured in the hedging relationship is recorded immediately in earnings in the period it occurs. The cash flows resulting from foreign exchange forward contracts are classified in the consolidated statements of cash flows as part of cash flows from operating activities. We do not enter into derivative instruments for trading or speculative purposes.

We also enter into foreign exchange forward contracts to hedge certain balance sheet amounts. To the extent the hedge accounting criteria is not met, the related foreign exchange forward contracts are considered as economic hedges and changes in the fair value of these contracts are recorded immediately in earnings in the period in which they occur. These include hedges that are used to reduce exchange rate risks arising from the change in fair value of certain foreign currency-denominated assets and liabilities (i.e., payables, receivables) and other economic hedges where the hedge accounting criteria were not met.

We had foreign exchange forward contracts with notional amounts totaling \$702 million outstanding at December 31, 2022, of which \$485 million was outstanding to exchange euro to U.S. dollars and \$75 million was outstanding to exchange South Korean won to U.S. dollars. We had foreign exchange forward contracts with notional amounts totaling \$241 million outstanding

at December 31, 2021, of which \$108 million was outstanding to exchange South Korean won to U.S. dollars and \$60 million was outstanding to exchange Japanese yen to U.S. dollars.

As of December 31, 2022, the unrealized loss that will be reclassified from accumulated other comprehensive income to earnings over the next twelve months is immaterial. Gains and losses on foreign exchange forward contracts that qualify for hedge accounting are classified in cost of products in 2022 and 2021 and totaled a gain of \$18 million and a loss of \$2 million, respectively. There were no ineffective portions of the derivatives recorded in 2022 and 2021.

We hedge certain intercompany accounts receivable and intercompany loans with foreign exchange forward contracts. Typically, as these derivatives hedge existing amounts that are denominated in foreign currencies, the derivatives do not qualify for hedge accounting. Realized and unrealized gains and losses on foreign exchange forward contracts that do not qualify for hedge accounting are recognized immediately in earnings. The net foreign exchange gains or losses on these derivatives were immaterial in each of 2022 and 2021. Foreign currency gains or losses are classified in other expense, net. The cash flows resulting from foreign exchange forward contracts are classified in our consolidated statements of cash flows as part of cash flows from operating activities. We do not hold or issue derivative financial instruments for trading purposes.

Contractual Obligations

As of December 31, 2022, we are a party to purchase commitments for certain inventory components and other equipment and services used in our normal operations totaling approximately \$795 million. The majority of these purchase commitments covered by these arrangements are for periods of less than one year.

In addition, we have various operating leases for real estate and non-real estate items. The non-real estate leases are mainly comprised of automobiles but also include office equipment and other lower-valued items. We also have a small number of finance leases for real estate.

Future payments related to operating and finance leases are as follows:

Year Ending December 31,	Operating Leases	Finance Leases
2023	\$ 26	\$ 7
2024	23	6
2025	20	6
2026	17	4
2027	15	4
Thereafter	150	21
Total lease payments	251	48
Less: imputed interest	47	11
Total lease liabilities	\$ 204	\$ 37

Contractual maturities of our debt obligations as of December 31, 2022 are as follows:

Year	Amount
2023	\$ 93
2024	93
2025	110
2026	115
2027	695
Thereafter	4,016

We have a number of defined benefit pension plans, which cover some of our employees outside the United States. In addition, we have certain pension assets and liabilities relating to our former employees in the United Kingdom. As of December 31, 2022, our estimated benefit payments over the next 10 years amount to \$88 million. The majority of the benefit payments covered by these arrangements occurs after 2027.

Item 7A. *Quantitative and Qualitative Disclosures about Market Risk*

Market Risk and Sensitivity Analysis

Our primary exposures to market risks include fluctuations in interest rates on our New Term Loan Facility, as defined and as described further in Item 7 of this Annual Report on Form 10-K, and investment portfolio, as well as fluctuations in foreign currency exchange rates.

Foreign Exchange Rate Risk

We mainly enter into foreign exchange forward contracts to reduce currency exposure arising from intercompany sales of inventory. We also enter into foreign exchange forward contracts to reduce foreign exchange risks arising from the change in fair value of certain foreign currency denominated assets and liabilities.

We had foreign exchange forward contracts with notional amounts totaling \$702 million outstanding and a net fair value liability of \$1 million at December 31, 2022. We had foreign exchange forward contracts with notional amounts totaling \$241 million outstanding and a net fair value asset of \$3 million at December 31, 2021. The potential fair value loss for a hypothetical 10% adverse change in the currency exchange rate on our foreign exchange forward contracts at December 31, 2022 and 2021 would be immaterial.

Interest Rate Risk

We hold our cash, cash equivalents and short-term investments for working capital purposes. Some of the securities we invest in are subject to market risk. This means that a change in prevailing interest rates may cause the principal amount of such investments to fluctuate. To minimize this risk, we maintain our portfolio of cash, cash equivalents and short-term investments in a variety of securities, including money market funds and government debt securities. Due to the short-term nature of these instruments, we believe that we do not have any material exposure to changes in the fair value of our investment portfolio as a result of changes in interest rates. Declines in interest rates, however, would reduce future interest income. The effect of a hypothetical 10% increase or decrease in overall interest rates would not have had a material impact on our operating results or the total fair value of our portfolio.

We have various interest rate swap and cap agreements as described further in “Management's Discussion and Analysis of Financial Condition and Results of Operations—Critical Accounting Policies and Estimates—Derivatives” that exchange the variable Term SOFR interest rate to a fixed rate in order to manage the exposure to interest rate fluctuations associated with the variable Term SOFR interest rate paid on the outstanding balance of the New Term Loan Facility. We acquired USD LIBOR interest rate cap agreements as a result of the Atotech Acquisition and we are utilizing these agreements to offset the variable Term SOFR rate on our New Term Loan Facility. Our USD LIBOR-based swaps and USD LIBOR-based interest rate caps will convert to Term SOFR after LIBOR's termination in June 2023, according to the terms of each instrument.

We are exposed to market risks related to fluctuations in interest rates related to our New Term Loan Facility. As of December 31, 2022, the principal outstanding on our New Term Loan Facility was \$5.1 billion, at a weighted average interest rate of 6.8%. A 10% increase or decrease in the weighted average interest rate as of December 31, 2022 would increase or decrease annual interest expense by approximately \$36 million, excluding the effect of our interest rate hedges. Because the notional amount of our interest rate hedges as of December 31, 2022 equals approximately 50% of the principal outstanding on our New Term Loan Facility, the resulting net impact to interest expense would be approximately \$18 million.

Report of Independent Registered Public Accounting Firm

To the Board of Directors and Stockholders of MKS Instruments, Inc.

Opinions on the Financial Statements and Internal Control over Financial Reporting

We have audited the accompanying consolidated balance sheets of MKS Instruments, Inc. and its subsidiaries (the “Company”) as of December 31, 2022 and 2021, and the related consolidated statements of operations and comprehensive income, of stockholders’ equity and of cash flows for each of the three years in the period ended December 31, 2022, including the related notes and schedule of valuation and qualifying accounts for each of the three years in the period ended December 31, 2022 listed in the index appearing under Item 15(a)(2) (collectively referred to as the “consolidated financial statements”). We also have audited the Company’s internal control over financial reporting as of December 31, 2022, based on criteria established in *Internal Control - Integrated Framework* (2013) issued by the Committee of Sponsoring Organizations of the Treadway Commission (COSO).

In our opinion, the consolidated financial statements referred to above present fairly, in all material respects, the financial position of the Company as of December 31, 2022 and 2021, and the results of its operations and its cash flows for each of the three years in the period ended December 31, 2022 in conformity with accounting principles generally accepted in the United States of America. Also in our opinion, the Company did not maintain, in all material respects, effective internal control over financial reporting as of December 31, 2022, based on criteria established in *Internal Control - Integrated Framework* (2013) issued by the COSO because a material weakness in internal control over financial reporting existed as of that date related to ineffective design and maintenance of information technology (“IT”) controls to prevent or detect, on a timely basis, unauthorized access to the Company’s financial reporting systems.

A material weakness is a deficiency, or a combination of deficiencies, in internal control over financial reporting, such that there is a reasonable possibility that a material misstatement of the annual or interim financial statements will not be prevented or detected on a timely basis. The material weakness referred to above is described in Management’s Report on Internal Control over Financial Reporting appearing under Item 9A. We considered this material weakness in determining the nature, timing, and extent of audit tests applied in our audit of the December 31, 2022 consolidated financial statements, and our opinion regarding the effectiveness of the Company’s internal control over financial reporting does not affect our opinion on those consolidated financial statements.

Basis for Opinions

The Company’s management is responsible for these consolidated financial statements, for maintaining effective internal control over financial reporting, and for its assessment of the effectiveness of internal control over financial reporting, included in management’s report referred to above. Our responsibility is to express opinions on the Company’s consolidated financial statements and on the Company’s internal control over financial reporting based on our audits. We are a public accounting firm registered with the Public Company Accounting Oversight Board (United States) (PCAOB) and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audits in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audits to obtain reasonable assurance about whether the consolidated financial statements are free of material misstatement, whether due to error or fraud, and whether effective internal control over financial reporting was maintained in all material respects.

Our audits of the consolidated financial statements included performing procedures to assess the risks of material misstatement of the consolidated financial statements, whether due to error or fraud, and performing procedures that respond to those risks. Such procedures included examining, on a test basis, evidence regarding the amounts and disclosures in the consolidated financial statements. Our audits also included evaluating the accounting principles used and significant estimates made by management, as well as evaluating the overall presentation of the consolidated financial statements. Our audit of internal control over financial reporting included obtaining an understanding of internal control over financial reporting, assessing the risk that a material weakness exists, and testing and evaluating the design and operating effectiveness of internal control based on the assessed risk. Our audits also included performing such other procedures as we considered necessary in the circumstances. We believe that our audits provide a reasonable basis for our opinions.

As described in Management’s Report on Internal Control over Financial Reporting, management has excluded Atotech Limited (“Atotech”) from its assessment of internal control over financial reporting as of December 31, 2022 because it was acquired by the Company in a purchase business combination during 2022. We have also excluded Atotech from our audit of internal control over financial reporting. Atotech is a wholly-owned subsidiary whose total assets and total revenues excluded from management’s

assessment and our audit of internal control over financial reporting represent approximately 13% and 15%, respectively, of the related consolidated financial statement amounts as of and for the year ended December 31, 2022.

Definition and Limitations of Internal Control over Financial Reporting

A company's internal control over financial reporting is a process designed to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles. A company's internal control over financial reporting includes those policies and procedures that (i) pertain to the maintenance of records that, in reasonable detail, accurately and fairly reflect the transactions and dispositions of the assets of the company; (ii) provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with generally accepted accounting principles, and that receipts and expenditures of the company are being made only in accordance with authorizations of management and directors of the company; and (iii) provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use, or disposition of the company's assets that could have a material effect on the financial statements.

Because of its inherent limitations, internal control over financial reporting may not prevent or detect misstatements. Also, projections of any evaluation of effectiveness to future periods are subject to the risk that controls may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may deteriorate.

Critical Audit Matters

The critical audit matter communicated below is a matter arising from the current period audit of the consolidated financial statements that was communicated or required to be communicated to the audit committee and that (i) relates to accounts or disclosures that are material to the consolidated financial statements and (ii) involved our especially challenging, subjective, or complex judgments. The communication of critical audit matters does not alter in any way our opinion on the consolidated financial statements, taken as a whole, and we are not, by communicating the critical audit matter below, providing a separate opinion on the critical audit matter or on the accounts or disclosures to which it relates.

Acquisition of Atotech Limited ("Atotech") - Valuation of Customer Relationships and Completed Technology Intangible Assets

As described in Notes 2 and 4 to the consolidated financial statements, during 2022 the Company completed its acquisition of Atotech for a total net purchase price of \$5,664 million, which resulted in recording \$1,756 million of customer relationships intangible assets and \$595 million of completed technology intangible assets. The fair value of the customer relationships and completed technology intangible assets were determined using the income approach. In performing the valuation for the intangible assets, the key underlying assumptions used by management included the appropriate discount rate as well as forecasted revenue, gross profit and operating expenses.

The principal considerations for our determination that performing procedures relating to the valuation of the customer relationships and completed technology intangible assets acquired in the acquisition of Atotech is a critical audit matter are (i) the significant judgment by management when developing the fair value estimates of the customer relationships and completed technology intangible assets acquired; (ii) a high degree of auditor judgment, subjectivity and effort in performing procedures and evaluating management's significant assumptions related to the forecasted revenue, gross profit, operating expenses, and the discount rate for the customer relationships and the forecasted revenue and the discount rate for the completed technology; and (iii) the audit effort involved the use of professionals with specialized skill and knowledge.

Addressing the matter involved performing procedures and evaluating audit evidence in connection with forming our overall opinion on the consolidated financial statements. These procedures included testing the effectiveness of controls relating to the acquisition accounting, including controls over management's valuation of the customer relationships and completed technology intangible assets acquired. These procedures also included, among others, (i) reading the purchase agreements and (ii) testing management's process for developing the fair value estimate of the customer relationships and completed technology intangible assets. Testing management's process included evaluating the appropriateness of the valuation method, testing the completeness and accuracy of the underlying data used in the valuation method, and evaluating the reasonableness of the significant assumptions used by management related to the forecasted revenue, gross profit, operating expenses, and the discount rate for the customer relationships and the forecasted revenue and the discount rate for the completed technology. Evaluating the reasonableness of the forecasted revenue, gross profit and operating expenses for the customer relationships intangible assets and the forecasted revenue for the completed technology intangible assets involved considering the past performance of the acquired business as well as industry forecasts. Professionals with specialized skill and knowledge were used to assist in evaluating the appropriateness of the Company's valuation method and the reasonableness of the discount rate assumptions.

/s/ PricewaterhouseCoopers LLP
Boston, Massachusetts
March 14, 2023

We have served as the Company's auditor since 1981.

MKS Instruments, Inc.
Consolidated Balance Sheets
(in millions, except per share data)

	December 31,	
	2022	2021
ASSETS		
Current assets:		
Cash and cash equivalents	\$ 909	\$ 966
Short-term investments	1	76
Trade accounts receivable, net of allowance for doubtful accounts of \$11 and \$4 at December 31, 2022 and 2021, respectively	720	443
Inventories	977	577
Other current assets	187	85
Total current assets	2,794	2,147
Property, plant and equipment, net	800	326
Right-of-use assets	234	184
Goodwill	4,308	1,228
Intangible assets, net	3,173	576
Other assets	186	79
Total assets	\$ 11,495	\$ 4,540
LIABILITIES AND STOCKHOLDERS' EQUITY		
Current liabilities:		
Short-term debt	\$ 93	\$ 9
Accounts payable	426	168
Accrued compensation	101	132
Income taxes payable	51	25
Lease liabilities	26	18
Deferred revenue and customer advances	94	37
Other current liabilities	161	71
Total current liabilities	952	460
Long-term debt, net	4,834	808
Non-current deferred taxes	783	99
Non-current accrued compensation	138	49
Non-current lease liability	215	193
Other non-current liabilities	90	44
Total liabilities	7,012	1,653
Commitments and contingencies (Note 22)		
Stockholders' equity:		
Preferred stock, \$0.01 par value, 2 shares authorized; none issued and outstanding	—	—
Common stock, no par value, 200 shares authorized; 66.6 and 55.5 shares issued and outstanding at December 31, 2022 and 2021, respectively	—	—
Additional paid-in capital	2,142	907
Retained earnings	2,272	1,991
Accumulated other comprehensive income (loss)	69	(11)
Total stockholders' equity	4,483	2,887
Total liabilities and stockholders' equity	\$ 11,495	\$ 4,540

The accompanying notes are an integral part of the Consolidated Financial Statements.

MKS Instruments, Inc.
Consolidated Statements of Operations and Comprehensive Income
(in millions, except per share data)

	Years Ended December 31,		
	2022	2021	2020
Net revenues:			
Products	\$ 3,119	\$ 2,579	\$ 2,015
Services	428	371	315
Total net revenues	3,547	2,950	2,330
Cost of revenues:			
Products	1,774	1,371	1,107
Services	226	199	174
Total cost of revenues (exclusive of amortization shown separately below)	2,000	1,570	1,281
Gross profit	1,547	1,380	1,049
Research and development	241	200	173
Selling, general and administrative	488	385	353
Acquisition and integration costs	52	30	4
Restructuring and other	10	11	10
Amortization of intangible assets	146	55	55
Gain on sale of long-lived assets	(7)	—	—
Income from operations	617	699	454
Interest income	(4)	—	(1)
Interest expense	177	25	29
Other expense, net	11	9	3
Income before income taxes	433	665	423
Provision for income taxes	100	114	73
Net income	\$ 333	\$ 551	\$ 350
Other comprehensive income, net of tax:			
Changes in value of financial instruments designated as cash flow hedges	\$ 50	\$ 20	\$ (11)
Foreign currency translation adjustments	18	(31)	35
Unrecognized pension gain (loss)	12	—	(1)
Total comprehensive income	\$ 413	\$ 540	\$ 373
Net income per share:			
Basic	\$ 5.57	\$ 9.95	\$ 6.36
Diluted	\$ 5.56	\$ 9.90	\$ 6.33
Weighted average common shares outstanding:			
Basic	59.7	55.4	55.1
Diluted	59.9	55.7	55.3

The accompanying notes are an integral part of the Consolidated Financial Statements.

MKS Instruments, Inc.
Consolidated Statements of Stockholders' Equity
(in millions, except per share data)

	Common Stock		Additional Paid-In Capital	Retained Earnings	Accumulated Other Comprehensive Income (Loss)	Total Stockholders' Equity
	Shares	Amount				
Balance at December 31, 2019	54.6	\$ 0.1	\$ 864	\$ 1,181	\$ (23)	\$ 2,022
Net issuance under stock-based plans	0.6		(21)			(21)
Stock-based compensation			30			30
Cash dividend (\$0.80 per common share)				(44)		(44)
Comprehensive income (net of tax):						
Net income				350		350
Other comprehensive income					23	23
Balance at December 31, 2020	55.2	0.1	873	1,487	—	2,360
Net issuance under stock-based plans	0.3		(4)			(4)
Stock-based compensation			37			37
Cash dividend (\$0.86 per common share)				(47)		(47)
Comprehensive income (net of tax):						
Net income				551		551
Other comprehensive loss					(11)	(11)
Balance at December 31, 2021	55.5	0.1	907	1,991	(11)	2,887
Net issuance under stock-based plans	0.4		5			5
Shares issued for Atotech Acquisition	10.7		1,186			1,186
Stock-based compensation			45			45
Cash dividend (\$0.88 per common share)				(52)		(52)
Comprehensive income (net of tax):						
Net income				333		333
Other comprehensive income					80	80
Balance at December 31, 2022	66.6	\$ 0.1	\$ 2,142	\$ 2,272	\$ 69	\$ 4,483

The accompanying notes are an integral part of the Consolidated Financial Statements.

MKS Instruments, Inc.
Consolidated Statements of Cash Flows
(in millions)

	Years Ended December 31,		
	2022	2021	2020
Cash flows from operating activities:			
Net income	\$ 333	\$ 551	\$ 350
Adjustments to reconcile net income to net cash provided by operating activities:			
Depreciation and amortization	216	104	99
Unrealized loss (gain) on derivatives not designated as hedging instruments	13	(4)	—
Amortization of inventory step-up adjustment to fair value	52	—	—
Amortization of debt issuance costs and original issue discount	56	2	3
Gain on sale of long-lived assets	(7)	—	—
Stock-based compensation	45	37	30
Provision for excess and obsolete inventory	21	16	25
Deferred income taxes	(46)	2	(7)
Other	3	4	3
Changes in operating assets and liabilities, net of businesses acquired:			
Trade accounts receivable	(4)	(53)	(45)
Inventories	(236)	(92)	(52)
Other current and non-current assets	28	—	41
Accounts payable	61	56	21
Current and non-current accrued compensation	(31)	17	19
Income taxes payable	19	1	21
Other current and non-current liabilities	6	(1)	5
Net cash provided by operating activities	<u>529</u>	<u>640</u>	<u>513</u>
Cash flows from investing activities:			
Acquisitions of businesses, net of cash acquired	(4,473)	(268)	—
Purchases of investments	(1)	(497)	(522)
Maturities of investments	77	478	332
Sales of investments	—	169	73
Proceeds from sale of long-lived assets	9	—	—
Purchases of property, plant and equipment	(164)	(87)	(85)
Net cash used in investing activities	<u>(4,552)</u>	<u>(205)</u>	<u>(202)</u>
Cash flows from financing activities:			
Proceeds from borrowings, net of deferred financing fees paid	4,988	1	27
Payments of short and long-term borrowings	(962)	(15)	(84)
Payments of finance leases	(2)	—	—
Dividend payments	(52)	(47)	(44)
Net payments related to employee stock awards	(1)	(4)	(21)
Net cash provided by (used in) financing activities	<u>3,971</u>	<u>(65)</u>	<u>(122)</u>
Effect of exchange rate changes on cash and cash equivalents	<u>(5)</u>	<u>(12)</u>	<u>4</u>
(Decrease) increase in cash and cash equivalents	(57)	358	193
Cash and cash equivalents at beginning of period	966	608	415
Cash and cash equivalents at end of period	<u>\$ 909</u>	<u>\$ 966</u>	<u>\$ 608</u>
Supplemental disclosure of cash flow information:			
Cash paid during the period for:			
Interest	\$ 110	\$ 23	\$ 26
Income taxes	\$ 133	\$ 110	\$ 66

The accompanying notes are an integral part of the Consolidated Financial Statements.

1) Business Description

MKS Instruments, Inc. (“MKS” or the “Company”) was founded in 1961 and enables technologies that transform our world. The Company delivers foundational technology solutions to leading edge semiconductor manufacturing, electronics and packaging, and specialty industrial applications. The Company applies its broad science and engineering capabilities to create instruments, subsystems, systems, process control solutions and specialty chemicals technology that improve process performance, optimize productivity and enable unique innovations for many of the world's leading technology and industrial companies. The Company's solutions are critical to addressing the challenges of miniaturization and complexity in advanced device manufacturing by enabling increased power, speed, feature enhancement, and optimized connectivity. These solutions are also critical to addressing ever-increasing performance requirements across a wide array of specialty industrial applications.

2) Basis of Presentation

The Consolidated Financial Statements include the accounts of MKS Instruments, Inc. and its wholly owned subsidiaries. All intercompany accounts and transactions have been eliminated in consolidation. As a result of rounding, there may be immaterial differences in amounts presented and certain calculations may not sum to the total number expressed in each category or tie to a corresponding schedule.

The Consolidated Financial Statements have been prepared in accordance with accounting principles generally accepted in the United States of America (“U.S. GAAP”). The preparation of these financial statements requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities and the disclosure of contingent liabilities at the date of the financial statements and the reported amounts of revenues and expenses during the reporting period. On an ongoing basis, management evaluates its estimates and judgments, including those related to revenue recognition and allowance for doubtful accounts, inventory valuation, warranty costs, pension plan valuations, stock-based compensation, intangible assets, goodwill, other long-lived assets, in process research and development and income taxes. Management bases its estimates and judgments on historical experience and on various other factors that are believed to be reasonable under the circumstances, the results of which form the basis for making judgments about the carrying values of assets and liabilities that are not readily apparent from other sources. Actual results may differ from these estimates under different assumptions or conditions.

In the first quarter of 2022, MKS updated the names of its then-three divisions in order to simplify its naming convention. These divisions, formerly known as the Vacuum & Analysis Division, the Light & Motion Division and the Equipment & Solutions Division, were renamed the Vacuum Solutions Division (“VSD”), the Photonics Solutions Division (“PSD”) and the Equipment Solutions Division (“ESD”), respectively. On August 17, 2022, the Company completed its acquisition of Atotech Limited (“Atotech” and such transaction, the “Atotech Acquisition”) and refers to the Atotech business as its Materials Solutions Division (“MSD”). During the third quarter of 2022, MKS consolidated its equipment solutions business (“ESB”), previously ESD, into a component of PSD, with prior periods recast to reflect this change. MKS' reportable segments as of December 31, 2022 consist of its current three divisions, VSD, PSD and MSD. For additional information about the Atotech Acquisition, see Note 4 to the Consolidated Financial Statements.

3) Summary of Significant Accounting Policies

Revenue from Contracts with Customers

The Company accounts for revenue using Accounting Standards Codification (“ASC”) 606, “Revenue from Contracts with Customers” (“ASC Topic 606”). The Company applies ASC Topic 606 using the following steps:

- Identify the contract with a customer
- Identify the performance obligations in the contract
- Determine the transaction price
- Allocate the transaction price to performance obligations in the contract
- Recognize revenue when or as the Company satisfies a performance obligation

MKS INSTRUMENTS, INC.
NOTES TO CONSOLIDATED FINANCIAL STATEMENTS
(in millions, except per share data)

Revenue is recognized when or as obligations under the terms of a contract with a customer has been satisfied and control has transferred to the customer. The majority of the Company's performance obligations, and associated revenue, are transferred to customers at a point in time, generally upon shipment of a product to the customer or receipt of the product by the customer and without significant judgments. The Company recognizes revenue over time for contracts relating to the manufacturing, modifications and retrofits of its plating equipment, as the equipment is built to customer specification, and the Company has an enforceable right to payment for the performance completed to date. For these sales, the Company uses the cost-to-cost input method to measure progress. In cases, where cost-to-cost is not proportionate to its progress in satisfying the performance obligation because of uninstalled materials, the Company adjusts the measure of progress and recognizes revenue to the extent of cost incurred to satisfy the performance obligation under the contract. Revenue from customized products with no alternative future use to the Company, and that have an enforceable right to payment for performance completed to date, are also recorded over time. The Company considers this to be a faithful depiction of the transfer to the customer of revenue over time as the work is performed or service is delivered. Adjustments for custom products were not material for 2022 or 2021.

Installation services, other than those related to the Company's plating equipment, are not significant, are usually completed in a short period of time and, therefore, are recorded at a point in time when the installation services are completed, rather than over time, as they are not material. Extended warranty, service contracts, and repair services, which are transferred to the customer over time, are recorded as revenue as the services are performed. For repair services, the Company makes an accrual at each quarter end based upon historical repair times within its product groups to record revenue based upon the estimated number of days completed to date, which is consistent with ratable recognition.

Revenue is measured as the amount of consideration the Company expects to receive in exchange for transferring goods or providing services. Performance obligations promised in a contract are identified based on the products or services that will be transferred to the customer that are both capable of being distinct, whereby the customer can benefit from the product or service either on its own or together with other resources that are readily available from third parties or from the Company, and are distinct in the context of the contract, whereby the transfer of the product or service is separately identifiable from other promises in the contract. Sales, value add, and other taxes the Company collects concurrent with revenue-producing activities are excluded from revenue. The Company's normal payment terms are 30 to 60 days, but vary by the type and location of its customers and the products or services offered. For certain products and services and customer types, the Company requires payment before the products or services are delivered to, or performed for, the customer. None of the Company's contracts as of December 31, 2022 contained a significant financing component.

Contracts with Multiple Performance Obligations

The Company periodically enters into contracts with its customers in which a customer may purchase a combination of goods and or services, such as products with installation services or extended warranties. These contracts include multiple promises that the Company evaluates to determine if the promises are separate performance obligations. Once the Company determines the performance obligations, the Company then determines the transaction price, which includes estimating the amount of variable consideration to be included in the transaction price, if any. To the extent the transaction price includes variable consideration, the Company estimates the amount of variable consideration that should be included in the transaction price utilizing either the expected value method or the most likely amount method depending on the method the Company expects to better predict the amount of consideration to which it will be entitled. There are no constraints on the variable consideration recorded. The Company then allocates the transaction price to each performance obligation in the contract based on a relative stand-alone selling price charged separately to customers or using an expected cost-plus-margin method. The corresponding revenues are recognized when or as the related performance obligations are satisfied, which are noted above.

The Company's standard assurance warranty period is normally 12 to 24 months. The Company sells separately priced service contracts and extended warranty contracts related to certain of its products. The separately priced contracts generally range from 12 to 60 months. The Company normally receives payment at the inception of the contract and recognizes revenue over the term of the agreement in proportion to the costs expected to be incurred in satisfying the obligations under the contract. The Company has elected to use the practical expedient related to disclosing the remaining performance obligations as of December 31, 2022 and 2021, as the majority have a duration of less than one year.

MKS INSTRUMENTS, INC.
NOTES TO CONSOLIDATED FINANCIAL STATEMENTS
(in millions, except per share data)

Costs to Obtain and Fulfill a Contract

The Company expenses sales commissions when incurred because the amortization period would have been one year or less. These costs are recorded within selling, general and administration expenses. The Company has elected to recognize the costs for freight and shipping when control over products has transferred to the customer as an expense in cost of sales.

Accounts Receivable Allowances

Accounts receivable allowances include sales returns and bad debt allowances. The Company monitors and tracks the amount of product returns and reduces revenue at the time of shipment for the estimated amount of such future returns, based on historical experience. The Company makes estimates evaluating its allowance for doubtful accounts. The Company continuously monitors collections and payments from its customers and maintains a provision for estimated credit losses based upon its historical experience, current economic conditions and any specific customer collection issues that it has identified.

Research and Development

Research and development costs are expensed as incurred and consist mainly of compensation-related expenses and project materials. The Company's research and development efforts include numerous projects, which generally have a duration of 3 to 36 months. Acquired in-process research and development ("IPR&D") expenses, if acquired in a business combination, are capitalized at fair value as an intangible asset until the related project is completed, and are then amortized over the estimated useful life of the product. The Company monitors projects and, if they are abandoned, the Company writes them off.

Advertising Costs

Advertising costs are expensed as incurred and were immaterial in 2022, 2021 and 2020.

Leases

The Company accounts for leases under ASC Topic 842, "Leases" ("ASC Topic 842"). Under ASC Topic 842, a contract is or contains a lease when the Company has the right to control the use of the identified asset. The Company determines if an arrangement is a lease at inception of the contract, which is the date on which the terms of the contract are agreed to and the agreement creates enforceable rights and obligations. The commencement date of the lease is the date that the lessor makes an underlying asset available for use.

The Company determines if the lease is an operating or finance lease at the lease commencement date based upon the terms of the lease and the nature of the asset. The lease term used to calculate the lease liability includes options to extend or terminate the lease when it is reasonably certain that the option will be exercised. The Company has finance leases related to certain facilities it acquired as part of the Atotech Acquisition.

The Company measures the lease liability as the present value of future lease payments, discounted using the discount rate for the lease at the commencement date. The Company is typically unable to determine the implicit interest rate, so it uses an incremental borrowing rate based on the lease term and economic environment at commencement date. The right of use ("ROU") asset is initially measured as the amount of the lease liability, adjusted for any initial lease costs, prepaid lease payments and reduced by any lease incentives.

The Company's contracts often include non-lease components such as common area maintenance. MKS has elected the practical expedient to account for the lease and non-lease components as a single lease component. For leases with a term of one year or less the Company has elected not to record the lease asset or liability. The lease payments are recognized in the consolidated statement of earnings on a straight-line basis over the lease term. The Company includes lease costs within cost of revenues and operating expenses.

Stock-Based Compensation

The accounting for share-based compensation expense requires the measurement and recognition of compensation expense for all share-based payment awards made to employees and directors based on estimated fair values. For restricted stock units (“RSUs”), the fair value is measured on the date of grant and expensed normally over a three-year period. The Company also provides certain employees with the opportunity to purchase shares through its 2014 Employee Stock Purchase Plan (“2014 ESPP”). The Company estimates the fair value of shares issued under the 2014 ESPP using the Black-Scholes pricing model, which incorporates a number of complex and subjective variables, including expected stock price volatility over the term of the awards, expected life, risk-free interest rate and expected dividends.

Management determined that blended volatility, a combination of historical and implied volatility, is more reflective of market conditions and a better indicator of expected volatility than historical or implied volatility alone. The assumptions used in calculating the fair value of share-based payment awards represent management’s best estimates, but these estimates involve inherent uncertainties and the application of management judgment. As a result, if factors change and the Company uses different assumptions, stock-based compensation expense could be materially different in the future.

Accumulated Other Comprehensive Income

For foreign subsidiaries where the functional currency is the local currency, assets and liabilities are translated into U.S. dollars at the current exchange rate on the balance sheet date. Revenue and expenses are translated at average rates of exchange prevailing during the year. Translation adjustments resulting from this process are recorded to Accumulated Other Comprehensive Income (“OCI”). Unrealized gains and losses on securities classified as available-for-sale and unrecognized pension gains and losses are included in OCI in consolidated stockholders’ equity. For derivative instruments designated as cash-flow hedges and interest rate swap hedges, the effective portion of the derivative’s gain (loss) is initially reported as a component of OCI and is subsequently recognized in earnings when the hedged exposure is recognized in earnings.

Net Income Per Share

Basic net income per share is based on the weighted average number of common shares outstanding and diluted net income per share is based on the weighted average number of common shares outstanding and all potential dilutive common equivalent shares outstanding. The dilutive effect of equity awards is determined under the treasury stock method using the average market price for the period. Common equivalent shares are included in the per share calculations when the effect of their inclusion would be dilutive.

Cash and Cash Equivalents and Investments

All highly liquid investments with a maturity date of three months or less at the date of purchase are considered to be cash equivalents. The appropriate classification of investments in securities is determined at the time of purchase. Debt securities that the Company does not have the intent and ability to hold to maturity are classified as “available-for-sale” and are carried at fair value.

The Company classifies investments with maturity dates greater than twelve months in short-term investments rather than long-term investments. This method classifies these securities as current based on the nature of the securities and the availability for use in current operations. The Company believes this method is preferable because it is more reflective of the Company’s assessment of its overall liquidity position.

The Company reviews its investment portfolio on a quarterly basis to identify and evaluate individual investments that have indications of possible impairment. The factors considered in determining whether a loss is other-than-temporary include: the length of time and extent to which fair market value has been below the cost basis, the financial condition and near-term prospects of the issuer, credit quality, and the Company’s ability to hold the investment for a period of time sufficient to allow for any anticipated recovery in fair value.

Concentrations of Credit Risk

The Company's significant concentrations of credit risk consist principally of cash and cash equivalents, foreign exchange forward contracts, interest rate swaps and trade accounts receivable. The Company maintains cash and cash equivalents with financial institutions, including some banks with which it has borrowings. The Company enters into foreign exchange forward contracts with high credit-quality financial institutions in order to minimize credit risk exposure.

The Company's largest customers are primarily concentrated in the semiconductor industry, and a limited number of these customers account for a significant portion of the Company's revenues. The Company regularly monitors the creditworthiness of its customers and believes it has adequately provided for potential credit loss exposures. Credit is extended for all customers based primarily on financial condition, and collateral is not required.

During 2022, 2021 and 2020, approximately 58%, 62%, and 59% of the Company's net revenues, respectively, were from sales to customers in the semiconductor market. No single customer represented greater than 10% of the Company's accounts receivable balance as of December 31, 2022. One customer represented approximately 18% of the Company's accounts receivable balance as of December 31, 2021.

Inventories

Inventories are stated at the lower of cost or net realizable value, cost being determined using a standard costing system that approximates actual cost, based on a first-in, first-out method. The Company regularly reviews inventory quantities on hand and records a provision to write-down excess and obsolete inventory to its estimated net realizable value, if less than cost, based primarily on its estimated forecast of product demand.

Property, Plant and Equipment

Property, plant and equipment are stated at cost. Expenditures for major renewals and betterments that extend the useful lives of property, plant and equipment are capitalized. Expenditures for maintenance and repairs are charged to expense as incurred. When assets are sold or otherwise disposed of, the cost and related accumulated depreciation are eliminated from the accounts and any resulting gain or loss is recognized in earnings.

Depreciation is provided on the straight-line method over the estimated useful lives of ten to fifty years for buildings and building improvements, and three to eighteen years for machinery and equipment, furniture and fixtures, office equipment and software. Leasehold improvements are amortized over the shorter of the lease term or the estimated useful life of the leased asset.

Acquisition Accounting

The fair value of the consideration exchanged in a business combination is allocated to tangible assets and identifiable intangible assets acquired and liabilities assumed at acquisition date fair value. Goodwill is measured as the excess of the consideration transferred over the net fair value of identifiable assets acquired and liabilities assumed. The accounting for an acquisition involves a considerable amount of judgement and estimation. Cost, income, market or a combination of approaches may be used to establish the fair value of consideration exchanged, assets acquired, and liabilities assumed, depending on the nature of those items. The valuation approach is determined in accordance with generally accepted valuation methods. Key areas of estimation and judgment may include the selection of valuation approaches, cost of capital, market characteristics, cost structure, impacts of synergies, and estimates of terminal value, among other factors.

While the Company uses estimates and assumptions as part of the purchase price allocation process to estimate the value of assets acquired and liabilities assumed, estimates are inherently uncertain and subject to refinement. During the measurement period, which may be up to one year from the acquisition date, the Company may record adjustments to the assets acquired and liabilities assumed, with a corresponding offset to goodwill, to the extent that adjustments are identified to the preliminary purchase price allocation. Upon conclusion of the measurement period, or final determination of the value of the assets acquired and liabilities assumed, whichever comes first, any subsequent adjustments are recorded to results of operations.

Intangible Assets

Intangible assets resulting from the acquisitions of businesses are estimated by management based on the fair value of assets acquired. These include acquired customer lists, technology, trademarks, trade names and IPR&D. Intangible assets are amortized from one to eighteen years on a straight-line basis which represents the estimated periods of benefit and the expected pattern of consumption.

Goodwill

Goodwill is the amount by which the cost of acquired net assets exceeded the fair value of those net assets on the date of acquisition. The Company allocates goodwill to reporting units at the time of acquisition or when there is a change in the reporting structure and bases that allocation on which reporting units will benefit from the acquired assets and liabilities. Reporting units are defined as operating segments or one level below an operating segment, referred to as a component. The Company assesses goodwill for impairment on an annual basis as of October 31 or more frequently when events and circumstances occur indicating that the recorded goodwill may be impaired.

The estimated fair value of the Company's reporting units is based on discounted cash flow models derived from internal earnings and internal and external market forecasts. Determining fair value requires the exercise of significant judgment, including judgments about appropriate discount and terminal growth rates, as well as forecasted revenue, gross profit and operating expenses. Discount rates are based on a weighted average cost of capital ("WACC"), which represents the average rate a business must pay its providers of debt and equity. The WACC used to test goodwill is derived from a group of comparable companies. Assumptions in estimating future cash flows are subject to a high degree of judgment and complexity. The Company makes every effort to forecast these future cash flows as accurately as possible with the information available at the time the forecast is developed.

In performing the Company's annual goodwill impairment test, the Company is permitted to first assess qualitative factors to determine whether it is more likely than not that the fair value of the Company's reporting unit exceeds its carrying amount, including goodwill. In performing the qualitative assessment, the Company considers certain events and circumstances specific to the reporting unit and to the entity as a whole, such as macroeconomic conditions, industry and market considerations, overall financial performance and cost factors when evaluating whether it is more likely than not that the fair value of the reporting unit exceeds its carrying amount. The Company is also permitted to bypass the qualitative assessment and proceed directly to the quantitative test. If the Company chooses to undertake the qualitative assessment and concludes that it is more likely than not that the fair value of the reporting unit is less than its carrying amount, the Company would then proceed to the quantitative impairment test. In the quantitative assessment, the Company compares the fair value of the reporting unit to its carrying amount, which includes goodwill. If the fair value exceeds the carrying value, no impairment loss exists. If the fair value is less than the carrying amount, a goodwill impairment loss is measured and recorded.

As of October 31, 2022, the Company performed its annual impairment assessment of goodwill by performing a qualitative analysis for all of its reporting units and determined that it is more likely than not that the fair values of the reporting units exceed their carrying amounts.

Impairment of Long-Lived Assets

The Company evaluates the recoverability of its long-lived assets whenever events and changes in circumstances indicate that the carrying amount of an asset may not be fully recoverable. This periodic review may result in an adjustment of estimated depreciable lives or asset impairment. When indicators of impairment are present, the carrying values of the asset are evaluated in relation to their operating performance and future undiscounted cash flows of the underlying business. If the future undiscounted cash flows are less than their carrying value, impairment exists. The impairment is measured as the difference between the carrying value and the fair value of the underlying asset. Fair values are based on estimates of market prices and assumptions concerning the amount and timing of estimated future cash flows and assumed discount rates, reflecting varying degrees of perceived risk.

Foreign Exchange

The functional currency of the majority of the Company's foreign subsidiaries is the applicable local currency. For those subsidiaries, assets and liabilities are translated to U.S. dollars at year-end exchange rates. Income and expense

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accounts are translated at the average exchange rates prevailing during the year. The resulting translation adjustments are included in accumulated other comprehensive income (loss) in consolidated stockholders' equity. Foreign exchange transaction gains and losses are classified in other income/expense in the statement of operations and comprehensive income.

Net foreign exchange losses resulting from re-measurement were \$5, \$9, and \$4 for the years ended December 31, 2022, 2021, and 2020, respectively, and are included in other expense, net. These amounts do not reflect the corresponding gain (loss) from foreign exchange forward contracts, which are included in cost of sales. See Note 8 regarding foreign exchange forward contracts.

Employee Benefit Plans

The majority of the Company's employees participate in defined contribution plans, whereby the Company, at its discretion, makes certain matching contributions based on participating employees' annual contribution to the plan and their total compensation.

The Company also has defined benefit retirement plans at certain of its foreign subsidiaries. The Company accounts for these plans based on the provisions of ASC Topic 715, "Compensation-Retirement Benefits." Some of the key assumptions used to calculate the pension expense and projected benefit obligation include the discount rate, rate of forecasted salary increases, the expected long-term rate of return on plan assets and expected mortality. The obligation for these claims and the related periodic costs are measured using actuarial techniques and assumptions. Actuarial gains and losses are deferred and amortized over future periods.

Income Taxes

The Company records income taxes using the asset and liability method. Deferred income tax assets and liabilities are recognized for the future tax consequences attributable to differences between the financial statement carrying amounts of existing assets and liabilities and their respective income tax bases, and also for operating loss and tax credit carryforwards. On a quarterly basis, the Company evaluates both the positive and negative evidence that affects the realizability of net deferred tax assets and assesses the need for a valuation allowance. The future benefit to be derived from its deferred tax assets is dependent upon its ability to generate sufficient future taxable income in each jurisdiction of the right type to realize the assets. The Company records a valuation allowance to reduce its net deferred tax assets to the amount that is expected to be realized. To the extent the Company establishes a valuation allowance an expense will be recorded as a component of the provision for income taxes on the statement of operations.

Accounting for income taxes requires a two-step approach to recognize and measure uncertain tax positions. The first step is to evaluate the tax position for recognition by determining if, based on the technical merits, it is more likely than not that the position will be sustained upon audit, including resolutions of related appeals or litigation processes, if any. The second step is to measure the tax benefit as the largest amount that is more than 50% likely of being realized upon ultimate settlement. The Company re-evaluates these uncertain tax positions on a quarterly basis. This evaluation is based on factors including, but not limited to, changes in facts or circumstances, changes in tax law, effectively settled issues under audit and new audit activity. Any change in these factors could result in the recognition of a tax benefit or an additional charge to the tax provision.

Income tax effects resulting from changes in tax law are accounted for by the Company in the period in which the law is enacted and the effects are recorded as a component of provision for income taxes from continuing operations.

Derivatives

As a result of the Company's global operating activities and variable interest rate borrowings, the Company is exposed to market risks from changes in foreign currency exchange rates and interest rates, which may adversely affect its operating results and financial position. The Company enters into derivative instruments for risk management purposes only, including derivatives designated as hedging instruments and those utilized as economic hedges. The Company does not enter into derivative instruments for trading or speculative purposes.

The Company used derivative instruments, such as foreign exchange forward contracts and options, to manage certain foreign currency exposure, and interest rate swaps and interest rate caps to manage interest rate exposure. Changes in

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fair value of derivative instruments are recognized in the consolidated statement of operations or, if hedge accounting is applied, in other comprehensive income for the effective portion of the changes in fair value. The cash flows resulting from foreign exchange forward contracts are classified in the consolidated statements of cash flows as part of cash flows from operating activities. All derivatives are stated at fair value in the balance sheet.

Accounting principles for qualifying hedges require detailed documentation that describes the relationship between the hedging instrument and the hedged item, including, but not limited to, the risk management objectives and hedging strategy and the methods to assess the effectiveness of the hedging relationship. The Company assesses the hedging relationships, both at the inception of the hedge and on an ongoing basis, using either the critical terms matching approach or a regression analysis approach to determine whether the designated hedging instrument is highly effective in offsetting changes in the value of the hedged item.

By nature, all financial instruments involve market and credit risks. The Company enters into derivative instruments with major investment grade financial institutions, for which no collateral is required. The Company has policies to monitor the credit risk of these counterparties. While there can be no assurance, the Company does not anticipate any material non-performance by any of these counterparties.

4) Acquisitions

Atotech

On August 17, 2022 (the “Effective Date”), the Company completed the Atotech Acquisition, through the acquisition of the entire issued share capital of Atotech by Atotech Manufacturing, Inc. (“Bidco”), a Delaware corporation and indirect wholly owned subsidiary of the Company. The Atotech Acquisition was implemented by means of a scheme of arrangement under the laws of Jersey (the “Scheme”) pursuant to the definitive agreement entered into by the Company and Atotech on July 1, 2021, as amended by the Letter Agreement dated October 29, 2021 by and among the Company, Atotech and Bidco, and as further amended by the Amendment to the Implementation Agreement dated April 1, 2022 by and among the Company, Atotech and Bidco (together, the “Implementation Agreement”).

Atotech, which the Company operates as MSD, develops leading process and manufacturing technologies for advanced surface modification, electroless and electrolytic plating, and surface finishing. Applying a comprehensive systems-and-solutions approach, Atotech's portfolio includes chemistry, equipment, software, and services for innovative and high-technology applications in a wide variety of end markets. Atotech further broadens the Company's capabilities by bringing leadership in critical chemistry solutions for electronics and packaging and specialty industrial applications.

On the Effective Date, pursuant to the Scheme and in accordance with the terms and conditions of the Implementation Agreement, Bidco acquired each issued and outstanding ordinary share of Atotech in exchange for per share consideration of \$16.20 in cash and 0.0552 of a share of Company common stock. The Company funded the payment of the aggregate cash consideration with a combination of cash on hand and the proceeds from the New Term Loan Facility, as defined in Note 14. As a result of the Atotech Acquisition, the Company issued an aggregate of 10.7 shares of Company common stock to the former Atotech shareholders.

The purchase price of Atotech consisted of the following:

Cash consideration to Atotech stockholders, net	\$	2,886
Value of MKS shares issued		1,186
Repayment of Atotech debt ⁽¹⁾		1,545
Settlement of Atotech share-based awards ⁽²⁾		47
Total purchase price, net of cash and cash equivalents acquired	\$	5,664

⁽¹⁾ Represents the cash paid for the outstanding principal of Atotech's senior secured term loans.

⁽²⁾ Represents the amount paid to the holders of Atotech options that became fully vested on the Effective Date and the fair value of vested but unissued Atotech share-based awards.

Under the acquisition method of accounting, the total purchase price is allocated to the estimated acquired tangible and intangible assets and assumed liabilities of Atotech based on their fair values as of the Effective Date, except for contract assets and liabilities, which remain at book value in accordance with ASC Topic 606. Any excess of the acquisition consideration over the fair value of assets acquired and liabilities assumed is allocated to goodwill and

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none of this goodwill or intangible assets will be deductible for tax purposes. The Company believes the amount of goodwill relative to identifiable intangible assets relates to several factors, including (1) broadening its position in key industrial end markets to offer complementary solutions, and (2) leveraging component and systems expertise to provide robust solutions to meet its customers' evolving technology needs.

The following table summarizes the allocation of the purchase price to the preliminary fair values assigned to assets acquired and liabilities assumed at the Effective Date:

Cash and cash equivalents	\$	238
Trade accounts receivable		283
Inventories		244
Other current assets		104
Property, plant and equipment		381
Intangible assets		2,726
Goodwill		3,064
Other assets		131
Total assets acquired		7,171
Accounts payable		194
Other current liabilities		166
Non-current deferred taxes		729
Non-current accrued compensation		99
Other non-current liabilities		81
Total liabilities assumed		1,269
Fair value of assets acquired and liabilities assumed		5,902
Less: Cash and cash equivalents acquired		(238)
Total purchase price, net of cash and cash equivalents acquired	\$	<u>5,664</u>

The allocation of purchase consideration to the estimated acquired tangible and intangible assets and assumed liabilities of Atotech is preliminary and subject to change during the measurement period. While the Company uses its best estimates and assumptions as part of the purchase price allocation process to value the assets acquired and liabilities assumed on the Effective Date, its estimates and assumptions are subject to refinement. The fair value of the acquired intangible assets was determined using the income approach. In performing these valuations, the key underlying assumptions used included the appropriate discount rates as well as forecasted revenue growth rates, gross profit and operating expenses. Fair value estimates are based on a complex series of judgments about future events and uncertainties and rely heavily on estimates and assumptions. The judgments used to determine the estimated fair value assigned to each class of assets acquired and liabilities assumed, as well as asset lives, can materially impact the Company's results of operations. The finalization of the purchase accounting assessment may result in a change in the valuation of assets acquired and liabilities assumed and may have a material impact on the Company's results of operations and financial position. As a result, during the measurement period, which may be up to one year from the Effective Date, the Company records adjustments to the assets acquired and liabilities assumed with a corresponding offset to goodwill to reflect additional information received about facts and circumstances which existed at the Effective Date. The Company records adjustments to the assets acquired and liabilities assumed subsequent to the purchase price allocation period in the Company's operating results in the period in which the adjustments are determined.

The preliminary valuations were based on the information that was available through the filing date of this Annual Report on Form 10-K that existed as of the Effective Date and the expectations and assumptions that have been deemed reasonable by the Company's management. The size and breadth of the Atotech Acquisition may necessitate the use of this one-year measurement period to adequately analyze and assess a number of the factors used in establishing the fair value of certain tangible and intangible assets acquired and liabilities assumed as of the Effective Date and the related tax impacts of any changes made. The Company is still evaluating the tax impact of the assets acquired and liabilities assumed. Any potential adjustments made could be material in relation to the preliminary values presented above.

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The following table reflects the preliminary allocation of the acquired intangible assets and related estimate of useful lives at the Effective Date:

Customer relationships	\$	1,756	11-14 years
Completed technology		595	8-9 years
Trade names		145	16 years
Backlog		40	1.5 years
In-process research and development		190	
	\$	<u>2,726</u>	

The acquired intangible assets are being amortized on a straight-line basis, which approximates the economic use of the assets over their estimated useful lives. Upon completion of the related projects, we expect the in-process research and development intangible asset to be amortized over its estimated useful life of eight to nine years.

The results of this acquisition were included in the Company's consolidated statement of operations beginning on August 17, 2022. The Atotech business constitutes the Company's MSD reportable segment (see Note 20). The net loss of MSD since the Effective Date was not material.

During the year ended 2022, the Company recognized acquisition and integration costs of \$52, substantially all of which related to the Atotech Acquisition.

During the fourth quarter of 2022, the Company recorded adjustments to balances reported as of, and for the period ended, September 30, 2022, resulting from foreign currency translation of the preliminary allocation of intangible assets and goodwill from the Atotech Acquisition in August 2022 and the related effect on cumulative translation adjustment and deferred tax liabilities. The adjustments recorded were to correct an overstatement of goodwill of \$43, intangible assets, net of \$56, and non-current deferred tax liabilities of \$38, and an understatement of accumulated other comprehensive income and other comprehensive income of \$61. These adjustments that the Company recorded did not affect net income, earnings per share or the statement of cash flows. The Company assessed these adjustments in accordance with SEC Staff Accounting Bulletin ("SAB") No. 99 and SAB No. 108 and determined they were not material to the interim financial statements taken as a whole.

Pro Forma Results

The following unaudited pro forma financial information presents the combined results of operations of the Company as if the Atotech Acquisition had occurred on January 1, 2021. The unaudited pro forma financial information is not necessarily indicative of what the Company's consolidated results of operations actually would have been had the acquisition occurred on the assumed date. In addition, the unaudited pro forma financial information does not attempt to project the future results of operations of the combined Company.

	Years Ended December 31,	
	2022	2021
Total net revenues	\$ 4,450	\$ 4,450
Net income	\$ 197	\$ 292

The unaudited pro forma information for the year ended December 31, 2022 and 2021 give effect primarily to the following:

- Applying the Company's accounting policies;
- Incremental interest expense related to the New Term Loan Facility;
- Incremental amortization of acquired intangible assets related to the estimated fair value from the purchase price allocation;
- The exclusion of inventory step-up amortization in 2022 and the addition of this amortization to 2021;
- Incremental depreciation of acquired property, plant and equipment related to the estimated fair value from the purchase price allocation;
- Incremental compensation expense for share-based compensation arrangements; and
- The estimated tax impact of the above adjustments.

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Photon Control

On July 15, 2021, the Company completed its acquisition of Photon Control Inc. (“Photon Control”), a Canadian corporation (the “Photon Control Acquisition”), pursuant to a definitive agreement (the “Arrangement Agreement”). Photon Control designs, manufactures and distributes a wide range of optical sensors and systems to measure temperature and position used in semiconductor wafer fabrication. At the effective time of the Photon Control Acquisition and pursuant to the terms and conditions of the Arrangement Agreement, each share of Photon Control’s common stock issued and outstanding as of immediately prior to the effective time of the Photon Control Acquisition, was converted into the right to receive CAD 3.60 per share in cash, without interest and subject to deduction for any required withholding tax. The Company funded the payment of the aggregate consideration with available cash on hand. Photon Control is included in the Company’s PSD segment.

The purchase price of Photon Control consisted of the following:

Cash paid for outstanding shares	\$	302
Less: Cash and cash equivalents acquired		(34)
Total purchase price, net of cash and cash equivalents acquired	\$	<u>268</u>

Under the acquisition method of accounting, the total estimated acquisition consideration is allocated to the acquired tangible and intangible assets and assumed liabilities of Photon Control based on their fair values as of the acquisition date. Any excess of the acquisition consideration over the fair value of assets acquired and liabilities assumed is allocated to goodwill. The Company expects that none of such goodwill or intangible assets will be deductible for tax purposes. The Company believes the amount of goodwill relative to identifiable intangible assets relates to enhancing the Company’s Surround the Wafer® offering by adding optical sensors for temperature control for critical etch and deposition applications in semiconductor wafer fabrication.

The following table summarizes the allocation of the purchase price to the fair values assigned to assets acquired and liabilities assumed at the date of the Photon Control Acquisition:

Current assets	\$	51
Intangible assets		121
Goodwill		168
Other non-current assets		9
Total assets acquired		<u>349</u>
Current liabilities		14
Non-current deferred taxes		32
Other non-current liabilities		1
Total liabilities assumed		<u>47</u>
Fair value of assets acquired and liabilities assumed		302
Less: Cash and cash equivalents acquired		(34)
Total purchase price, net of cash and cash equivalents acquired	\$	<u>268</u>

The acquired intangible assets are being amortized on a straight-line basis, which approximates the economic use of the assets over their estimated useful lives.

The following table reflects the allocation of the acquired intangible assets and related estimate of useful lives:

Completed technology	\$	110	9 years
Customer relationships		9	10 years
Backlog		2	1.5 years
	\$	<u>121</u>	

The fair value of the acquired intangible assets was determined using the income approach. In performing these valuations, the key underlying assumptions used included the appropriate discount rates as well as forecasted revenue growth rates, gross profit and operating expenses. Fair value estimates are based on complex series of judgments about future events and uncertainties and rely heavily on estimates and assumptions. The valuations were based on the information that was available as of the acquisition date and the expectations and assumptions that have been deemed reasonable by the Company’s management. There are inherent uncertainties and management judgment required in

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these determinations. This acquisition resulted in a purchase price that exceeded the estimated fair value of tangible and intangible assets, the excess amount of which was allocated to goodwill.

The results of operations of the Photon Control business from the Photon Control Acquisition closing date of July 15, 2021 through December 31, 2021, were not material to the Company's results of operations. The acquisition was also not material to the Company's results of operations, for the periods presented, on a pro forma basis.

5) Revenue from Contracts with Customers

Contract assets as of December 31, 2022 and 2021 were \$46 and \$4, respectively, and were included in other current assets. The increase is attributable to the Atotech Acquisition.

A roll forward of the Company's deferred revenue and customer advances is as follows:

	2022	2021
Beginning balance, January 1 ⁽¹⁾	\$ 40	\$ 37
Assumed deferred revenue and customer advances from Atotech Acquisition	36	—
Additions to deferred revenue and customer advances	180	172
Amount of deferred revenue and customer advances recognized in income	(160)	(169)
Ending balance, December 31 ⁽²⁾	<u>\$ 96</u>	<u>\$ 40</u>

- (1) Beginning deferred revenue and customer advances as of January 1, 2022 included \$16 of current deferred revenue, \$3 of long-term deferred revenue and \$21 of current customer advances. Beginning deferred revenue and customer advances as of January 1, 2021 included \$18 of current deferred revenue, \$6 of long-term deferred revenue and \$13 of current customer advances. The majority of the beginning balance in 2022 and 2021 was recognized in each year.
- (2) Ending deferred revenue and customer advances as of December 31, 2022 included \$15 of current deferred revenue, \$2 of long-term deferred revenue and \$79 of current customer advances. Ending deferred revenue and customer advances as of December 31, 2021 included \$16 of current deferred revenue, \$3 of long-term deferred revenue and \$21 of current customer advances.

Disaggregation of Revenue

The following table summarizes revenue from contracts with customers:

	Year Ended December 31, 2022			
	VSD	PSD	MSD	Total
Net revenues:				
Products	\$ 1,720	\$ 913	\$ 486	\$ 3,119
Services	246	151	31	428
Total net revenues	<u>\$ 1,966</u>	<u>\$ 1,064</u>	<u>\$ 517</u>	<u>\$ 3,547</u>
	Year ended December 31, 2021			
	VSD	PSD	MSD	Total
Net revenues:				
Products	\$ 1,629	\$ 950	\$ —	\$ 2,579
Services	233	138	—	371
Total net revenues	<u>\$ 1,862</u>	<u>\$ 1,088</u>	<u>\$ —</u>	<u>\$ 2,950</u>
	Year Ended December 31, 2020			
	VSD	PSD	MSD	Total
Net revenues:				
Products	\$ 1,222	\$ 793	\$ —	\$ 2,015
Services	184	131	—	315
Total net revenues	<u>\$ 1,406</u>	<u>\$ 924</u>	<u>\$ —</u>	<u>\$ 2,330</u>

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Refer to Note 20 for revenue by reportable segment, geography and groupings of similar products.

6) Investments

The following table shows the gross unrealized gains and (losses) aggregated by investment category for available-for-sale investments:

As of December 31, 2022	Cost	Gross Unrealized Gains	Gross Unrealized (Losses)	Estimated Fair Value
Short-term investments:				
Available-for-sale investments:				
Time deposits and certificates of deposit	\$ 1	\$ —	\$ —	\$ 1
	<u>\$ 1</u>	<u>\$ —</u>	<u>\$ —</u>	<u>\$ 1</u>

As of December 31, 2022:	Cost	Gross Unrealized Gains	Gross Unrealized (Losses)	Estimated Fair Value
Long-term investments:				
Available-for-sale investments:				
Group insurance contracts	\$ 5	\$ 1	\$ —	\$ 6

As of December 31, 2021:	Cost	Gross Unrealized Gains	Gross Unrealized (Losses)	Estimated Fair Value
Short-term investments:				
Available-for-sale investments:				
Time deposits and certificates of deposit	\$ 22	\$ —	\$ —	\$ 22
Commercial paper	42	—	—	42
U.S. treasury obligations	11	—	—	11
U.S. agency obligations	1	—	—	1
	<u>\$ 76</u>	<u>\$ —</u>	<u>\$ —</u>	<u>\$ 76</u>

As of December 31, 2021	Cost	Gross Unrealized Gains	Gross Unrealized (Losses)	Estimated Fair Value
Long-term investments:				
Available-for-sale investments:				
Group insurance contracts	\$ 5	\$ 1	\$ —	\$ 6

The tables above, which show the gross unrealized gains and (losses) aggregated by investment category for available-for-sale investments as of December 31, 2022 and 2021, reflect the inclusion within short-term investments of investments with contractual maturities greater than one year from the date of purchase. Management has the ability, if necessary, to liquidate any of its investments in order to meet the Company's liquidity needs in the next 12 months. Accordingly, those investments with contractual maturities greater than one year from the date of purchase are classified as short-term on the accompanying balance sheets.

Interest income is accrued as earned. Dividend income is recognized as income on the date the security trades "ex-dividend." Realized gains or losses are reflected in income and were not material in 2022, 2021 and 2020.

7) Fair Value Measurements

In accordance with the provisions of fair value accounting, a fair value measurement assumes that the transaction to sell an asset or transfer a liability occurs in the principal market for the asset or liability or, in the absence of a principal market, the most advantageous market for the asset or liability and defines fair value based upon an exit price model.

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The fair value measurement guidance establishes a fair value hierarchy, which requires an entity to maximize the use of observable inputs and minimize the use of unobservable inputs when measuring fair value. The guidance describes three levels of inputs that may be used to measure fair value:

- Level 1 Quoted prices in active markets for identical assets or liabilities as of the reporting date. Active markets are those in which transactions for the asset or liability occur in sufficient frequency and volume to provide pricing information on an ongoing basis.
- Level 2 Observable inputs other than Level 1 prices, such as quoted prices for similar assets or liabilities; quoted prices in markets that are not active; or other inputs that are observable or can be corroborated by observable market data for substantially the full term of the assets or liabilities. Level 2 assets and liabilities include debt securities with quoted prices that are traded less frequently than exchange-traded instruments or securities or derivative contracts that are valued using a pricing model with inputs that are observable in the market or can be derived principally from or corroborated by observable market data.
- Level 3 Unobservable inputs that are supported by little or no market activity and that are significant to the fair value of the assets or liabilities. Level 3 assets and liabilities include financial instruments whose value is determined using pricing models, discounted cash flow methodologies, or similar techniques, as well as instruments for which the determination of fair value requires significant management judgment or estimation.

In certain cases, the inputs used to measure fair value may fall into different levels of the fair value hierarchy. In such cases, the Company categorizes such assets and liabilities based on the lowest level input that is significant to the fair value measurement in its entirety. The Company's assessment of the significance of a particular input to the fair value measurement in its entirety requires judgment and considers factors specific to the asset.

Assets and liabilities of the Company measured at fair value on a recurring basis as of December 31, 2022, are summarized as follows:

Description	December 31, 2022	Fair Value Measurements at Reporting Date Using		
		Quoted Prices in Active Markets for Identical Assets (Level 1)	Significant Other Observable Inputs (Level 2)	Significant Unobservable Inputs (Level 3)
Assets:				
Cash equivalents:				
Money market funds	\$ 60	\$ 60	\$ —	\$ —
Available-for-sale securities:				
Time deposits and certificates of deposit	1	—	1	—
Group insurance contracts	6	—	6	—
Derivatives				
Foreign exchange forward contracts	7	—	7	—
Interest rate hedge-non-current	104	—	104	—
Pension and deferred compensation plan assets	17	—	17	—
Total assets	<u>\$ 195</u>	<u>\$ 60</u>	<u>\$ 135</u>	<u>\$ —</u>
Liabilities:				
Derivatives				
Foreign exchange forward contracts	\$ 8	\$ —	\$ 8	\$ —
Total liabilities	<u>\$ 8</u>	<u>\$ —</u>	<u>\$ 8</u>	<u>\$ —</u>
Reported as follows:				
Assets:				
Cash and cash equivalents	\$ 60	\$ 60	\$ —	\$ —
Short-term investments	1	—	1	—
Other current assets	8	—	8	—
Total current assets	<u>\$ 69</u>	<u>\$ 60</u>	<u>\$ 9</u>	<u>\$ —</u>
Other assets	<u>\$ 126</u>	<u>\$ —</u>	<u>\$ 126</u>	<u>\$ —</u>
Liabilities:				
Other current liabilities	<u>\$ 8</u>	<u>\$ —</u>	<u>\$ 8</u>	<u>\$ —</u>

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Assets and liabilities of the Company measured at fair value on a recurring basis as of December 31, 2021, are summarized as follows:

Description	December 31, 2021	Fair Value Measurements at Reporting Date Using		
		Quoted Prices in Active Markets for Identical Assets (Level 1)	Significant Observable Inputs (Level 2)	Significant Unobservable Inputs (Level 3)
Assets:				
Cash equivalents:				
Money market funds	\$ 55	\$ 55	\$ —	\$ —
U.S. treasury obligations	175	—	175	—
Available-for-sale securities:				
Time deposits and certificates of deposit	22	—	22	—
Commercial paper	42	—	42	—
U.S. treasury obligations	12	—	12	—
U.S. agency obligations	1	—	1	—
Group insurance contracts	6	—	6	—
Derivatives-foreign exchange forward contracts	4	—	4	—
Derivatives-foreign currency options	3	—	3	—
Derivatives-interest rate hedge-non-current	9	—	9	—
Funds in investments and other assets:				
Israeli pension assets	20	—	20	—
Deferred compensation plan assets:				
Mutual funds and exchange traded funds	2	—	2	—
Total assets	\$ 351	\$ 55	\$ 296	\$ —
Liabilities:				
Derivatives – foreign exchange forward contracts	\$ 1	\$ —	\$ 1	\$ —
Derivatives – interest rate hedge – non-current	5	—	5	—
Total liabilities	\$ 6	\$ —	\$ 6	\$ —
Reported as follows:				
Assets:				
Cash and cash equivalents	\$ 230	\$ 55	\$ 175	\$ —
Short-term investments	77	—	77	—
Other current assets	7	—	7	—
Total current assets	\$ 314	\$ 55	\$ 259	\$ —
Long-term investments	\$ 6	\$ —	\$ 6	\$ —
Other assets	31	—	31	—
Total long-term assets	\$ 37	\$ —	\$ 37	\$ —
Liabilities:				
Other current liabilities	\$ 1	\$ —	\$ 1	\$ —
Other liabilities	\$ 5	\$ —	\$ 5	\$ —

Other Fair Value Disclosures

The estimated fair value and carrying value of the Company's debt as of December 31, 2022 and 2021 is as follows:

	2022		2021	
	Carrying Value	Fair Value	Carrying Value	Fair Value
Total debt, excluding deferred financing costs	\$ 5,122	\$ 5,071	\$ 825	\$ 824

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The estimated fair value of the Company's debt was determined using available market information based on recent trades or activity of debt instruments with substantially similar risks, terms and maturities, which fall within Level 2 under the fair value hierarchy.

Money Market Funds

Money market funds are cash and cash equivalents and are classified within Level 1 of the fair value hierarchy.

Pension and Deferred Compensation Plan Assets

The pension and deferred compensation plan assets represent investments in mutual funds, exchange traded funds, government securities and other time deposits. These investments are set aside for retirement benefits of certain of the Company's subsidiaries.

Derivatives

As a result of the Company's global operating activities, the Company is exposed to market risks from changes in foreign currency exchange rates and variable interest rates, which may adversely affect its operating results and financial position. When deemed appropriate, the Company minimizes its risks from foreign currency exchange rate and interest rate fluctuations through the use of derivative financial instruments. The principal market in which the Company executes its foreign exchange forward contracts, options and interest rate swaps is the institutional market in an over-the-counter environment with a relatively high level of price transparency. The market participants usually are large commercial banks. The foreign exchange forward contracts, options and interest rate hedge are valued using broker quotations, or market transactions and are classified within Level 2 of the fair value hierarchy.

8) Derivatives

Foreign Exchange Forward Contracts

The Company hedges a portion of its forecasted foreign currency-denominated intercompany sales of inventory, over a maximum period of eighteen months, using foreign exchange forward contracts accounted for as cash-flow hedges. To the extent these derivatives are effective in offsetting the variability of the hedged cash flows, and otherwise meet the hedge accounting criteria, changes in the derivatives' fair value are not included in current earnings but are included in other comprehensive income ("OCI") in stockholders' equity. These changes in fair value will subsequently be reclassified into earnings, as applicable, when the forecasted transaction occurs. To the extent that a previously designated hedging transaction is no longer an effective hedge, any ineffectiveness measured in the hedging relationship is recorded in earnings in the period it occurs. The cash flows resulting from foreign exchange forward contracts are classified in the consolidated statements of cash flows as part of cash flows from operating activities. The Company does not enter into derivative instruments for trading or speculative purposes.

The Company also enters into foreign exchange forward contracts to hedge against changes in the balance sheet for certain subsidiaries to mitigate the risk associated with certain foreign currency transactions in the ordinary course of business. These derivatives are not designated as cash flow hedging instruments and gains or losses from these derivatives are recorded immediately in other (income) expense, net.

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As of December 31, 2022 and 2021, the Company had outstanding foreign exchange forward contracts. The following tables provide a summary of the primary net hedging positions and corresponding fair values held as of December 31, 2022 and 2021:

Currency Hedged (Buy/Sell)	December 31, 2022	
	Net Notional Value	Fair Value Asset (Liability)
U.S. dollar/Japanese yen	\$ 57	\$ —
U.S. dollar/South Korean won	75	(4)
U.S. dollar/Taiwan dollar	33	1
U.S. dollar/U.K. pound sterling	7	—
U.S. dollar/Singapore dollar	1	—
U.S. dollar/Chinese renminbi	9	—
euro/U.S. dollar	485	1
euro/Chinese renminbi	31	1
U.K. pound sterling/euro	4	—
Total	<u>\$ 702</u>	<u>\$ (1)</u>

Currency Hedged (Buy/Sell)	December 31, 2021	
	Net Notional Value	Fair Value Asset
U.S. dollar/Japanese yen	\$ 60	\$ 2
U.S. dollar/South Korean won	108	1
U.S. dollar/euro	15	—
U.S. dollar/U.K. pound sterling	11	—
U.S. dollar/Taiwan dollar	47	—
Total	<u>\$ 241</u>	<u>\$ 3</u>

The following table provides a summary of the net gain (loss) on derivatives designated as cash flow hedging instruments:

Foreign exchange forward contracts:	Years Ended December 31,		
	2022	2021	2020
Net gain (loss) recognized in accumulated OCI	\$ 50	\$ 20	\$ (11)
Net gain (loss) reclassified from accumulated OCI into income	\$ 18	\$ (2)	\$ 2

The net amount of existing gains as of December 31, 2022 expected to be reclassified from OCI into earnings within the next 12 months is immaterial.

Interest Rate Swap and Interest Rate Cap Agreements

The Company has various interest rate swap agreements that exchange a forward-looking term rate based on the variable secured overnight financing rate (“Term SOFR”) paid on the outstanding balance of its New Term Loan Facility, as defined and further described in Note 14, to a fixed rate. The Company acquired USD LIBOR interest rate cap agreements as a result of the Atotech Acquisition and is utilizing these agreements to offset the variable Term SOFR rate on its New Term Loan Facility. The Company's USD LIBOR based swaps and USD LIBOR based interest rate caps will convert to Term SOFR after LIBOR's termination in June 2023 according to the terms of each

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instrument. The table below summarizes interest rate swaps and interest rate caps outstanding at December 31, 2022 and December 31, 2021:

Effective Date	Maturity	Fixed Rate	Notional Amount at Effective Date	Notional Amount at December 31, 2022	As of December 31,	
					2022	2021
					Fair Value Asset (Liability)	Fair Value Asset (Liability)
April 5, 2019	March 31, 2023	2.309 %	\$ 300	\$ 200	\$ 1	\$ (5)
October 26, 2021	February 28, 2025	0.485 %	200	200	16	4
March 31, 2022	February 28, 2025	0.623 %	100	100	22	5
September 30, 2022	September 30, 2026	3.156 %	350	350	8	—
January 2, 2024	January 31, 2028	2.841 %	250	—	5	—
September 30, 2022	September 30, 2027	3.198 %	350	350	8	—
January 2, 2024	January 31, 2029	2.986 %	250	—	4	—
September 30, 2022	September 30, 2026	3.358 %	600	600	10	—
			2,400	1,800	74	4
March 31, 2020	January 31, 2024	1.000 %	350	350	15	—
March 31, 2020	January 31, 2024	1.000 %	350	350	15	—
			700	700	30	—
Total			\$ 3,100	\$ 2,500	\$ 104	\$ 4

The interest rate swaps are recorded at fair value on the balance sheet and changes in the fair value are recognized in OCI. To the extent these arrangements are no longer effective hedges, any ineffectiveness measured in the hedging relationships is recorded immediately in earnings in the period it occurs. Changes in the fair value of interest rate caps are recorded immediately in earnings, as the Company has not designated these instruments as hedges and therefore these instruments do not qualify for hedge accounting.

The following table provides a summary of gain (loss) on derivatives not designated as cash flow hedging instruments:

	Years Ended December 31,		
	2022	2021	2020
Net (loss) gain recognized in income	\$ (8)	\$ 5	\$ (2)

Currency Option Agreements

In connection with financing the Atotech Acquisition, the Company issued euro denominated term loan debt. In anticipation of entering into these euro denominated loans, the Company purchased foreign currency option contracts

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in 2021 to fix the conversion of EUR 300 into U.S. dollars. The options settled on January 31, 2022 and the Company recorded a gain of \$5, net of premiums, which is included in other expense, net.

In conjunction with the Photon Control Acquisition, which closed in July 2021, the Company entered into a foreign currency contract to hedge the Canadian dollar purchase price. In 2021, the Company recorded a fair value realized loss of \$10, which is included in other expense, net.

9) Inventories

Inventories consist of the following:

	Years Ended December 31,	
	2022	2021
Raw material	\$ 689	\$ 394
Work-in-process	115	83
Finished goods	173	100
Total	<u>\$ 977</u>	<u>\$ 577</u>

Inventory-related excess and obsolete charges of \$21, \$16 and \$25 were recorded in cost of products and services in the years ended December 31, 2022, 2021 and 2020, respectively.

10) Property, Plant and Equipment

Property, plant and equipment consist of the following:

	Years Ended December 31,	
	2022	2021
Land	\$ 75	\$ 12
Buildings and building improvements	330	133
Machinery and equipment	611	428
Furniture and fixtures, office equipment and software	214	187
Leasehold improvements	157	152
Construction in progress	75	27
	<u>1,462</u>	<u>939</u>
Less: accumulated depreciation	662	613
Total	<u>\$ 800</u>	<u>\$ 326</u>

Depreciation of property, plant and equipment totaled \$70, \$49 and \$44 for the years ended 2022, 2021 and 2020, respectively.

11) Leases

The Company has various operating leases for real estate and non-real estate items. The non-real estate leases are mainly comprised of automobiles but also include office equipment and other lower-valued items.

The elements of lease expense were as follows:

	Years Ended December 31,	
	2022	2021
Operating lease ⁽¹⁾	\$ 27	\$ 28
Finance lease	3	—
Short-term lease	10	4
Total lease expense	<u>\$ 13</u>	<u>\$ 32</u>

⁽¹⁾ Operating lease expense includes an immaterial amount of variable expenses, offset by certain sublease rental income.

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Supplemental cash flow information related to leases was as follows:

	Years Ended December 31,	
	2022	2021
Cash paid for amounts included in measurement of liabilities:		
Operating cash flows used for operating leases ⁽¹⁾	\$ 28	\$ 13
Financing cash flows used for finance leases	2	—
ROU assets obtained in exchange for new lease liabilities		
Operating leases	7	24
Finance leases	3	—

⁽¹⁾ Operating cash flows used for operating leases for the year ended December 31, 2022 and 2021 include an immaterial amount of tenant improvement allowance receipts.

The weighted average remaining terms for all leases were as follows:

	Years Ended December 31,	
	2022	2021
Weighted-average remaining lease term in years-operating leases	13.4	14.2
Weighted-average remaining lease term in years-finance leases	11.3	—
Weighted-average discount rate-operating leases	3.0%	3.0%
Weighted-average discount rate-finance leases	3.9%	—

Future lease payments under non-cancelable leases as of December 31, 2022 are detailed as follows:

Year Ending December 31,	Operating Leases	Finance Leases
2023	\$ 26	\$ 7
2024	23	6
2025	20	6
2026	17	4
2027	15	4
Thereafter	150	21
Total lease payments	251	48
Less: imputed interest	47	11
Total lease liabilities	\$ 204	\$ 37

Amounts presented above do not include payments relating to immaterial leases excluded from the balance sheet as well as leases with terms of less than twelve months.

12) Goodwill and Intangible Assets

Goodwill

The Company's methodology for allocating the purchase price relating to purchase acquisitions is determined through established and generally accepted valuation techniques. Goodwill is measured as the excess of the cost of the acquisition over the sum of the amounts assigned to tangible and identifiable intangible assets acquired less liabilities assumed. The Company assigns assets acquired (including goodwill) and liabilities assumed to one or more reporting units as of the date of acquisition. If the products obtained in an acquisition are assigned to multiple reporting units, the goodwill is distributed to the respective reporting units as part of the purchase price allocation process.

Goodwill and purchased intangible assets with indefinite useful lives are not amortized but are reviewed for impairment annually during the fourth quarter of each fiscal year and whenever events or changes in circumstances indicate that the carrying value of an asset may not be recoverable. The process of evaluating the potential impairment of goodwill and intangible assets requires significant judgment.

The Company regularly monitors current business conditions and other factors including, but not limited to, adverse industry or economic trends, restructuring actions and lower projections of profitability that may impact future operating results. During the quarter ended June 30, 2022, following softening industry demand for flexible printed

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circuit board (“PCB”) via drilling systems and declines in projected operating results for its ESB reporting unit, the Company evaluated the carrying values of goodwill, purchased intangible assets and other long-lived assets assigned to the reporting unit and determined the carrying values were recoverable. The Company performed its analysis using the income approach and key underlying assumptions included forecasted revenue, gross profit and operating expenses as well as discount rate. Fair value estimates are based on complex series of judgments about future events and uncertainties and rely heavily on estimates and assumptions that have been deemed reasonable by the Company's management. There are inherent uncertainties and management judgment required in these determinations. In its quantitative assessment of the reporting unit, the Company estimated fair value exceeded carrying value by 10%. The Company determined that there were no further triggering events that required an impairment assessment during the remainder of the year ended December 31, 2022 for its ESB reporting unit.

The changes in the carrying amount of goodwill and accumulated impairment losses were as follows:

	2022			2021		
	Gross Carrying Amount	Accumulated Impairment Loss	Net	Gross Carrying Amount	Accumulated Impairment Loss	Net
Beginning balance at January 1	\$ 1,374	\$ (146)	\$ 1,228	\$ 1,212	\$ (146)	\$ 1,066
Acquired goodwill ⁽¹⁾	3,064	—	3,064	168	—	168
Foreign currency translation	16	—	16	(6)	—	(6)
Ending balance at December 31	<u>\$ 4,454</u>	<u>\$ (146)</u>	<u>\$ 4,308</u>	<u>\$ 1,374</u>	<u>\$ (146)</u>	<u>\$ 1,228</u>

⁽¹⁾ During the year ended December 31, 2022, the Company recorded goodwill related to the Atotech Acquisition. During the year ended December 31, 2021, the Company recorded goodwill related to the Photon Control Acquisition. See Note 4 to the Notes to Consolidated Financial Statements.

Intangible Assets

Components of the Company's intangible assets are comprised of the following:

As of December 31, 2022	Gross	Accumulated Impairment Charges	Accumulated Amortization	Foreign Currency Translation	Net
Completed technology ⁽¹⁾	\$ 1,151	\$ —	\$ (303)	\$ 4	\$ 852
Customer relationships ⁽¹⁾	2,072	(1)	(190)	11	1,892
Patents, trademarks, trade names and other ⁽¹⁾	498	—	(71)	2	429
	<u>\$ 3,721</u>	<u>\$ (1)</u>	<u>\$ (564)</u>	<u>\$ 17</u>	<u>\$ 3,173</u>

⁽¹⁾ During the year ended December 31, 2022, the Company recorded \$2,726 of separately identified intangible assets related to the Atotech Acquisition, including \$595 in completed technology, \$1,756 in customer relationships and \$375 in patents, trademarks, trade names and other.

As of December 31, 2021	Gross	Accumulated Impairment Charges	Accumulated Amortization	Foreign Currency Translation	Net
Completed technology ⁽¹⁾	\$ 556	\$ —	\$ (242)	\$ —	\$ 314
Customer relationships ⁽¹⁾	318	(1)	(124)	(1)	192
Patents, trademarks, trade names and other ⁽¹⁾	123	—	(52)	(1)	70
	<u>\$ 997</u>	<u>\$ (1)</u>	<u>\$ (418)</u>	<u>\$ (2)</u>	<u>\$ 576</u>

⁽¹⁾ During the year ended December 31, 2021, the Company recorded \$121 of separately identified intangible assets related to the Photon Control Acquisition, representing \$110 in completed technology, \$9 in customer relationships and \$2 in patents, trademarks, trade names and other.

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Aggregate amortization expense related to acquired intangible assets for 2022, 2021 and 2020 was \$146, \$55 and \$55, respectively. Aggregate net amortization expense related to acquired intangible assets for future years is:

Year	Amount
2023	\$ 286
2024	257
2025	256
2026	252
2027	251
Thereafter	1,625

The Company excluded from the above table intangible assets of \$56 of indefinite-lived trademarks and trade names, and \$190 of in-process research and development, which were not subject to amortization.

13) Product Warranties

The Company provides for the estimated costs to fulfill customer warranty obligations upon the recognition of the related revenue. The Company's warranty obligations are affected by shipment volume, product failure rates, utilization levels, material usage and supplier warranties on parts delivered to the Company. Should actual product failure rates, utilization levels, material usage, or supplier warranties on parts differ from the Company's estimates, revisions to the estimated warranty liability would be required. The Company engages in extensive product quality programs and processes, including actively monitoring and evaluating the quality of its component suppliers.

Product warranty activities were as follows:

	Years Ended December 31,	
	2022	2021
Beginning balance	\$ 21	\$ 18
Provision for product warranties	31	38
Assumed product warranty liability from Photon Control Acquisition	—	1
Assumed product warranty liability from Atotech Acquisition	5	—
Direct and other charges to warranty liability	(30)	(36)
Ending balance	<u>\$ 27</u>	<u>\$ 21</u>

Short-term product warranties of \$19 and long-term product warranties of \$8, each as of December 31, 2022, are included within other current liabilities and other non-current liabilities, respectively, within the accompanying consolidated balance sheet. Short-term product warranties of \$20 and long-term product warranties of \$1, each as of December 31, 2021, are included within other current liabilities and other non-current liabilities, respectively, within the accompanying consolidated balance sheet.

14) Debt

The Company's outstanding debt is as follows:

	December 31, 2022	December 31, 2021
Short-term debt:		
New Term Loan Facility	\$ 93	\$ —
Prior Term Loan Facility	—	9
Total short-term debt	<u>\$ 93</u>	<u>\$ 9</u>
Long-term debt:		
New Term Loan Facility, net ⁽¹⁾	\$ 4,834	\$ —
Prior Term Loan Facility, net ⁽¹⁾	—	808
Total long-term debt	<u>\$ 4,834</u>	<u>\$ 808</u>

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- (1) Net of remaining deferred financing fees, original issuance discount and repricing fees in the aggregate of \$195 and \$8 as of December 31, 2022 and 2021, respectively.

The Company recognized interest expense of \$177, \$25 and \$29 for the years ended December 30, 2022, 2021 and 2020, respectively.

New Term Loan Facility and New Revolving Facility

In connection with the completion of the Atotech Acquisition, the Company entered into a credit agreement with JPMorgan Chase Bank, N.A., as administrative agent and collateral agent, Barclays Bank PLC, and the lenders from time to time party thereto (the “New Credit Agreement”). The New Credit Agreement provides for (i) a senior secured term loan facility (the “New Term Loan Facility”) comprised of three tranches: a USD 1,000 loan (the “USD Tranche A”), a USD 3,600 loan (the “USD Tranche B”) and a EUR 600 loan (the “Euro Tranche B”), each of which were borrowed in full on the Effective Date, and (ii) a senior secured revolving credit facility of USD 500 (the “New Revolving Facility” and, together with the New Term Loan Facility, the “New Credit Facilities”), with the commitments under each of the foregoing facilities subject to increase from time to time subject to certain conditions.

Borrowings under the New Credit Facilities bear interest at a rate per annum equal to, at the Company's option, any of the following, plus, in each case, an applicable margin: (a) with respect to the USD Tranche A, the USD Tranche B and the New Revolving Facility, (x) a base rate determined by reference to the highest of (1) the federal funds effective rate plus 0.50%, (2) the prime rate quoted in *The Wall Street Journal*, or (3) a forward-looking term rate based on Term SOFR (plus an applicable credit spread adjustment) for an interest period of one month, plus 1.00%; and (y) a Term SOFR rate (plus an applicable credit spread adjustment) for the interest period relevant to such borrowing, subject to a rate floor of (I) with respect to the USD Tranche B, 0.50% and (II) with respect to the USD Tranche A and the New Revolving Facility, 0.0%; and (b) with respect to the Euro Tranche B, a EURIBOR rate determined by reference to the costs of funds for Euro deposits for the interest period relevant to such borrowing adjusted for certain additional costs, subject to a EURIBOR rate floor of 0.0%. The USD Tranche A was issued with original issue discount of 0.25% of the principal amount thereof. The USD Tranche B and the Euro Tranche B were issued with original issue discount of 2.00% of the principal amount thereof. The applicable margin for borrowings under the USD Tranche A is 1.50% with respect to base rate borrowings and 2.50% with respect to Term SOFR borrowings. The applicable margin for borrowings under the USD Tranche B is 1.75% with respect to base rate borrowings and 2.75% with respect to Term SOFR borrowings. The applicable margin for borrowings under the Euro Tranche B is 3.00%. The initial applicable margin for borrowings under the New Revolving Facility is 1.50% with respect to base rate borrowings and 2.50% with respect to Term SOFR borrowings. Commencing with the delivery of financial statements with respect to the first quarter ending after the closing of the New Credit Agreement, the applicable margin for borrowings under the New Revolving Facility is subject to adjustment each fiscal quarter, based on the Company's first lien net leverage ratio as of the end of the preceding quarter.

In addition to paying interest on outstanding principal under the New Credit Facilities, the Company is required to pay a commitment fee in respect of the unutilized commitments under the New Revolving Facility. The initial commitment fee is 0.375% per annum. Commencing with the delivery of financial statements with respect to the first quarter ending after the closing of the New Credit Agreement, the commitment fee is subject to downward adjustment based on the Company's first lien net leverage ratio as of the end of the preceding quarter. The Company must also pay customary letter of credit fees and agency fees.

The Company incurred \$242 of deferred financing fees and original issue discount fees related to the term loans under the New Term Loan Facility, which are included in long-term debt in the accompanying consolidated balance sheets and are being amortized to interest expense over the estimated life of the term loans using the effective interest method. A portion of the deferred financing fees and original issue discount has been accelerated in connection with the debt prepayment and extinguishment of the Prior Term Loan Facility (as defined below).

Under the New Credit Agreement, the Company is required to prepay outstanding term loans, subject to certain exceptions, with portions of its annual excess cash flow as well as with the net cash proceeds of certain of its asset sales, certain casualty and condemnation events and the incurrences or issuances of certain debt.

If at any time the aggregate amount of outstanding loans, unreimbursed letter of credit drawings and undrawn letters of credit under the New Revolving Facility exceeds the aggregate commitments under the New Revolving Facility, the Company is required to repay outstanding loans and/or cash collateralize letters of credit, with no reduction of the commitment amount.

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The Company may voluntarily prepay outstanding loans under the New Credit Facilities from time to time, subject to certain conditions, without premium or penalty other than customary “breakage” costs with respect to Term SOFR or EURIBOR loans; provided, however, that subject to certain exceptions, if on or prior to the date that is twelve months after the closing date of the New Term Loan Facility, the Company prepays any loans under the USD Tranche B or the Euro Tranche B in connection with a repricing transaction, the Company must pay a prepayment premium of 1.00% of the aggregate principal amount of the loans so prepaid. Additionally, the Company may voluntarily reduce the unutilized portion of the commitment amount under the New Revolving Facility.

The Company is required to make scheduled quarterly payments each equal to 1.25% of the original principal amount of the USD Tranche A (increasing to 1.875% in years 3 and 4 and 2.50% in year 5) and 0.25% of the original principal amount of the USD Tranche B and the Euro Tranche B, beginning with the fiscal quarter ending December 31, 2022, with the balance due thereunder on the fifth anniversary of the closing date in the case of the USD Tranche A and the seventh anniversary of the closing date in the case of the USD Tranche B and the Euro Tranche B.

There is no scheduled amortization under the New Revolving Facility. Any principal amount outstanding under the New Revolving Facility is due and payable in full on the fifth anniversary of the closing date.

The Company incurred \$7 of costs in connection with the New Revolving Facility, which were capitalized and included in other assets in the accompanying consolidated balance sheet and are being amortized to interest expense over the estimated life of four years. As a result of the termination of the Prior ABL Credit Facility (as defined below) concurrently with the Company's entry into the New Revolving Facility, the Company wrote off an immaterial amount of previously capitalized debt issuance costs.

All obligations under the New Credit Facilities are guaranteed by certain of the Company's wholly-owned domestic subsidiaries and are required to be guaranteed by certain of the Company's future wholly-owned domestic subsidiaries, and are secured by substantially all of the Company's assets and the assets of such subsidiaries, subject to certain exceptions and exclusions.

Under the New Credit Agreement, the Company has the ability to incur additional incremental debt facilities in an amount up to (x) the greater of (1) \$1,011 and (2) 75% of consolidated EBITDA, plus (y) an amount equal to the sum of all voluntary prepayments of term loans under the New Term Loan Facility, plus (z) an additional unlimited amount subject to pro forma compliance with certain leverage ratio tests (based on the security and priority of such incremental debt).

Under the USD Tranche A and the New Revolving Facility, so long as any USD Tranche A loans (or commitments in respect thereof) are outstanding as of the end of any fiscal quarter, the Company may not allow its total net leverage ratio as of the end of such fiscal quarter to be greater than 5.50 to 1.00, with an annual step-down of 0.25:1.00 and subject to a step-up of 0.50:1.00 for the four full fiscal quarter period following any material acquisition, not to exceed 5.50 to 1.00.

In addition, in the event there are no loans outstanding under the USD Tranche A, as of the end of any fiscal quarter of the Company when the aggregate amount of loans outstanding under the New Revolving Facility (net of (a) all letters of credit (whether cash collateralized or not) and (b) unrestricted cash of the Company and its restricted subsidiaries) exceeds 35% of the aggregate amount of all commitments under the New Revolving Facility in effect as of such date, the Company may not allow its first lien net leverage ratio as of the end of each such fiscal quarter to be greater than 6.00 to 1.00.

The USD Tranche B and the Euro Tranche B are not subject to financial maintenance covenants.

The New Credit Agreement contains a number of negative covenants that, among other things and subject to certain exceptions, restrict the ability of the Company and each of its subsidiaries to incur additional indebtedness; pay dividends on its capital stock or redeem, repurchase or retire its capital stock or its subordinated indebtedness; make investments, loans and acquisitions; create restrictions on the payment of dividends or other amounts to the Company from the Company's restricted subsidiaries or restrictions on the ability of the Company's restricted subsidiaries to incur liens; engage in transactions with its affiliates; sell assets, including capital stock of its subsidiaries; materially alter the business it conducts; consolidate or merge; incur liens; and engage in sale-leaseback transactions.

The New Credit Agreement also contains customary representations and warranties, affirmative covenants and provisions relating to events of default. If an event of default occurs, the lenders under the New Credit Facilities will be entitled to take various actions, including the acceleration of amounts due under the New Credit Facilities and all

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actions permitted to be taken by a secured creditor. As of December 31, 2022, the Company was in compliance with all covenants under the New Credit Agreement.

The proceeds of the New Term Loan Facility were used on the Effective Date, among other things, to fund a portion of the consideration payable in connection with the Atotech Acquisition and to refinance the Prior Term Loan Facility and the Prior ABL Credit Facility and certain indebtedness of Atotech. The Company also paid certain customary fees and expenses of JPMorgan Chase Bank, N.A., Barclays Bank PLC, BofA Securities Inc., Citigroup Global Markets Inc., HSBC Securities (USA) Inc. and Mizuho Bank, Ltd. in their respective capacities as lead arrangers and bookrunners in connection with the New Credit Facilities.

On the Effective Date, in connection with the entry into the New Credit Agreement described above, the Company terminated and prepaid the prior term loan credit facility under that certain Term Loan Credit Agreement, dated as of April 29, 2016, by and among the Company, Barclays Bank PLC and the other financial institutions from time to time party thereto (as amended, the "Prior Term Loan Credit Agreement") and the term loan credit facility thereunder, the "Prior Term Loan Facility") and terminated the prior revolving credit facility under that certain ABL Credit Agreement, dated as of February 1, 2019, by and among the Company, Barclays Bank PLC and the other financial institutions from time to time party thereto (as amended, the "Prior ABL Credit Agreement" and the revolving credit facility thereunder, the "Prior ABL Credit Facility"). At the time of termination, there were approximately \$820 in borrowings outstanding under the Prior Term Loan Facility that were prepaid and no borrowings outstanding under the Prior ABL Credit Facility. The Company has determined the termination to be a full extinguishment of debt and has written off to expense the immaterial remaining balance of deferred finance costs and debt issuance costs related to the Prior Term Loan Facility and the Prior ABL Credit Facility.

As of December 31, 2022, the outstanding principal amount of the New Term Loan Facility was \$5,122 and the weighted average interest rate was 6.8%. As of December 31, 2022, there were no borrowings under the New Revolving Facility.

Lines of Credit and Borrowing Arrangements

Certain of the Company's Japanese subsidiaries have lines of credit and a financing facility with various financial institutions, many of which generally expire and are renewed at three-month intervals with the remaining having no expiration date. The lines of credit and financing facility provided for aggregate borrowings as of December 31, 2022 and December 31, 2021 of up to an equivalent of \$27 and \$29, respectively. There were no borrowings outstanding under these arrangements at December 31, 2022 or December 31, 2021.

Contractual maturities of the Company's debt obligations as of December 31, 2022 are as follows:

<u>Year</u>	<u>Amount</u>
2023	\$ 93
2024	93
2025	110
2026	115
2027	695
Thereafter	4,016

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15) Income Taxes

A reconciliation of the Company's effective tax rate to the U.S. federal statutory rate is as follows:

	Years Ended December 31,		
	2022	2021	2020
U.S. federal statutory tax rate	21.0%	21.0%	21.0%
Federal tax credits	(1.5)	(0.7)	(1.5)
State income taxes, net of credits and net of federal benefit	(0.3)	1.5	1.1
Effect of foreign operations taxed at various rates	(6.8)	(4.5)	(5.0)
Executive compensation	1.5	0.9	1.1
Foreign derived intangible income deduction	(4.8)	(1.7)	(1.5)
Global intangible low taxed income, net of foreign tax credits	3.6	0.5	0.9
Stock-based compensation	0.3	(0.5)	(0.7)
Deferred tax asset valuation allowance	(0.4)	(0.8)	0.6
Change in income tax reserves (including interest)	0.8	(0.6)	—
Withholding taxes on foreign dividends, net of foreign tax credits	10.7	1.5	0.7
Other	(1.0)	0.4	0.5
	<u>23.1%</u>	<u>17.1%</u>	<u>17.2%</u>

The components of income before income taxes and the related provision (benefit) for income taxes consist of the following:

	Years Ended December 31,		
	2022	2021	2020
Income before income taxes:			
United States	\$ (90)	\$ 249	\$ 132
Foreign	523	416	291
	<u>\$ 433</u>	<u>\$ 665</u>	<u>\$ 423</u>
Current taxes:			
United States	\$ 40	\$ 38	\$ 29
State	7	10	6
Foreign	99	64	45
	<u>146</u>	<u>112</u>	<u>80</u>
Deferred taxes:			
United States	(68)	5	(8)
State and Foreign	22	(3)	1
	<u>(46)</u>	<u>2</u>	<u>(7)</u>
Provision for income taxes	<u>\$ 100</u>	<u>\$ 114</u>	<u>\$ 73</u>

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The significant components of the deferred tax assets and deferred tax liabilities are as follows:

	December 31,	
	2022	2021
Deferred tax assets:		
Interest, loss, and credit carryforwards	\$ 224	\$ 49
Inventory and warranty reserves	50	37
Accrued expenses and other reserves	22	16
Stock-based compensation	3	4
Executive supplemental retirement benefits	1	1
Capitalized research expenditures	31	—
Loan costs	9	—
Lease liability	55	45
Other	4	1
Total deferred tax assets	\$ 399	\$ 153
Deferred tax liabilities:		
Acquired intangible assets and goodwill	\$ (781)	\$ (137)
Depreciation and amortization	(62)	(23)
Loan costs	—	(2)
Right-of-use asset	(55)	(41)
Foreign withholding taxes	(56)	(6)
Unrealized gain	(14)	(2)
Total deferred tax liabilities	(968)	(211)
Valuation allowance	(181)	(26)
Net deferred tax liabilities	\$ (750)	\$ (84)

As of December 31, 2022, the Company had U.S. federal and state as well as foreign gross research and other tax credit carryforwards of \$42. Included in the total carryforwards are \$12 of credits that can be carried forward indefinitely while the remaining credits expire at various dates through 2036. The Company also had U.S. federal and state as well as foreign gross net operating loss and capital loss carryforwards of \$370. Included in the total carryforwards are \$52 of losses that can be carried forward indefinitely while the remaining losses expire at various dates through 2039. The Company has \$444 of foreign interest carryforwards that can be carried forward indefinitely.

Although the Company believes that its tax positions are consistent with applicable U.S. federal, state and international laws, it maintains certain income tax reserves as of December 31, 2022 in the event its tax positions were to be challenged by the applicable tax authority and additional tax assessed upon audit.

A reconciliation of the beginning and ending amount of gross unrecognized tax benefits, excluding interest and penalties, is as follows:

	Years Ended December 31,		
	2022	2021	2020
Balance at beginning of year	\$ 43	\$ 47	\$ 44
Increases for tax positions taken during prior years	35	—	1
Increases for tax positions taken during the current year	9	2	6
Reductions related to expiration of statutes of limitations and audit settlements	(4)	(6)	(4)
Balance at end of year	\$ 83	\$ 43	\$ 47

The net increase in gross unrecognized tax benefits during 2022, particularly the increases for tax positions taken during prior years, was primarily attributable to the addition of historical gross unrecognized tax benefits of Atotech as a result of the Atotech Acquisition.

The Company accrues interest and, if applicable, penalties for any uncertain tax positions. Interest and penalties are classified as a component of income tax expense. As of December 31, 2022, 2021 and 2020, the Company accrued interest on unrecognized tax benefits of approximately \$6, \$1 and \$1, respectively.

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Over the next 12 months, it is reasonably possible that the Company may recognize approximately \$3 of previously net unrecognized tax benefits, excluding interest and penalties, related to various U.S. federal and state as well as foreign tax positions, primarily due to the expiration of statutes of limitations.

The Company is subject to examination by U.S. federal and state as well as foreign tax authorities. The U.S. federal statute of limitations remains open for tax years 2018 through the present. The statute of limitations for the Company's tax filings in other jurisdictions varies between fiscal years 2015 through present. The Company also has certain U.S. federal and state as well as foreign tax loss and credit carryforwards that are open to examination. In addition, the 2017 U.S. federal transition tax remains open for examination.

On a quarterly basis, the Company evaluates both positive and negative evidence that affects the realizability of its net deferred tax assets and assesses the need for a valuation allowance. The future benefit to be derived from its deferred tax assets is dependent upon its ability to generate sufficient future taxable income to realize the assets.

During 2022, the Company increased its valuation allowance by \$155, primarily related to the valuation allowance recorded in connection with foreign interest and net operating loss carryforwards associated with the Atotech Acquisition. During 2021, the Company decreased its valuation allowance by \$4. This decrease was primarily related to the release of the valuation allowance on its Austrian entities. During 2020, the Company increased its valuation allowance by \$3. This increase was primarily related to certain foreign net operating loss carry-forward amounts.

Deferred taxes have been recorded related to historical outside basis differences, primarily unremitted earnings, of certain of the Company's foreign subsidiaries. During 2022, the Company recorded a tax provision of \$33 related to such taxes for prior periods.

The Company has a tax incentive in Singapore with benefits of approximately \$0.05 (\$0.01 per share) in 2022 and \$0.4 (\$0.01 per share) in 2021. The tax incentive in Singapore expires in June 2026.

16) Stock-Based Compensation

Employee Stock Purchase Plans

The 2014 ESPP was adopted by the Board of Directors on February 10, 2014 and approved by the Company's stockholders on May 5, 2014. The 2014 ESPP authorizes the issuance of up to an aggregate of 2.5 shares of common stock to participating employees. Offerings under the 2014 ESPP commence on June 1 and December 1 and terminate on November 30 and May 31, respectively. Under the 2014 ESPP, eligible employees can purchase shares of common stock through payroll deductions up to 10% of their compensation, up to a defined maximum annual amount. The price at which an employee's purchase option is exercised for each offering period is the lower of (1) 90% of the closing price on the common stock on the Nasdaq Global Select Market on the day that each offering commences, or (2) 90% of the closing price on the day that the offering terminates. The Company issued 0.1 shares of common stock during each of 2022, 2021 and 2020 to employees who participated in the 2014 ESPP at exercise prices of \$111.15 and \$75.47 per share in 2022, \$126.00 and \$136.94 per share in 2021, and \$95.07 and \$93.77 per share in 2020. As of December 31, 2022 there were 1.5 shares reserved for future issuance under the 2014 ESPP.

Equity Incentive Plans

Prior to May 10, 2022, the Company granted RSUs to employees and directors under the 2014 Stock Incentive Plan (the "2014 Plan"). Following shareholder approval of the 2022 Stock Incentive Plan (the "2022 Plan," and together with the 2014 Plan, the "Plans") on May 10, 2022, the Company discontinued granting RSUs to employees and directors under the 2014 Plan and began granting them under the 2022 Plan. The Plans are administered by the Compensation Committee of the Company's Board of Directors. The Plans are intended to attract and retain employees and directors, and to provide an incentive for these individuals to assist the Company to achieve long-range performance goals and enable these individuals to participate in the long-term growth of the Company. Up to 6.6 shares of common stock (subject to adjustment in the event of stock splits and other similar events) may be issued pursuant to awards granted under the 2022 Plan. The Company may grant options, RSUs, restricted stock, stock appreciation rights ("SARs") and other stock-based awards to employees, officers, directors, consultants and advisors under the 2022 Plan. Any full-value awards granted under the 2022 Plan will be counted against the shares reserved for issuance under the 2022 Plan as 1.91 shares for each share of common stock subject to such award. Any award granted under the 2022 Plan that is not a full-value award (including, without limitation, any option or SAR) will be

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counted against the shares reserved for issuance under the plan on a one-for-one basis of common stock subject to such award. “Full-value award” means any restricted stock, RSUs, or other stock-based award with a per share price or per unit purchase price lower than 100% of fair market value on the date of grant. To the extent an award that is not a full-value award is returned to the 2022 Plan, the share reserve under the 2022 Plan will be credited with one share. To the extent that a full-value award is returned to the 2022 Plan, the share reserve under the 2022 Plan will be credited with 1.91 shares. As of December 31, 2022, there were 5.8 shares reserved for future issuance under the 2022 Plan.

Time-based RSUs granted to employees generally vest 33% per year beginning on the first anniversary of the date of grant. Performance-based RSUs granted to the Company’s executive officers in 2022, 2021 and 2020 were based on the Company’s achievement of adjusted EBITDA for each respective year, defined as GAAP operating income excluding any charges or income not related to the operating performance of the Company plus depreciation and stock compensation expense, set at varying revenue levels. The final number of performance-based RSUs that vest varies based on the level of performance achieved from 0% to 150% of the underlying target shares granted in 2020 and from 0% to 200% of the underlying target shares granted in 2021 and 2022. The performance-based RSUs earned generally vest 33% per year beginning on the first anniversary of the date of grant. RSUs granted to certain employees who meet certain retirement eligibility requirements will vest in full upon each such employee’s retirement and are expensed immediately. RSUs granted to directors generally vest at the earliest of (1) one day prior to the next annual meeting, (2) 13 months from date of grant, or (3) the effective date of a change in control of the Company.

In connection with the Atotech Acquisition, all Atotech time-based RSUs and performance-based RSU awards outstanding immediately prior to the acquisition were cancelled and replaced with the Company’s time-based RSUs under the 2022 Plan in accordance with the Implementation Agreement. These RSUs are subject to the terms and conditions of the 2022 Plan and the related RSU agreements.

The following tables present the activity for the RSUs under the Plans:

	Year ended December 31, 2022	
	RSUs	Weighted Average Grant Date Fair Value
RSUs — beginning of period	0.5	\$ 127.93
RSUs issued in Atotech Acquisition	0.1	\$ 110.30
Granted	0.5	\$ 111.60
Vested	(0.3)	\$ 118.06
RSUs — end of period	<u>0.8</u>	<u>\$ 118.96</u>

	Year ended December 31, 2021	
	RSUs	Weighted Average Grant Date Fair Value
RSUs — beginning of period	0.6	\$ 93.26
Granted	0.2	\$ 177.71
Vested	(0.3)	\$ 95.95
RSUs — end of period	<u>0.5</u>	<u>\$ 127.93</u>

The Company had no outstanding SARs as of December 31, 2022 and an immaterial amount of SARs as of December 31, 2021.

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Stock-Based Compensation Expense

The Company recognized the full impact of its share-based payment plans in the consolidated statements of operations and comprehensive income. The following table reflects the effect of recording stock-based compensation:

	Years Ended December 31,		
	2022	2021	2020
Stock-based compensation expense by type of award:			
RSUs	\$ 42	\$ 34	\$ 27
Employee stock purchase plan	3	3	3
Total stock-based compensation	45	37	30
Windfall tax effect on stock-based compensation	(1)	(5)	(2)
Net effect on net income	\$ 44	\$ 32	\$ 28
Effect on net earnings per share:			
Basic	\$ 0.74	\$ 0.58	\$ 0.49
Diluted	\$ 0.73	\$ 0.58	\$ 0.49

The pre-tax effect within the consolidated statements of operations and comprehensive income of recording stock-based compensation was as follows:

	Years Ended December 31,		
	2022	2021	2020
Cost of revenues	\$ 5	\$ 4	\$ 4
Research and development expense	6	5	4
Selling, general and administrative expense	34	28	21
Acquisition and integration related expense	—	—	1
Total pre-tax stock-based compensation expense	\$ 45	\$ 37	\$ 30

Valuation Assumptions

The Company determines the fair value of RSUs based on the closing market price of the Company's common stock on the date of the award and estimates the fair value of employee stock purchase plan rights using the Black-Scholes valuation model. Such values are recognized as expense on a straight-line basis for time-based awards and using the accelerated graded vesting method for performance-based awards, both over the requisite service periods.

The weighted average fair value per share of employee stock purchase plan rights granted in 2022, 2021 and 2020 was \$29.68, \$33.55, and \$23.88, respectively. The fair value of employee stock purchase plan rights was estimated using the Black-Scholes option-pricing model with the following weighted average assumptions:

	Years Ended December 31,		
	2022	2021	2020
Employee stock purchase plan rights:			
Expected life (years)	0.5	0.5	0.5
Risk-free interest rate	0.9%	0.1%	0.9%
Expected volatility	41.9%	39.3%	45.4%
Expected annual dividends per share	\$ 0.88	\$ 0.88	\$ 0.80

Expected volatilities are based on a combination of implied and historical volatilities of the Company's common stock; the expected life represents the weighted average period of time that options granted are expected to be outstanding giving consideration to vesting schedules and the Company's historical exercise patterns; and the risk-free interest rate is based on the U.S. Treasury yield curve in effect at the time of grant for periods corresponding with the expected life of the option.

The total fair value of RSUs vested during 2022, 2021 and 2020 was approximately \$40, \$57 and \$86, respectively. As of December 31, 2022, the unrecognized compensation cost related to RSUs was approximately \$46 and will be recognized over an estimated weighted average amortization period of 1 year.

17) Stockholders' Equity

Share Repurchase Program

On July 25, 2011, the Company's Board of Directors approved a share repurchase program for the repurchase of up to an aggregate of \$200 of its outstanding common stock from time to time in open market purchases, privately negotiated transactions or through other appropriate means. The timing and quantity of any shares repurchased will depend upon a variety of factors, including business conditions, stock market conditions and business development activities, including, but not limited to, merger and acquisition opportunities. These repurchases may be commenced, suspended or discontinued at any time without prior notice. The Company has repurchased approximately 2.6 shares of common stock for approximately \$127 pursuant to the program since its adoption. During 2022, 2021 and 2020, there were no repurchases of common stock.

Cash Dividends

Holders of the Company's common stock are entitled to receive dividends when they are declared by the Company's Board of Directors. The Company's Board of Directors declared a cash dividend of \$0.22 per share during each quarter of 2022, which totaled \$52 or \$0.88 per share. The Company's Board of Directors declared a cash dividend of \$0.20 per share during the first quarter and \$0.22 per share during the second, third and fourth quarters of 2021, which totaled \$47 or \$0.86 per share.

On February 6, 2023, the Company's Board of Directors declared a quarterly cash dividend of \$0.22 per share that was paid on March 10, 2023 to Stockholders of record as of February 27, 2023.

Future dividend declarations, if any, as well as the record and payment dates for such dividends, are subject to the final determination of the Company's Board of Directors.

18) Employee Benefit Plans

The Company has a 401(k) profit-sharing plan for U.S. employees meeting certain requirements, in which eligible employees may contribute between 1% and 50% of their annual compensation to this plan, and, with respect to employees who are age 50 and older, certain specified additional amounts, limited by an annual maximum amount determined by the Internal Revenue Service. The Company, at its discretion, makes certain matching contributions to this plan based on participating employees' annual contribution to this plan and their total compensation. The Company's contributions were \$10, \$8 and \$7 for 2022, 2021 and 2020, respectively.

The Company also has a number of defined contribution plans at some of its foreign locations. The Company's contributions were immaterial for 2022, 2021 and 2020.

The Company maintains a bonus plan which provides cash awards to certain employees, at the discretion of the Compensation Committee of the Company's Board of Directors, based upon the Company's operating results. In addition, the Company's foreign locations also have various bonus plans based upon local operating results and employee performance. The total bonus expense was \$48, \$76 and \$66 for 2022, 2021 and 2020, respectively.

Defined Benefit Pension Plans

The Company has a number of defined benefit pension plans at many of its foreign location, which cover most of its full-time employees at these respective locations. In addition, the Company has certain pension assets and liabilities relating to its former employees in the United Kingdom. One of the Company's German pension plans is unfunded, as permitted under the plan and applicable laws.

As a result of the Atotech Acquisition, the Company assumed all assets and liabilities of Atotech's defined benefit pension plans.

For financial reporting purposes, the Company obtained actuarial reports supporting the calculation of net periodic pension costs that used a number of actuarial assumptions, including a discount rate for plan obligations, an assumed rate of return on pension plan assets and an assumed rate of compensation increase for employees covered by the various plans. The Company reviewed these actuarial assumptions and concluded they were reasonable based upon management's judgment, considering known trends and uncertainties. Actual results that differ from these

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assumptions would impact future expense recognition and the cash funding requirements of the Company's pension plans.

The net periodic benefit costs for the defined benefit plans included the following components:

	Years Ended December 31,	
	2022	2021
Service cost	\$ 1	\$ 1
Interest cost on projected benefit obligations	2	—
Amortization of actuarial net loss	1	1
	<u>\$ 4</u>	<u>\$ 2</u>

The changes in projected benefit obligations and plan assets, as well as the ending balance sheet amounts for the Company's defined benefit plans, were as follows:

	Years Ended December 31,	
	2022	2021
Change in projected benefit obligations:		
Projected benefit obligations, beginning of year	\$ 34	\$ 36
Liabilities assumed through Atotech Acquisition	122	—
Service cost	1	1
Interest cost	2	—
Actuarial (gain) loss	(17)	—
Benefits paid	(3)	—
Currency translation adjustments	5	(3)
Projected benefit obligations, end of year	<u>144</u>	<u>34</u>
Change in plan assets:		
Fair value of plan assets, beginning of year	12	13
Assets assumed through Atotech Acquisition	24	—
Company contributions	1	1
Loss on plan assets	(5)	—
Benefits paid	(1)	(1)
Currency translation adjustments	—	(1)
Fair value of plan assets, end of year	<u>31</u>	<u>12</u>
Net underfunded status	<u>\$ (113)</u>	<u>\$ (22)</u>

As of December 31, 2022, the estimated benefit payments for the Company's defined benefit plans for the next 10 years were as follows:

	Estimated benefit payments
2023	\$ 7
2024	7
2025	8
2026	9
2027	10
2028-2032	47
	<u>\$ 88</u>

The Company expects to contribute less than \$1 to the plans during 2023.

The weighted-average rates used to determine the net periodic benefit costs were as follows:

	December 31, 2022	December 31, 2021
Discount rate	3.7%	1.0%
Rate of increase in salary levels	3.1%	2.0%
Expected long-term rate of return on assets	2.6%	1.0%

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In determining the expected long-term rate of return on plan assets, the Company considers the relative weighting of plan assets, the historical performance of total plan assets and individual asset classes, and economic and other indicators of future performance.

Plan assets were held in the following categories as a percentage of total plan assets:

	December 31, 2022		December 31, 2021	
	Amount	Percentage	Amount	Percentage
Debt securities	\$ 20	65%	\$ 5	41%
Equity securities	7	22	1	6
Other	4	13	6	53
	\$ 31	100%	\$ 12	100%

In general, the Company's asset management objectives include maintaining an adequate level of diversification to reduce interest rate and market risk, while providing adequate liquidity to meet immediate and future benefit payment requirements.

The Company's Israeli plans account for the deferred vested benefits using the shut-down method of accounting, which resulted in assets of \$19 and vested benefit obligations of \$22 as of December 31, 2022 and assets of \$20 and vested benefit obligations of \$23 as of December 31, 2021. Under the shut-down method, the liability is calculated as if it were payable as of the balance sheet date, on an undiscounted basis.

Other Pension-Related Assets

As of December 31, 2022 and 2021, the Company had assets with an aggregate market value of \$6 for each period, for one of its German pension plans. These assets are invested in group insurance contracts through the insurance companies administering these plans, in accordance with applicable pension laws. These group insurance contracts have a guaranteed minimum rate of return ranging from 2.0% to 4.25%, depending on the contract. Because these assets were not separate legal assets of the pension plan, they were not included in the Company's plan assets shown above. However, the Company has designated such assets to pay pension benefits. Such assets are included in other assets in the accompanying consolidated balance sheet.

19) Net Income Per Share

The following is a reconciliation of basic to diluted net income per share:

Numerator:	Years Ended December 31,		
	2022	2021	2020
Net income	\$ 333	\$ 551	\$ 350
Denominator:			
Shares used in net income per common share – basic	59.7	55.4	55.1
Effect of dilutive securities	0.2	0.3	0.2
Shares used in net income per common share – diluted	59.9	55.7	55.3
Net income per common share:			
Basic	\$ 5.57	\$ 9.95	\$ 6.36
Diluted	\$ 5.56	\$ 9.90	\$ 6.33

Basic earnings per share ("EPS") is computed by dividing income available to holders of the Company's common stock by the weighted-average number of common shares outstanding during the period. The computation of diluted EPS is similar to the computation of basic EPS except that the denominator is increased to include the number of additional common shares that would have been outstanding (using the treasury stock method) if securities containing potentially dilutive common shares (RSUs) had been converted to such common shares, and if such assumed conversion is dilutive.

In 2022, 2021 and 2020, the potential dilutive effect of the weighted average shares of RSUs that were excluded from the computation of diluted weighted-average shares outstanding, as the shares would have had an anti-dilutive effect on EPS, was immaterial.

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20) Business Segment, Geographic Area, Product Information and Significant Customer Information

Reportable Segments and Products

The Company's Chief Operating Decision Maker ("CODM"), which is the Company's Chief Executive Officer, utilizes financial information to make decisions about allocating resources and assessing performance for the entire Company, which is used in the decision-making process to assess performance. The Company has a diverse base of customers across its primary served markets, which include semiconductor, electronics and packaging, and specialty industrial.

VSD delivers foundational technology solutions to leading edge semiconductor manufacturing, electronics and packaging and specialty industrial applications. VSD products are derived from the Company's core competencies in pressure measurement and control, flow measurement and control, gas and vapor delivery, gas composition analysis, electronic control technology, reactive gas generation and delivery, power generation and delivery, and vacuum technology.

PSD provides a full range of solutions including lasers, beam measurement and profiling, precision motion control, vibration isolation systems, photonics instruments, temperature sensing, opto-mechanical components, optical elements, systems for flexible PCB laser processing, high-speed multilayer ceramic capacitor testing, laser-based systems for high density interconnect PCB and package manufacturing.

MSD develops leading process and manufacturing technologies for advanced surface modification, electroless and electrolytic plating, and surface finishing. Atotech is a brand within MSD. Applying a comprehensive systems-and-solutions approach, MSD's portfolio includes chemistry, equipment, software, and services for innovative and high-technology applications in a wide variety of end-markets.

The Company derives its segment results directly from the manner in which results are reported in its management reporting system. The accounting policies that the Company uses to derive reportable segment results are substantially the same as those used for external reporting purposes. The Company groups its product offerings by its reportable segments, VSD, PSD, and MSD. The Company also provides services relating to the maintenance and repair of its products, installation services and training to all three of its reportable segments.

The following table sets forth net revenues by reportable segment:

	Years Ended December 31,		
	2022	2021	2020
Vacuum Solutions Division	\$ 1,966	\$ 1,862	\$ 1,406
Photonics Solutions Division	1,064	1,088	924
Materials Solutions Division	517	—	—
	<u>\$ 3,547</u>	<u>\$ 2,950</u>	<u>\$ 2,330</u>

MKS INSTRUMENTS, INC.
NOTES TO CONSOLIDATED FINANCIAL STATEMENTS
(in millions, except per share data)

The following table sets forth a reconciliation of segment gross profit to consolidated net income:

	Years Ended December 31,		
	2022	2021	2020
Gross profit by reportable segment:			
Vacuum Solutions Division	\$ 856	\$ 868	\$ 633
Photonics Solutions Division	499	512	416
Materials Solutions Division	192	—	—
Total gross profit by reportable segment	1,547	1,380	1,049
Operating expenses:			
Research and development	241	200	173
Selling, general and administrative	488	385	353
Acquisition and integration costs	52	30	4
Restructuring and other	10	11	10
Amortization of intangible assets	146	55	55
Gain on sale of long-lived assets	(7)	—	—
Income from operations	617	699	454
Interest income	(4)	—	(1)
Interest expense	177	25	29
Other expense, net	11	9	3
Income before income taxes	433	665	423
Provision for income taxes	100	114	73
Net income	<u>\$ 333</u>	<u>\$ 551</u>	<u>\$ 350</u>

The following table set forth capital expenditures by reportable segment:

	Years Ended December 31,		
	2022	2021	2020
Vacuum Solutions Division	\$ 96	\$ 37	\$ 36
Photonics Solutions Division	40	50	49
Materials Solutions Division	28	—	—
Total capital expenditures	<u>\$ 164</u>	<u>\$ 87</u>	<u>\$ 85</u>

The following table sets forth depreciation and amortization by reportable segment:

	Years Ended December 31,		
	2022	2021	2020
Vacuum Solutions Division	\$ 24	\$ 23	\$ 20
Photonics Solutions Division	88	81	79
Materials Solutions Division	104	—	—
Total depreciation and amortization	<u>\$ 216</u>	<u>\$ 104</u>	<u>\$ 99</u>

Total income tax expense is not presented by reportable segment because the necessary information is not available or used by the CODM.

The following table sets forth segment assets by reportable segment:

	Accounts Receivable	Inventory	Total
December 31, 2022			
Vacuum Solutions Division	\$ 307	\$ 491	\$ 798
Photonics Solutions Division	210	296	506
Materials Solutions Division	298	190	488
Corporate, Eliminations & Other	(95)	—	(95)
Total segment assets	<u>\$ 720</u>	<u>\$ 977</u>	<u>\$ 1,697</u>

MKS INSTRUMENTS, INC.
NOTES TO CONSOLIDATED FINANCIAL STATEMENTS
(in millions, except per share data)

	Accounts Receivable	Inventory	Total
December 31, 2021			
Vacuum Solutions Division	\$ 285	\$ 339	\$ 624
Photonics Solutions Division	183	239	422
Materials Solutions Division	—	—	—
Corporate, Eliminations & Other	(25)	(1)	(26)
Total segment assets	<u>\$ 443</u>	<u>\$ 577</u>	<u>\$ 1,020</u>

The following is a reconciliation of segment assets to consolidated total assets:

	December 31,	
	2022	2021
Total segment assets	\$ 1,697	\$ 1,020
Cash and cash equivalents and short-term investments	910	1,042
Other current assets	187	85
Property, plant and equipment, net	800	326
Right-of-use assets	234	184
Goodwill and intangible assets, net	7,481	1,804
Other assets and long-term assets	186	79
Consolidated total assets	<u>\$ 11,495</u>	<u>\$ 4,540</u>

Geographic Area

Information about the Company's operations by geographic region is presented in the tables below. Net revenues from unaffiliated customers are based on the location in which the sale originated. Intercompany sales between geographic areas are at tax transfer prices and have been eliminated from consolidated net revenues.

	Years Ended December 31,		
	2022	2021	2020
Net revenues:			
United States	\$ 1,479	\$ 1,259	\$ 1,059
China	497	355	274
South Korea	360	386	279
Germany	243	144	125
Other	968	806	593
	<u>\$ 3,547</u>	<u>\$ 2,950</u>	<u>\$ 2,330</u>

Long-lived assets include property, plant and equipment, net, right-of-use assets, and certain other assets, and exclude goodwill, intangible assets and long-term tax-related accounts.

	December 31,	
	2022	2021
Long-lived assets:		
United States	\$ 508	\$ 412
Germany	160	18
China	175	16
Other	343	128
	<u>\$ 1,186</u>	<u>\$ 574</u>

Goodwill associated with each of the Company's reportable segments is as follows:

	December 31,	
	2022	2021
Vacuum Solutions Division	\$ 195	\$ 195
Photonics Solutions Division	1,026	1,033
Materials Solutions Division	3,087	—
Total goodwill	<u>\$ 4,308</u>	<u>\$ 1,228</u>

MKS INSTRUMENTS, INC.
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(in millions, except per share data)

The Company sells products and services to thousands of customers worldwide, in a wide range of end markets. Revenues from its top ten customers accounted for 42%, 46% and 44% of net revenues for 2022, 2021, and 2020, respectively.

The Company had two customers with net revenues greater than or equal to 10% of total net revenues for the years ended December 31, 2022, 2021 and 2020, as shown below.

	Years Ended December 31,		
	2022	2021	2020
Lam Research Corporation	14%	15%	14%
Applied Materials, Inc.	10%	11%	11%

21) Restructuring and Other

Restructuring

Restructuring costs were \$10 in 2022, primarily related to severance costs due to a global cost-saving initiative and the closure of two facilities in Europe, as well as executive payments related to the Atotech Acquisition. Restructuring costs totaled \$7 in 2021, primarily related to severance costs due to a global cost-saving initiative, costs related to the pending closure of two facilities in Europe and the movement of the manufacturing of products to low-cost regions.

The activity related to the Company's restructuring accrual is shown below:

	2022	2021
Balance at January 1	\$ 3	\$ —
Charged to expense	10	7
Payments and adjustments	(10)	(4)
Balance at December 31	<u>\$ 3</u>	<u>\$ 3</u>

Other

During 2021, the Company recorded charges of \$3 related primarily to duplicate facility costs.

22) Commitments and Contingencies.

As of December 31, 2022, the Company has entered into purchase commitments for certain inventory components and other equipment and services used in its normal operations. The majority of the purchase commitments covered by these arrangements are for periods of less than one year and aggregate to approximately \$795.

The Company is subject to various legal proceedings and claims that have arisen in the ordinary course of business. In the opinion of management, the ultimate disposition of these matters, will not have a material adverse effect on the Company's results of operations, financial condition or cash flows.

23) Subsequent Events

On February 3, 2023, the Company identified that it had become subject to a ransomware event and took immediate action to activate its incident response and business continuity protocols to contain the incident. The Company engaged appropriate incident response professionals and notified law enforcement authorities. The Company then initiated the recovery phase and has since made substantial progress by completing restoration of its enterprise resource planning systems and reopening certain of its affected manufacturing and service operations.

Based on its investigation, the Company concluded ransomware actors encrypted certain of its systems by deploying malware. This incident required the Company to temporarily suspend operations at certain of its facilities and has had a material impact in the first quarter of 2023 on the Company's ability to process orders, ship products and provide service to its VSD and PSD customers. The incident did not impact the operations of MSD.

The Company has incurred costs in the first quarter of 2023 and expects to continue to incur costs, which may be significant, in connection with this incident. In the first quarter of 2023, these costs have been primarily comprised of

MKS INSTRUMENTS, INC.
NOTES TO CONSOLIDATED FINANCIAL STATEMENTS
(in millions, except per share data)

various third-party consulting services, including forensic experts, restoration experts, legal counsel, and other information technology and accounting professional expenses, enhancements to its cybersecurity measures, costs to restore its systems and access its data, and employee-related expenses, including with respect to increased overtime. The Company expects to incur these and other costs related to this incident in the future.

Item 9. Changes in and Disagreements with Accountants on Accounting and Financial Disclosure

None.

Item 9A. Controls and Procedures

Evaluation of Disclosure Controls and Procedures

Our management, with the participation of our Chief Executive Officer and Chief Financial Officer, evaluated the effectiveness of our disclosure controls and procedures as of December 31, 2022. The term “disclosure controls and procedures,” as defined in Rules 13a-15(e) and 15d-15(e) under the Securities Exchange Act of 1934, as amended (the “Exchange Act”), means controls and other procedures of an issuer that are designed to ensure that information required to be disclosed by the issuer in the reports that it files or submits under the Exchange Act is recorded, processed, summarized and reported, within the time periods specified in the SEC’s rules and forms. Disclosure controls and procedures include, without limitation, controls and procedures designed to ensure that information required to be disclosed by an issuer in the reports that it files or submits under the Exchange Act is accumulated and communicated to the issuer’s management, including its principal executive and principal financial officers, or persons performing similar functions as appropriate to allow timely decisions regarding required disclosure. Management recognizes that any controls and procedures, no matter how well designed and operated, can provide only reasonable assurance of achieving their objectives and management necessarily applies its judgment in evaluating the cost-benefit relationship of possible controls and procedures. Based on that evaluation, our Chief Executive Officer and Chief Financial Officer concluded that, as of December 31, 2022, the Company’s disclosure controls and procedures were not effective because of the material weakness in our internal control over financial reporting described below.

Management’s Report on Internal Control over Financial Reporting

Our management is responsible for establishing and maintaining adequate internal control over financial reporting. Internal control over financial reporting is defined in Rules 13a-15(f) and 15d-15(f) under the Exchange Act as a process designed by, or under the supervision of our Chief Executive Officer and Chief Financial Officer, or persons performing similar functions, and effected by our Board of Directors, management and other personnel, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles and includes those policies and procedures that:

- Pertain to the maintenance of records that in reasonable detail accurately and fairly reflect the transactions and dispositions of the assets of the Company;
- Provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with generally accepted accounting principles, and that our receipts and expenditures of the Company are being made only in accordance with authorization of our management and directors of the Company; and
- Provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use or disposition of our assets that could have a material effect on the financial statements.

Because of its inherent limitations, internal control over financial reporting may not prevent or detect misstatements. Projections of any evaluation of effectiveness to future periods are subject to the risk that controls may become inadequate because of changes in conditions, or that the degree of compliance with the policies or procedures may deteriorate.

Under the supervision and with the participation of our management including our Chief Executive Officer and Chief Financial Officer, we conducted an assessment of the effectiveness of our internal control over financial reporting as of December 31, 2022. In making this assessment, we used the criteria set forth in the Internal Control-Integrated Framework (2013) issued by the Committee of Sponsoring Organizations of the Treadway Commission. Based on this evaluation, due to the material weakness described below, management concluded that our internal control over financial reporting was not effective as of December 31, 2022. A material weakness is a deficiency, or a combination of deficiencies, in internal control over financial reporting, such that there is a reasonable possibility that a material misstatement of our annual or interim financial statements will not be prevented or detected on a timely basis.

Based on its assessment, our management concluded that a material weakness existed as of December 31, 2022. We did not maintain sufficient information technology (“IT”) controls to prevent or detect, on a timely basis, unauthorized access to the Company’s financial reporting systems. Specifically, we did not design and maintain effective controls with regard to our

financial reporting systems related to access authentication, intrusion detection and response capability, and backup and restoration such that recovery from a cybersecurity incident could be performed in a more timely manner. This material weakness did not result in a misstatement to the annual or interim consolidated financial statements previously filed or included in this Annual Report on Form 10-K. However, this material weakness could result in a material misstatement to the annual or interim consolidated financial statements that would not be prevented or detected.

We excluded Atotech, which we acquired in 2022, from our assessment of internal control over financial reporting as of December 31, 2022. Atotech's assets and net revenues represented approximately 13% and 15%, respectively, of the Company's assets and net revenues, as of and for the year ended December 31, 2022.

Our internal controls over financial reporting as of December 31, 2022 have been audited by PricewaterhouseCoopers LLP, an independent registered public accounting firm, as stated in its attestation report, which appears in Item 8 of this Annual Report on Form 10-K.

Remediation Plan for Material Weakness in Internal Control over Financial Reporting

We have been actively addressing the identified material weakness. Some remediation measures have been completed and actions with regard to our remediation plan are ongoing and include the following:

- engaging security specialists to assist in the review, assessment and remediation of our IT controls;
- strengthening access requirements and unauthorized access detection to our financial reporting systems; and
- implementing procedures to facilitate more timely restoration of our financial reporting systems.

Though the remediation plan is subject to continual review, we expect the remediation plan described above will address the identified material weakness. The remediation plan is subject to oversight by the Audit Committee of our Board of Directors and the identified material weakness will not be considered remediated until the remediation plan has been fully implemented, the applicable controls operate for a sufficient period of time, and we have concluded that newly implemented controls are operating effectively.

Changes in Internal Control over Financial Reporting

There was no change in our internal control over financial reporting (as defined in Rules 13a-15(f) and 15d-15(f) under the Exchange Act) during our fourth fiscal quarter that has materially affected, or is reasonably likely to materially affect, our internal control over financial reporting.

Item 9B. Other Information

None.

Item 9C. Disclosure Regarding Foreign Jurisdictions that Prevent Inspections

Not applicable.

PART III

Item 10. *Directors, Executive Officers and Corporate Governance*

The information required by this item will be set forth under the captions “Proposal One — Election of Directors,” “Directors,” “Corporate Governance,” “Executive Officers,” “Corporate Governance — Code of Business Conduct and Ethics” and “Corporate Governance — Board of Directors Meetings and Committees of the Board of Directors — Audit Committee” in our definitive proxy statement for the 2023 Annual Meeting of Stockholders, to be filed with the SEC no later than 120 days after the end of our fiscal year, and is incorporated herein by reference.

We are also required under Item 405 of Regulation S-K to provide information concerning delinquent filers of reports under Section 16 of the Securities and Exchange Act of 1934, as amended. This information will be set forth under the caption “Delinquent Section 16(a) Reports,” if applicable, in our definitive proxy statement for the 2023 Annual Meeting of Stockholders, to be filed with the SEC no later than 120 days after the end of our fiscal year, and is incorporated herein by reference.

Item 11. *Executive Compensation*

The information required by this item will be set forth under the captions “Executive Officers,” “Executive Compensation – Compensation Discussion and Analysis,” “Corporate Governance – Board of Director Meetings and Committees of the Board of Directors – Compensation Committee - Compensation Committee Interlocks and Insider Participation,” “Compensation Committee Report” and “Director Compensation” in our definitive proxy statement for the 2023 Annual Meeting of Stockholders, to be filed with the SEC no later than 120 days after the end of our fiscal year, and, other than the information required by Item 402(v) of Regulation S-K, is incorporated herein by reference.

Item 12. *Security Ownership of Certain Beneficial Owners and Management and Related Stockholder Matters*

The information required by Item 403 of Regulation S-K will be set forth under the caption “Security Ownership of Certain Beneficial Owners and Management” in our definitive proxy statement for the 2023 Annual Meeting of Stockholders, to be filed with the SEC no later than 120 days after the end of our fiscal year, and is incorporated herein by reference.

The information required by Item 201(d) of Regulation S-K will be set forth under the caption “Equity Compensation Plan Information” in our definitive proxy statement for the 2023 Annual Meeting of Stockholders, to be filed with the SEC no later than 120 days after the end of our fiscal year, and is incorporated herein by reference.

Item 13. *Certain Relationships and Related Transactions and Director Independence*

The information required by this item will be set forth under the captions “Corporate Governance – Board Independence” and “Corporate Governance – Transactions with Related Persons” in our definitive proxy statement for the 2023 Annual Meeting of Stockholders, to be filed with the SEC no later than 120 days after the end of our fiscal year, and is incorporated herein by reference.

Item 14. *Principal Accountant Fees and Services*

The information required by this item will be set forth under the caption “Audit and Financial Accounting Oversight — Principal Accountant Fees and Services” in our definitive proxy statement for the 2023 Annual Meeting of Stockholders, to be filed with the SEC no later than 120 days after the end of our fiscal year, and is incorporated herein by reference.

PART IV

Item 15. Exhibits and Financial Statement Schedules

(a) The following documents are filed as a part of this Annual Report on Form 10-K:

1. *Financial Statements.* The following Consolidated Financial Statements are included under Item 8 of this Annual Report on Form 10-K.

INDEX TO CONSOLIDATED FINANCIAL STATEMENTS

Financial Statements:

Report of Independent Registered Public Accounting Firm (PCAOB ID 238)	60
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Consolidated Statements of Operations and Comprehensive Income for the years ended December 31, 2022, 2021 and 2020	63
Consolidated Statements of Stockholders' Equity for the years ended December 31, 2022, 2021 and 2020	64
Consolidated Statements of Cash Flows for the years ended December 31, 2022, 2021 and 2020	65
Notes to Consolidated Financial Statements	66

2. *Financial Statement Schedules.* The following consolidated financial statement schedule is included in this Annual Report on Form 10-K.

[Schedule II – Valuation and Qualifying Accounts](#)

Schedules other than those listed above have been omitted since they are either not required or information is otherwise included.

3. *Exhibits.* The following exhibits are filed as part of this Annual Report on Form 10-K.

Exhibit No.	Title
+2.1(1)	Implementation Agreement, between the Registrant and Atotech Limited, dated as of July 1, 2021
+2.2(2)	Letter Agreement, by and among the Registrant, Atotech Limited and Atotech Manufacturing, Inc., dated October 29, 2021
+2.3(3)	Amendment to Implementation Agreement, dated April 1, 2022, by and among Atotech Limited, the Registrant and Atotech Manufacturing, Inc.
+3.1(4)	Restated Articles of Organization of the Registrant
+3.2(5)	Articles of Amendment to Restated Articles of Organization, as filed with the Secretary of State of Massachusetts on May 18, 2001
+3.3(6)	Articles of Amendment to Restated Articles of Organization, as filed with the Secretary of State of Massachusetts on May 16, 2002
+3.4(7)	Amended and Restated By-Laws of the Registrant
+4.1(8)	Specimen certificate representing the Common Stock
+4.2(8)	Description of Capital Stock Registered Under Section 12 of the Exchange Act
+10.1(9)	Credit Agreement, dated as of August 17, 2022, by and among the Registrant, the lenders and letter of credit issuers party thereto and JPMorgan Chase Bank, N.A., as administrative agent and collateral agent
+10.2(10)*	2022 Stock Incentive Plan

Exhibit No.	Title
+10.3(11)*	Form of Restricted Stock Unit Agreement for Non-Employee Directors under the 2022 Stock Incentive Plan
+10.4(11)*	Form of Restricted Stock Unit Agreement for Employees under the 2022 Stock Incentive Plan for 2022
10.5*	Form of Restricted Stock Unit Agreement for Employees under the 2022 Stock Incentive Plan for 2023
+10.6(7)*	2014 Stock Incentive Plan
+10.7(7)*	2014 Employee Stock Purchase Plan
+10.8(7)*	Form of Restricted Stock Unit Agreement for Non-Employee Directors under the 2014 Stock Incentive Plan
+10.9(12)*	Form of Restricted Stock Unit Agreement for Employees under the 2014 Stock Incentive Plan
+10.10(13)*	Employment Agreement, dated October 22, 2013, between Gerald G. Colella and the Registrant
+10.11(14)*	Amendment, dated March 27, 2018, to Employment Agreement, dated as of October 22, 2013, between Gerald G. Colella and the Registrant
+10.12(15)*	Second Amendment, dated October 29, 2018, to Employment Agreement, dated as of October 22, 2013, between Gerald G. Colella and the Registrant
+10.13(16) *	Employment Agreement, dated as of November 18, 2019, between John T.C. Lee and the Registrant
+10.14(17)*	Employment Agreement, effective August 1, 2016, between Seth Bagshaw and the Registrant
+10.15(15)*	Amendment, dated October 29, 2018, to Employment Agreement, effective August 1, 2016, by and between Seth Bagshaw and the Registrant
+10.16(18)*	Employment Agreement, effective August 1, 2016, between Kathleen Burke and the Registrant, as amended on October 29, 2018
+10.17(8)*	Employment Agreement, effective September 16, 2019, between James A. Schreiner and the Registrant
+10.18(19)*	Amendment, dated October 25, 2021, to Employment Agreement, effective September 16, 2019, between James A. Schreiner and the Registrant
+10.19(20)*	Employment Agreement, effective February 18, 2021, between Mark Gitin, the Registrant and Newport Corporation
+10.20(20)*	Employment Agreement, effective January 1, 2020, between David Henry and the Registrant
+10.21(20)*	Employment Agreement, effective February 17, 2021, between Eric Taranto and the Registrant
+10.22(21)*	Management Incentive Plan
+10.23(9)	Investor Rights Agreement, dated August 17, 2022, by and among the Registrant and the Carlyle Stockholders
21.1	Subsidiaries of the Registrant
23.1	Consent of PricewaterhouseCoopers LLP
31.1	Certification of Principal Executive Officer pursuant to Rule 13a-14(a)/Rule 15d-14(a) of the Securities Exchange Act of 1934
31.2	Certification of Principal Financial Officer pursuant to Rule 13a-14(a)/Rule 15d-14(a) of the Securities Exchange Act of 1934
32.1	Certification of Chief Executive Officer and Chief Financial Officer pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002
101.INS**	Inline XBRL Instance Document - the instance document does not appear in the Interactive Data File because its XBRL tags are embedded within the Inline XBRL document.
101.SCH**	Inline XBRL Taxonomy Extension Schema Document
101.CAL**	Inline XBRL Taxonomy Calculation Linkbase

Exhibit No.	Title
101.DEF**	Inline XBRL Taxonomy Extension Definition Linkbase Document
101.LAB**	Inline XBRL Taxonomy Labels Linkbase Document
101.PRE**	Inline XBRL Taxonomy Presentation Linkbase Document
104	Cover Page Interactive Data File (formatted as inline XBRL with applicable taxonomy extension information contained in Exhibits 101)

+ Previously filed

* Management contract or compensatory plan arrangement

** Filed with this Annual Report on Form 10-K for the year ended December 31, 2022 are the following documents formatted in iXBRL (Inline Extensible Business Reporting Language): (i) the Consolidated Balance Sheets; (ii) the Consolidated Statements of Operations and Comprehensive Income; (iii) the Consolidated Statements of Stockholders' Equity; (iv) the Consolidated Statements of Cash Flows; and (v) the Notes to Consolidated Financial Statements.

The following materials from MKS Instruments, Inc.'s Annual Report on Form 10-K for the year ended December 31, 2022, are formatted in XBRL (Extensible Business Reporting Language): (i) the Consolidated Balance Sheets, (ii) the Consolidated Statements of Operations and Comprehensive Income, (iii) the Consolidated Statements of Stockholders' Equity, (iv) the Consolidated Statements of Cash Flows, and (v) Notes to Consolidated Financial Statements.

- (1) Incorporated by reference to the Registrant's Current Report on Form 8-K (File No. 000-23621), filed with the Securities and Exchange Commission on July 2, 2021.
- (2) Incorporated by reference to the Registrant's Annual Report on Form 10-K for the year ended December 31, 2021 (File No. 000-23621), filed with the Securities and Exchange Commission on February 28, 2022.
- (3) Incorporated by reference to the Registrant's Current Report on Form 8-K (File No. 000-23621), filed with the Securities and Exchange Commission on April 1, 2022.
- (4) Incorporated by reference to the Registration Statement on Form S-4 (File No. 333-49738), filed with the Securities and Exchange Commission on November 13, 2000.
- (5) Incorporated by reference to the Registrant's Quarterly Report on Form 10-Q for the quarter ended June 30, 2001 (File No. 000-23621), filed with the Securities and Exchange Commission on August 14, 2001.
- (6) Incorporated by reference to the Registrant's Quarterly Report on Form 10-Q for the quarter ended June 30, 2002 (File No. 000-23621), filed with the Securities and Exchange Commission on August 13, 2002.
- (7) Incorporated by reference to the Registrant's Current Report on Form 8-K (File No. 000-23621), filed with the Securities and Exchange Commission on May 6, 2014.
- (8) Incorporated by reference to the Registrant's Annual Report on Form 10-K for the year ended December 31, 2019 (File No. 000-23621), filed with the Securities and Exchange Commission on February 28, 2020.
- (9) Incorporated by reference to the Registrant's Current Report on Form 8-K (File No. 000-23621), filed with the Securities and Exchange Commission on August 17, 2022.
- (10) Incorporated by reference to the Registration Statement on Form S-8 (File No. 333-264817), filed with the Securities and Exchange Commission on May 10, 2022.
- (11) Incorporated by reference to the Registrant's Current Report on Form 8-K (File No. 000-23621), filed with the Securities and Exchange Commission on May 11, 2022.
- (12) Incorporated by reference to the Registrant's Annual Report on Form 10-K for the year ended December 31, 2018 (File No. 000-23621), filed with the Securities and Exchange Commission on February 26, 2019.
- (13) Incorporated by reference to the Registrant's Current Report on Form 8-K (File No. 000-23621), filed with the Securities and Exchange Commission on October 24, 2013.
- (14) Incorporated by reference to the Registrant's Quarterly Report on Form 10-Q for the quarter ended March 31, 2018 (File No. 000-23621), filed with the Securities and Exchange Commission on May 8, 2018.
- (15) Incorporated by reference to the Registrant's Current Report on Form 8-K (File No. 000-23621), filed with the Securities and Exchange Commission on November 1, 2018.

- (16) Incorporated by reference to the Registrant's Current Report on Form 8-K (File No. 000-23621), filed with the Securities and Exchange Commission on November 20, 2019.
- (17) Incorporated by reference to the Registrant's Quarterly Report on Form 10-Q for the quarter ended June 30, 2016 (File No. 000-23621), filed with the Securities and Exchange Commission on August 3, 2016.
- (18) Incorporated by reference to the Registrant's Quarterly Report on Form 10-Q for the quarter ended June 30, 2019 (File No. 000-23621), filed with the Securities and Exchange Commission on August 7, 2019.
- (19) Incorporated by reference to the Registrant's Current Report on Form 8-K (File No. 000-23621), filed with the Securities and Exchange Commission on October 29, 2021.
- (20) Incorporated by reference to the Registrant's Annual Report on Form 10-K for the year ended December 31, 2020 (File No.000-23621), filed with the Securities and Exchange Commission on February 23, 2021.
- (21) Incorporated by reference to the Registrant's Current Report on Form 8-K (File No. 000-23621), filed with the Securities and Exchange Commission on February 11, 2022.

(b) Exhibits

MKS hereby files as exhibits to our Annual Report on Form 10-K those exhibits listed in Item 15(a) above.

Item 16. Form 10-K Summary

Not applicable.

MKS INSTRUMENTS, INC.
SCHEDULE II - VALUATION AND QUALIFYING ACCOUNTS
(in millions)

Description	Balance at Beginning of Year	Additions			Deductions & Write-offs	Balance at End of Year
		Acquisition Beginning Balance	Charged to Costs and Expenses	Charged to Other Accounts		
Allowance for doubtful accounts:						
Years ended December 31,						
2022	\$ 4	\$ 10	\$ 2	\$ —	\$ (5)	\$ 11
2021	\$ 2	\$ —	\$ 1	\$ —	\$ 1	\$ 4
2020	\$ 2	\$ —	\$ —	\$ —	\$ —	\$ 2

Description	Balance at Beginning of Year	Additions			Deductions & Write-offs	Balance at End of Year
		Acquisition Beginning Balance	Charged to Costs and Expenses	Charged to Other Accounts		
Allowance for sales returns:						
Years ended December 31,						
2022	\$ 2	\$ —	\$ (1)	\$ —	\$ —	\$ 1
2021	\$ 1	\$ —	\$ 1	\$ —	\$ —	\$ 2
2020	\$ 1	\$ —	\$ —	\$ —	\$ —	\$ 1

Description	Balance at Beginning of Year	Additions			Deductions & Write-offs	Balance at End of Year
		Acquisition Beginning Balance	Charged to Costs and Expenses	Charged to Other Accounts		
Valuation allowance on deferred tax assets:						
Years ended December 31,						
2022	\$ 26	\$ 156	\$ —	\$ —	\$ (1)	\$ 181
2021	\$ 31	\$ —	\$ 2	\$ —	\$ (7)	\$ 26
2020	\$ 27	\$ —	\$ 4	\$ —	\$ —	\$ 31

SIGNATURES

Pursuant to the requirements of Section 13 or 15(d) of the Securities Exchange Act of 1934, the registrant has duly caused this annual report on Form 10-K for the fiscal year ended December 31, 2022 to be signed on its behalf by the undersigned, thereunto duly authorized on the 14th day of March 2023.

MKS INSTRUMENTS, INC.

By: /s/ John T.C. Lee
John T.C. Lee
President and Chief Executive Officer
(Principal Executive Officer)

Pursuant to the requirements of the Securities Exchange Act of 1934, this report has been signed below by the following persons on behalf of the registrant and in the capacities and on the date indicated.

<u>SIGNATURES</u>	<u>TITLE</u>	<u>DATE</u>
<u>/s/ Gerald G. Colella</u> Gerald G. Colella	Chairman of the Board of Directors	March 14, 2023
<u>/s/ John T.C. Lee</u> John T.C. Lee	President, Chief Executive Officer and Director (Principal Executive Officer)	March 14, 2023
<u>/s/ Seth H. Bagshaw</u> Seth H. Bagshaw	Executive Vice President, Chief Financial Officer and Treasurer (Principal Financial and Accounting Officer)	March 14, 2023
<u>/s/ Rajeev Batra</u> Rajeev Batra	Director	March 14, 2023
<u>/s/ Peter J. Cannone III</u> Peter J. Cannone III	Director	March 14, 2023
<u>/s/ Joseph B. Donahue</u> Joseph B. Donahue	Director	March 14, 2023
<u>/s/ Jacqueline F. Moloney</u> Jacqueline F. Moloney	Director	March 14, 2023
<u>/s/ Elizabeth A. Mora</u> Elizabeth A. Mora	Director	March 14, 2023
<u>/s/ Michelle M. Warner</u> Michelle M. Warner	Director	March 14, 2023
<u>/s/ Geoffrey Wild</u> Geoffrey Wild	Director	March 14, 2023

MKS INSTRUMENTS, INC.
 Restricted Stock Unit Agreement
Granted Under the 2022 Stock Incentive Plan

AGREEMENT made _____ (the "Grant Date"), between MKS Instruments, Inc., a Massachusetts corporation (the "Company"), and _____ (the "Participant").

For valuable consideration, receipt of which is acknowledged, the parties hereto agree as follows:

1. **General.** The Company hereby grants to the Participant restricted stock units ("RSUs") with respect to the number of shares set forth in Exhibit A hereto (the "Shares") of common stock, no par value, of the Company ("Common Stock"), subject to the terms and conditions set forth in this Agreement and in the Company's 2022 Stock Incentive Plan (the "Plan"). The RSUs represent a promise by the Company to deliver Shares upon vesting and settlement.

(a) **Definitions.** Capitalized terms not explicitly defined in this Agreement shall have the same meanings given to them in the Plan.

(i) "Code" means the U.S. Internal Revenue Code of 1986, as amended.

(ii) "Determination Date" (if applicable) is defined in Exhibit A hereto.

(iii) "Disability" means either (A) the Participant is unable to engage in any substantial gainful activity by reason of any medically determinable physical or mental impairment that can be expected to result in death or can be expected to last for a continuous period of not less than 12 months; or (B) the Participant is, by reason of any medically determinable physical or mental impairment that can be expected to result in death or can be expected to last for a continuous period of not less than 12 months, receiving income replacement benefits for a period of not less than three months under an accident and health plan covering employees of the Company.

(iv) "Employ" or "employment" with the Company includes employment with a parent or subsidiary of the Company as defined in Code Section 424(e) or (f), during the time in which such entity is a parent or subsidiary of the Company.

(v) "Forfeiture" means any forfeiture of RSUs pursuant to Section 2.

(vi) "Retirement"¹ means a voluntary termination of employment by the Participant after he or she is at least age [sixty (60) and has at least ten (10) Continuous Years of Service with the Company][sixty-five (65) and has at least ten (10) Continuous Years of Service with the Company or after he or she is at least age sixty (60) and has at least fifteen (15) Continuous Years of Service with the Company ("Early Retirement")]. A Participant's termination shall not be deemed to be on account of Retirement unless he or she provides the Company with notice of the Retirement at least sixty (60) days in advance of his or her proposed termination date and assists in the orderly transition of duties as requested by the Company. The Company may waive such advance notice requirement in its sole discretion.

(vii) "Vesting Date" is defined on Exhibit A hereto.

(viii) "Continuous Years of Service" means the total number of years of employment since Participant's most recent date of employment with the Company; provided, however, that if the Participant left or was terminated from employment with the Company and was then rehired, all or a portion of the previous employment period may be included in the Continuous Years of Service according to the Company's local country practices.

¹ The definition of Retirement as a voluntary termination of employment by the Participant after he or she is at least age sixty-five (65) and has at least ten (10) Continuous Years of Service with the Company or after he or she is at least age sixty (60) and has at least fifteen (15) Continuous Years of Service with the Company ("Early Retirement") shall apply only to certain officers designated by the Compensation Committee. The definition of Retirement for all other Participants shall be a voluntary termination of employment by the Participant after he or she is at least age sixty (60) and has at least ten (10) Continuous Years of Service with the Company.

(b) Vesting Period. Subject to the terms and conditions of this Agreement (including the Forfeiture provisions described in Section 2 below), the RSUs shall vest according to the terms set forth in Exhibit A. As soon as practicable after each applicable Vesting Date, but no later than thirty (30) days following the applicable Vesting Date, the Company shall instruct its transfer agent to deposit the Shares subject to the RSUs into the Participant's existing equity account at Fidelity Stock Plan Services, LLC, or such other broker with which the Company has established a relationship ("Broker"), subject to payment in accordance with Section 6 of all applicable [withholding]² taxes. Notwithstanding the above, the Shares may be distributed following the date contemplated in this Section 1(b) solely to the extent permitted or required under Code Section 409A and regulations thereunder ("Section 409A").

2. Forfeiture.

(a) Cessation of Employment.

(i) In the event that the Participant ceases to be employed by the Company for any reason or no reason (except for death, Disability or Retirement), with or without cause, prior to a Vesting Date, all of the Participant's unvested RSUs shall automatically be forfeited as of such cessation. For purposes hereof, employment shall not be considered as having ceased during any bona fide leave of absence if such leave of absence has been approved in writing by the Company. However, in the event of any leave of absence, the Company may, in its sole discretion, suspend vesting of the RSUs, subject to applicable law and the provisions of Section 409A. The vesting of the RSUs shall not be affected by any change in the type of employment the Participant has with the Company so long as the Participant continuously maintains employment.

(ii) In the event that the Participant ceases to be employed by the Company by reason of death or Disability prior to a Vesting Date, then all of the Participant's unforfeited RSUs shall become immediately and fully vested (subject to any performance criteria in Exhibit A) and shall no longer be subject to the Forfeiture provisions under this Agreement and the Shares subject to such RSUs shall be delivered to the Participant as soon as practicable (but no later than thirty (30) days) following the Participant's termination date, provided, however, that, if such death or Disability occurs prior to the Determination Date, if any, then the number of RSUs to be so vested shall be determined, and become vested, on the Determination Date, if any, and the Shares subject to such vested portion of the RSUs shall be delivered to the Participant as soon as practicable (but no later than thirty (30) days) following such Determination Date, if any.

(iii) [In the event that the Participant ceases to be employed by the Company by reason of Retirement prior to a Vesting Date, then all of the Participant's unforfeited RSUs shall become immediately and fully vested (subject to any performance criteria in Exhibit A) and shall no longer be subject to the Forfeiture provisions under this Agreement and the Shares subject to such RSUs shall be delivered to the Participant as soon as practicable (but no later than thirty (30) days) following the Participant's termination date, provided, however, that, if such Retirement occurs prior to the Determination Date, if any, then the number of RSUs to be so vested shall be determined, and become vested, on the Determination Date, if any, and the Shares subject to such vested portion of the RSUs shall be delivered to the Participant as soon as practicable (but no later than thirty (30) days) following such Determination Date, if any[, provided further that if such Retirement is an Early Retirement and occurs prior to the Determination Date, if any, then the number of RSUs to be so vested shall be determined by prorating the total amount earned by the portion of the performance period during which the Participant was employed.]]³. [In the event that the Participant ceases to be employed by the Company by reason of Retirement prior to a Vesting Date, then (i) if such Retirement occurs prior to the first anniversary of the Grant Date, then all of the Participant's unvested RSUs shall automatically be forfeited as of such cessation and (ii) if such Retirement occurs on or after the first anniversary of the Grant Date, then all of the Participant's unforfeited RSUs shall become immediately and fully vested and shall no longer be subject to the Forfeiture provisions under this Agreement and the Shares subject to such RSUs shall be delivered to the Participant as soon as practicable (but no later than thirty (30) days) following the Participant's termination date.]⁴.

². Delete for employees located outside of the United States.

³. Include for only those officers designated by the Compensation Committee. The final bracketed proviso to be included only if such officer's definition of Retirement includes a definition of Early Retirement.

⁴. Include for all Participants other than those officers designated by the Compensation Committee.

(b) Change in Control. Notwithstanding the foregoing, if, prior to any Vesting Date, and within two years after the effectiveness of a Change in Control (as defined below), the Participant is (i) terminated by the Company without Cause (as defined below) or (ii) terminates his employment for Good Reason (as defined below), then, all (or, in the case of a performance-based RSU that is still subject to performance criteria per Exhibit A, the Target Number of RSUs (as defined on Exhibit A, if applicable) of the Participant's unforfeited RSUs shall become immediately and fully vested and shall no longer be subject to the Forfeiture provisions under this Agreement and the Shares subject to such RSUs shall be delivered to the Participant as soon as practicable (but no later than thirty (30) days) following the date of the date of termination. For purposes of this section "Change in Control" means the first to occur of any of the following events: (I) any "person" (as that term is used in Section 13 and 14(d)(2) of the Securities Exchange Act of 1934 ("Exchange Act")) becomes the beneficial owner (as that term is used in Section 13(d) of the Exchange Act), directly or indirectly, of fifty percent (50%) or more of the Company's capital stock entitled to vote in the election of directors; (II) the shareholders of the Company approve any consolidation or merger of the Company, other than a consolidation or merger of the Company in which the holders of Common Stock immediately prior to the consolidation or merger hold more than fifty percent (50%) of the common stock of the surviving corporation immediately after the consolidation or merger; or (III) the shareholders of the Company approve the sale or transfer of all or substantially all of the assets of the Company to parties that are not within a "controlled group of corporations" (as defined in Code Section 1563) in which the Company is a member; provided, that, in the event that the RSUs constitute nonqualified deferred compensation subject to Section 409A, such Change in Control is also a "change in control event" within the meaning of Treasury Regulation Section 1.409A-3(i)(5). For purposes of this Agreement, "Cause" shall mean (I) Participant commits a felony or engages in fraud, misappropriation or embezzlement, (II) Participant knowingly fails or refuses to perform his or her duties in a material way and, to the extent that the Company determines such failure or refusal can be reasonably cured, Participant fails or refuses to effect a cure within 10 days after the Company notifies the Participant in writing of the failure or refusal, (III) Participant knowingly causes, or knowingly creates a serious risk of causing, material harm to the Company's business or reputation or (IV) Participant breaches, in a material way, Participant's employment agreement (an "Employment Agreement"), to the extent one exists, Participant's confidential information agreement or any other material agreement between the Participant and the Company, and to the extent that the Company determines such breach can reasonably be cured, Participant fails or refuses to effect a cure within 10 days after the Company's notification to the Participant in writing of the breach. For purposes of this section, "Good Reason" shall mean termination of the Participant's employment by the Participant within 90 days following (I) a material diminution in the Participant's positions, duties or responsibilities, (II) a material reduction in the Participant's then current base salary, (III) a material breach of any provision of the Participant's Employment Agreement, to the extent one exists, by the Company or (IV) the Company changes Participant's principal place of work to a location more than 50 miles from Participant's then current principal place of work, unless Participant is on an international assignment, in which case, if, during the term of such assignment, the Company changes Participant's principal place of work to a location more than 50 miles from the host location specified in his or her international assignment terms, as may be in effect from time to time. Notwithstanding the foregoing, a termination shall not be treated as a termination for Good Reason (I) if the Participant shall have consented in writing to the occurrence of the event giving rise to the claim of termination for Good Reason or (II) unless the Participant shall have delivered a written notice to the Company within thirty (30) days of his having actual knowledge of the occurrence of one of such events stating that he intends to terminate his employment for Good Reason and specifying the factual basis for such termination, and such event, if capable of being cured, shall not have been cured within thirty (30) days of the receipt of such notice.

(c) Clawback. In accepting the RSUs, the Participant agrees to be bound by any clawback policy that the Company has in effect or may adopt in the future. The Participant hereby acknowledges and consents to the Company's application, implementation and enforcement of (i) any applicable clawback policy as may be in effect from time to time and (ii) any provision of applicable law relating to cancellation, recoupment, rescission or payment of compensation, and agrees that the Company may take such actions as may be necessary to effectuate the clawback policy without further consideration or action.

3. Restrictions on Transfer. The Participant shall not sell, assign, transfer, pledge, hypothecate or otherwise dispose of, by operation of law or otherwise (collectively "transfer") any RSUs, or any interest therein; provided that the Participant may transfer the RSUs to the extent necessary to fulfill a domestic relations order (as defined in Section 414(p)(1)(B) of the Code); provided, further, that any such transferred RSUs shall remain subject to this Agreement (including without limitation the terms of Forfeiture and the restrictions on transfer set forth in this Section 3) and such permitted transferee shall, as a condition to such transfer, deliver to the Company a written instrument confirming that such transferee shall be bound by all of the terms and conditions of this Agreement.

4. Provisions of the Plan. This Agreement is subject to the provisions of the Plan, a copy of which is furnished to the Participant with this Agreement.

5. Section 409A. To the extent the Participant is or becomes subject to U.S. Federal income taxation, the RSUs and payments made pursuant to this Agreement are intended to comply with or qualify for an exemption from the requirements of Section 409A and this Agreement shall be construed consistently therewith. Neither the Company nor the Participant shall have any right to accelerate or defer payment under this Agreement except to the extent specifically permitted or required by Section 409A. Terms defined in the Agreement shall have the meanings given such terms under Section 409A if and to the extent required to comply with Section 409A, including that references to “termination of employment” or similar terms shall be considered to be references to a “separation from service” as defined under Section 409A. Notwithstanding any other provision of this Agreement, the Company reserves the right, to the extent it deems necessary or advisable, in its sole discretion, to unilaterally amend the Plan and/or this Agreement to ensure that all awards hereunder qualify for exemption from or otherwise comply with Section 409A; provided, however, that the Company makes no undertaking to preclude Section 409A from applying to this Award or to guarantee compliance therewith. Any payments described in this Section 5 that are due within the “short term deferral period” as defined in Section 409A shall not be treated as deferred compensation unless applicable law requires otherwise. If and to the extent any portion of any payment, compensation or other benefit provided to the Participant in connection with his or her employment termination is determined to constitute “nonqualified deferred compensation” within the meaning of Section 409A and the Participant is a specified employee as defined in Section 409A(2)(B)(i) of the Code, as determined by the Company in accordance with its procedures, by which determination the Participant hereby agrees that he or she is bound, such portion of the payment, compensation or other benefit shall not be paid before the day that is six months plus one day after the date of separation from service (as determined under Section 409A (the “New Payment Date”)), except as Section 409A may then permit. The aggregate of any payments that otherwise would have been paid to the Participant during the period between the date of separation from service and the New Payment Date shall be paid to the Participant in a lump sum on the New Payment Date, and any remaining payments will be paid on their original schedule. Notwithstanding the foregoing, the Company, its affiliates, directors, officers and agents shall have no liability to a Participant, or any other party, if the RSU that is intended to be exempt from, or compliant with, Section 409A is not so exempt or compliant, or for any action taken by the Board, a Committee or its delegates.

6. Withholding Taxes^{5,6.}

^{5.} This section is applicable to employees who are located in the United States. For employees located outside of the United States, Section 6 shall read as follows:

6. Tax Obligations.

(a) Regardless of any action the Company or the affiliate that employs the Participant (the “Employer”) takes with respect to any or all income tax, social insurance, payroll tax, fringe benefits tax, payment on account, or other tax-related items related to the Participant’s participation in the Plan and legally applicable to the Participant (“Tax-Related Items”), the Participant acknowledges that the ultimate liability for all Tax-Related Items owed Participant by the Participant is and remains the Participant’s responsibility and that such amount may exceed the amount actually withheld by the Company and/or the Employer. The Participant further acknowledges that the Company and/or the Employer (i) make no representations or undertakings regarding the treatment of any Tax-Related Items in connection with any aspect of the RSUs, including the grant or vesting of the RSUs, the issuance of Shares in settlement of the RSUs, the subsequent sale of Shares, and the receipt of any dividends; and (ii) do not commit and are under no obligation to structure the terms of the grant or any aspect of the RSUs to reduce or eliminate the Participant’s liability for Tax-Related Items or achieve any particular tax result. Further, if the Participant becomes subject to tax in more than one jurisdiction, the Participant acknowledges that the Company and/or the Employer (or former Employer, as applicable) may be required to withhold or account for Tax-Related Items in more than one jurisdiction.

(b) To satisfy any withholding obligations of the Company and/or the Employer with respect to Tax-Related Items (the “Withholding Taxes”), the Company will withhold through the retention by the Company of Shares. Accordingly, the Participant hereby instructs the Company, with no further action by the Participant, to deduct and retain from the number of Shares to which the Participant is entitled from the RSUs then vested or scheduled to vest such number of Shares as is equal to the value of the Withholding Taxes. The fair market value of such surrendered Shares will be based on the closing price of the Common Stock on the respective Vesting Date, provided, however, that if such date is not a trading day, the Company shall use the closing price on the first trading day following such date. Alternatively, or in addition, the Participant authorizes the Company and/or the Employer, or their respective agents, at their discretion, to satisfy their obligations, if any, with regard to all Withholding Taxes by one or a combination of the following: (i) withholding from Participant’s wages or other cash compensation payable to the Participant by the Company, the Employer, or any affiliate, (ii) requiring the Participant to tender a cash payment to the Company or an affiliate in the amount of the Withholding Taxes and/or (iii) any other method of withholding determined by the Company to be permitted under the Plan and, to the extent required by applicable law or under the Plan, approved by the Board or a Committee. Notwithstanding the foregoing, if the Participant is a Section 16 officer of the Company under the Exchange Act, the Company will withhold Shares from the Shares to be issued upon payment of the RSUs, as described herein, and will not use the other means set forth in this Section 6.

(c) The Company may withhold for Withholding Taxes by considering statutory or other withholding rates, including maximum applicable rates in the Participant’s jurisdiction(s). In the event of over-withholding, the Participant may receive a refund of any over-withheld amount in cash (with no entitlement to the equivalent amount in Shares) from the Company or the Employer, otherwise, the Participant may be able to seek a refund from the local tax authorities. In the event of under-withholding, the Participant may be required to pay any additional Tax-Related Items directly to the applicable tax authority or to the Company and/or the Employer. The Company may refuse to issue or deliver the Shares or the proceeds of the sale of Shares, if the Participant fails to comply with his or her obligations in connection with the Tax-Related Items.

^{6.} For employees located in certain countries outside of the United States, specific local tax law and securities law provisions will also be inserted or added as an addendum to the RSU Agreement.

(a) The Company's obligation to deliver Shares to the Participant upon the vesting and settlement of RSUs shall be subject to the satisfaction of all income tax (including federal, state and local taxes), social insurance, payroll tax, payment on account or other tax related withholding requirements ("Withholding Taxes"). In order to satisfy all Withholding Taxes of the Participant's RSUs, the Participant agrees to the following:

(b) The Participant hereby elects to satisfy all Withholding Taxes obligation that may arise through the retention by the Company of Shares. Accordingly, the Participant hereby instructs the Company, with no further action by the Participant, to deduct and retain from the number of Shares to which the Participant is entitled from the RSUs then vested or scheduled to vest such number of Shares as is equal to the value of the Withholding Taxes. The fair market value of such surrendered Shares will be based on the closing price of the Common Stock on the respective Vesting Date, provided, however, that if such date is not a trading day, the Company shall use the closing price on the first trading day following such date. The Participant agrees that in the event the Company withholds RSUs with a value in excess of the maximum amount of social insurance that can be imposed in any particular year, the Company will refund the excess amount in cash to the Participant.

(c) Participant has reviewed with the Participant's own tax advisors the federal, state, local and foreign tax consequences of this equity award and the transactions contemplated by this Agreement. The Participant is relying solely on such advisors and not on any statements or representations of the Company or any of its agents. The Participant understands that the Participant (and not the Company) shall be responsible for the Participant's own tax liability that may arise as a result of this equity award or the transactions contemplated by this Agreement.

(d) The Participant represents to the Company that, as of the date hereof, he/she is not aware of any material nonpublic information about the Company or the Common Stock. The Participant and the Company have structured this Agreement to constitute a "binding contract" relating to the retention by the Company of Common Stock pursuant to this Section 6, consistent with the affirmative defense to liability under Section 10(b) of the Securities Exchange Act of 1934 under Rule 10b5-1(c) promulgated under such Act.

7. Nature of the Grant. In signing this Agreement, the Participant acknowledges that:

(a) The Plan is established voluntarily by the Company, it is discretionary in nature and may be modified, amended, suspended or terminated by the Company at any time, except to the extent otherwise provided in the Plan and this Agreement.

(b) The grant of RSUs is voluntary and occasional and does not create any contractual or other right to receive future awards of RSUs, or benefits in lieu of RSUs even if RSUs have been awarded repeatedly in the past.

(c) All decisions with respect to future grants of RSUs, if any, will be at the sole discretion of the Company.

(d) The Participant's participation in the Plan is voluntary.

(e) RSUs are not part of normal or expected compensation or salary for any purpose, including, but not limited to, calculation of any wage payment, severance, redundancy, or other end of service payments, bonuses, long-service awards, pension or retirement benefits or similar payments and in no event should be considered as compensation for, or relating in any way to, past services for the Company or the Participant's employer or arising under any employment agreement.

(f) No voting or dividend or distribution rights apply with respect to the RSUs.

(g) The future value of the underlying Shares is unknown and cannot be predicted with certainty.

(h) If the Participant receives Shares upon vesting and settlement, the value of such Shares acquired on vesting and settlement of RSUs may increase or decrease in value.

(i) In consideration of the grant of RSUs, no claim or entitlement to compensation or damages arises from termination of the RSUs or diminution in value of the RSUs or Shares received upon vesting and settlement of RSUs resulting from termination of the Participant's employment by the Company or the Participant's employer (for any reason whatsoever and whether or not in breach of local labor laws) and the Participant irrevocably releases the Company and his or her employer from any such claim that may arise; if, notwithstanding the foregoing, any such claim is found by a court of competent jurisdiction to have arisen, then, by signing this Agreement, the Participant shall be deemed irrevocably to have waived his or her entitlement to pursue such claim.

(j) Other than as otherwise provided in Section 2 of this Agreement, if the Participant ceases to be an employee (whether or not in breach of local labor laws), the Participant's right to receive RSUs and vest under the Plan, if any, will terminate effective as of the date that the Participant is no longer actively employed by the Company and will not be extended by any notice period mandated under local law (e.g., active employment would not include a period of "garden leave" or similar period pursuant to local law); the Company shall have the exclusive discretion to determine when the Participant is no longer actively employed for purposes of the Plan, subject to Section 409A.

8. **Data Privacy Notice and Consent.** *By accepting the RSUs, the Participant is consenting to the processing of his or her personal data as follows:*

(a) **Data Collection and Usage.** *The Company is located at 2 Tech Drive, Suite 201, Andover, Massachusetts 01810, U.S.A. and grants the RSUs to the Participant at his or her sole discretion. The Company and its subsidiaries collect, process and use the Participant's personal data, including his or her name, home address, date of birth, social security number, salary, employee identification number, corporate email address and details of all RSUs canceled, vested, or outstanding in the Participant's favor, which the Company receives from the Participant or the Participant's employer ("Data"). The Company collects the Data for purposes of implementing, administering and managing the Plan. The Company's legal basis for the processing of the Data is the Participant's consent.*

(b) **Stock Plan Administration Service Providers.** *The Company and/or its subsidiaries may transfer Data to Fidelity Stock Plan Services, LLC and its affiliates, which are assisting the Company with the implementation, administration and management of the Plan. In the future, the Company may select a different service provider and share the Data with another company that serves in a similar manner. The Company's service provider will open an account for the Participant to receive Shares. The Participant will be asked to agree on separate terms and data processing practices with the service provider, which is a condition to the Participant's ability to participate in the Plan.*

(c) **International Data Transfers.** *The Company is based in the U.S. and its service providers are based in the U.S. If the Participant is outside the U.S., the Participant should note that the Participant's country has enacted data privacy laws that are different from those of the U.S. The Company's legal basis for the transfer of the Data is the Participant's consent.*

(d) **Data Retention.** *The Company will use the Data only as long as is necessary to implement, administer and manage the Participant's participation in the Plan or as required to comply with legal or regulatory obligations, including under tax, securities, exchange control and labor laws. This period may extend beyond the termination of the Participant's employment. When the Company no longer needs the Data, the Company will remove it from its systems to the fullest extent reasonably practicable. If the Company keeps Data longer, it would be to satisfy legal or regulatory obligations and the Company's legal basis would be relevant laws or regulations.*

(e) **Voluntariness and Consequences of Consent Denial or Withdrawal.** *Participation in the Plan and the Participant's grant of consent are purely voluntary. The Participant may deny or withdraw his or her consent at any time. If the Participant does not consent, or if the Participant withdraws his or her consent, the Participant cannot participate in the Plan. This would not affect the Participant's salary from or the Participant's employment with the Participant's employer; the Participant would merely forfeit the opportunities associated with the Plan.*

(f) **Data Subject Rights.** *The Participant has a number of rights under data privacy laws in his or her country. Depending on where the Participant is based, the Participant's rights may include the right to (a) request access to or copies of Data, (b) rectification of incorrect Data, (c) deletion of Data, (d) restrictions on processing, (e) portability of Data, (f) lodge complaints with competent authorities in the Participant's country, and/or (g) a list with the names and addresses of any potential recipients of Data. To receive clarification regarding the Participant's rights or to exercise the Participant's rights, the Participant should contact the Company at 2 Tech Drive, Suite 201, Andover, Massachusetts 01810, U.S.A.*

9. Miscellaneous⁷.

(a) **No Rights to Employment or Service.** The Participant acknowledges and agrees that the vesting of the RSUs pursuant to Sections 1 or 2 and Exhibit A hereof is earned only in accordance with the terms of such sections. The Participant further acknowledges and agrees that the transactions contemplated hereunder and the vesting schedule set forth herein do not constitute an express or implied promise of continued engagement as an employee or other service provider for the vesting period, for any other period, or at all.

(b) **Severability.** The invalidity or unenforceability of any provision of this Agreement shall not affect the validity or enforceability of any other provision of this Agreement, and each other provision of this Agreement shall be severable and enforceable to the extent permitted by law.

(c) **Waiver.** Any provision for the benefit of the Company contained in this Agreement may be waived, either generally or in any particular instance, by the Board, a Committee or its delegate.

(d) **Binding Effect.** This Agreement shall be binding upon and inure to the benefit of the Company and the Participant and their respective heirs, executors, administrators, legal representatives, successors and assigns, subject to the restrictions on transfer set forth in Section 3 of this Agreement.

(e) **Notice.** All notices required or permitted hereunder shall be in writing and deemed effectively given upon personal delivery or five (5) days after deposit in first class mail, postage prepaid, return receipt requested, or any comparable or superior postal or air courier service then in effect, addressed to the other party hereto at the address shown beneath his or its respective signature to this Agreement, or at such other address or addresses as either party shall designate to the other in accordance with this Section 9(e).

(f) **Pronouns.** Whenever the context may require, any pronouns used in this Agreement shall include the corresponding masculine, feminine or neuter forms, and the singular form of nouns and pronouns shall include the plural, and vice versa.

(g) **Language.** If the Participant has received this Agreement or any other document related to the Plan translated into a language other than English and if the translated version is different than the English version, the English version will control.

(h) **Electronic Delivery.** The Company may, in its sole discretion, decide to deliver any documents related to participation in the Plan, RSUs granted under the Plan or future RSUs that may be granted under the Plan by electronic means or to request the Participant's consent to participate in the Plan by electronic means. The Participant hereby consents to receive such documents by electronic delivery and, if requested, to agree to participate in the Plan through an on-line or electronic system established and maintained by the Company or another third party designated by the Company.

⁷ For employees located outside of the United States (excluding France and Israel), the following new subsection will be inserted as 9(i) and the remaining subsections will be relabeled (j)-(n).

(i) **Appendix.** Notwithstanding any provisions in this Agreement, the RSU grant shall be subject to any additional terms and conditions set forth in any Appendix to this Agreement for the Participant's country. Moreover, if the Participant relocates to one of the countries included in the Appendix, the additional terms and conditions for such country will apply to the Participant, to the extent the Company determines that the application of such terms and conditions is necessary or advisable for legal or administrative reasons. The Appendix constitutes part of this Agreement.

(i) Entire Agreement. This Agreement and the Plan constitute the entire agreement between the parties, and supersedes all prior agreements and understandings, relating to the subject matter of this Agreement.

(j) Amendment. Except as provided in Section 5, this Agreement may be amended or modified only by a written instrument executed by both the Company and the Participant.

(k) Governing Law; Venue. This Agreement shall be construed, interpreted and enforced in accordance with the internal laws of the Commonwealth of Massachusetts without regard to any applicable conflicts of laws. For purposes of any action, lawsuit or other proceedings brought to enforce this Agreement, relating to it, or arising from it, the parties hereby submit to and consent to the sole and exclusive jurisdiction of the courts within the Commonwealth of Massachusetts, and no other courts, where this grant is made and/or to be performed.

(l) Imposition of Other Requirements. The Company reserves the right to impose other requirements on the Participant's participation in the Plan, and on any Shares acquired under the Plan, to the extent the Company determines it is necessary or advisable for legal or administrative reasons, and to require the Participant to sign any additional agreements or undertakings that may be necessary to accomplish the foregoing.

(m) The Participant's Acknowledgments. The Participant acknowledges that he or she: (i) has read this Agreement; (ii) has been represented in the preparation, negotiation, and execution of this Agreement by legal counsel of the Participant's own choice or has voluntarily declined to seek such counsel; (iii) understands the terms and consequences of this Agreement; and (iv) is fully aware of the legal and binding effect of this Agreement.

IN WITNESS WHEREOF, the parties hereto have executed this Agreement as of the day and year first above written.

MKS INSTRUMENTS, INC.

By: _____

Name:

Title:

2 Tech Drive, Suite 201

Andover, MA 01810

Participant's Signature

SUBSIDIARIES OF THE REGISTRANT

SUBSIDIARY	JURISDICTION OF INCORPORATION
Alpha 2 B.V.	Netherlands
Alpha 3 B.V.	Netherlands
Alpha 4 B.V.	Netherlands
Alpha 5 B.V.	Netherlands
Alpha Germany Bidco GmbH	Germany
Atotech (China) Chemicals Ltd.	China
Atotech (Malaysia) Sdn. Bhd.	Malaysia
Atotech (Philippines) Chemicals, Inc.	Philippines
Atotech (Singapore) Chemicals Pte. Ltd.	Singapore
Atotech (Thailand) Co., Ltd.	Thailand
Atotech (Yangzhou) Chemicals Ltd.	China
Atotech Argentina SA	Argentina
Atotech Asia Pacific Limited	Hong Kong
Atotech Asset Management GmbH	Germany
Atotech Australia Pty. Ltd	Australia
Atotech B.V.	Netherlands
Atotech Beteiligungs und Management GmbH & Co. KG	Germany
Atotech Bulgaria EOOD	Bulgaria
Atotech Canada Ltd.	Canada
Atotech CZ, a.s.	Czech Republic
Atotech de Mexico S.A. de C.V.	Mexico
Atotech Deutschland GmbH & Co. KG	Germany
Atotech Development Center Pte. Ltd.	India
Atotech do Brasil Galvanotecnica Ltda.	Brazil
Atotech España, S.A	Spain
Atotech France S.A.	France
Atotech Global Services Private Ltd.	India
Atotech India Pte. Ltd.	India
Atotech Istanbul Kimya S. Ltd. Sirketi	Turley
Atotech Italia S.r.l.	Italy
Atotech Japan K.K.	Japan
Atotech Korea Ltd	Korea
Atotech Limited	Jersey
Atotech Manufacturing, Inc.	Delaware
Atotech Österreich GmbH	Austria
Atotech Poland Sp. z.o.o.	Poland
Atotech Servicios de Mexico S.A. de C.V.	Mexico
Atotech SK, s.r.o.	Slovakia
Atotech Skandinavien AB	Sweden
Atotech Slovenija d.d.	Slovenia
Atotech Taiwan Ltd.	Taiwan
Atotech UK Limited	United Kingdom
Atotech UK Topco Limited	United Kingdom
Atotech USA, LLC	Delaware
Atotech Vietnam Co., Ltd.	Vietnam
Atotech-Chemeta Ltd.	Russian Federation
Beijing Newport Spectra-Physics Technologies Co., Ltd.	China
Electro Scientific Industries Europe Ltd	United Kingdom
Electro Scientific Industries GmbH	Germany
Electro Scientific Industries Singapore Pte. Ltd.	Singapore

Electro Scientific Industries, Inc.	Oregon
ESI China, Inc.	Oregon
ESI Electronic Equipment (Shanghai) Co., Ltd.	China
ESI International Corporation	Oregon
ESI Japan, K.K.	Japan
ESI Korea, Inc.	Korea
ESI Vietnam Company Limited	Vietnam
High Q Laser GmbH	Austria
Hilger Analytical Limited	United Kingdom
J-KEM International AB	Sweden
LAI Lightwave Aerospace Industries Ltd.	Canada
Micro-Controle Spectra-Physics S.A.S.	France
Micronor LLC	Delaware
MKS Denmark ApS	Denmark
MKS German Holding GmbH	Germany
MKS Instruments (China) Company Ltd.	China
MKS Instruments (Hong Kong) Limited	Hong Kong
MKS Instruments (Singapore) Pte. Ltd.	Singapore
MKS Instruments Deutschland GmbH	Germany
MKS Instruments ESI Switzerland GmbH	Switzerland
MKS Instruments Holdings Ltd	United Kingdom
MKS Instruments Israel Ltd.	Israel
MKS Instruments Italy S.r.l.	Italy
MKS Instruments Mexico S. de R.L. de C.V.	Mexico
MKS Instruments UK Limited	United Kingdom
MKS Japan, Inc.	Japan
MKS Korea Ltd.	Korea
MKS Spectra Holdings Limited	United Kingdom
MKS Taiwan Technology Limited	Taiwan
Newport Corporation	Nevada
Newport Instruments Canada Corporation	Canada
Newport Laser Holding GmbH	Austria
Newport Ophir Holdings Ltd.	Israel
Newport Opto-Electronics Technologies (Singapore) Pte. Ltd.	Singapore
Newport Opto-Electronics Technologies (Wuxi) Company Limited	China
Newport Spectra-Physics B.V.	Netherlands
Newport Spectra-Physics GmbH	Germany
Newport Spectra-Physics Limited	United Kingdom
Ophir Japan Ltd.	Japan
Ophir Optics S.R.L.	Romania
Ophir Optronics Ltd.	Israel
Ophir Optronics Solutions Ltd.	Israel
Ophir Spiricon Europe GmbH	Germany
Ophir-Spiricon, LLC	Utah
Photon Control (Alberta) Inc.	Canada
Photon Control (USA) Inc.	Delaware
Photon Control Inc.	Canada
Pt. Atotech Indonesia Chemicals	Indonesia
Spectra-Physics, K.K.	Japan
UAB Atotech-Chemeta	Lithuania
V-Gen Ltd.	Israel
Visutech Plating Ltd.	Belarus

CONSENT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

We hereby consent to the incorporation by reference in the Registration Statements on Form S-3 (Nos. 333-34450, 333-109753 and 333-267046) and Form S-8 (Nos. 333-78069, 333-78071, 333-78073, 333-31224, 333-54486, 333-54488, 333-54490, 333-90498, 333-90500, 333-90502, 333-116385, 333-116387, 333-116389, 333-127221, 333-161211, 333-195750, 333-211026, 333-229483, and 333-264817) of MKS Instruments, Inc. of our report dated March 14, 2023 relating to the consolidated financial statements and financial statement schedule and the effectiveness of internal control over financial reporting, which appears in this Form 10-K.

/s/ PricewaterhouseCoopers LLP
Boston, Massachusetts
March 14, 2023

CERTIFICATION OF PRINCIPAL EXECUTIVE OFFICER
PURSUANT TO RULE 13a-14(a)/RULE 15d-14(a) OF THE
SECURITIES EXCHANGE ACT OF 1934, AS AMENDED

I, John T.C. Lee, certify that:

1. I have reviewed this annual report on Form 10-K of MKS Instruments, Inc.;
2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;
3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;
4. The registrant's other certifying officer and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:
 - a) Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;
 - b) Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;
 - c) Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and
 - d) Disclosed in this report any change in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter (the registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and
5. The registrant's other certifying officer and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of the registrant's board of directors (or persons performing the equivalent functions):
 - a) All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and
 - b) Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

Dated: March 14, 2023

/s/ John T.C. Lee

John T.C. Lee
President and Chief Executive Officer
(Principal Executive Officer)

CERTIFICATION OF PRINCIPAL FINANCIAL OFFICER
PURSUANT TO RULE 13a-14(a)/RULE 15d-14(a) OF THE
SECURITIES EXCHANGE ACT OF 1934, AS AMENDED

I, Seth H. Bagshaw, certify that:

1. I have reviewed this annual report on Form 10-K of MKS Instruments, Inc.;
2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;
3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;
4. The registrant's other certifying officer and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:
 - a) Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;
 - b) Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;
 - c) Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and
 - d) Disclosed in this report any change in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter (the registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and
5. The registrant's other certifying officer and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of the registrant's board of directors (or persons performing the equivalent functions):
 - a) All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and
 - b) Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

Dated: March 14, 2023

/s/ Seth H. Bagshaw

Seth H. Bagshaw

Executive Vice President, Chief Financial Officer and Treasurer
(Principal Financial Officer)

CERTIFICATION OF CHIEF EXECUTIVE OFFICER AND CHIEF FINANCIAL OFFICER
PURSUANT TO 18 U.S.C. SECTION 1350,
AS ADOPTED PURSUANT TO
SECTION 906 OF THE SARBANES-OXLEY ACT OF 2002

In connection with the Annual Report on Form 10-K of MKS Instruments, Inc. (the "Company") for the period ended December 31, 2022 as filed with the Securities and Exchange Commission on the date hereof (the "Report"), the undersigned, John T.C. Lee, President and Chief Executive Officer of the Company, and Seth H. Bagshaw, Executive Vice President, Chief Financial Officer and Treasurer of the Company, each hereby certifies, pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002, that, based on his knowledge:

- (1) The Report fully complies with the requirements of Section 13(a) or 15(d) of the Securities Exchange Act of 1934; and
- (2) The information contained in the Report fairly presents, in all material respects, the financial condition and results of operations of the Company.

Dated: March 14, 2023

/s/ John T.C. Lee

John T.C. Lee
President and Chief Executive Officer
(Principal Executive Officer)

Dated: March 14, 2023

/s/ Seth H. Bagshaw

Seth H. Bagshaw
Executive Vice President, Chief Financial Officer and Treasurer
(Principal Financial Officer)
