ENTEGRIS INC
Form 10-K
February 11, 2019
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UNITED STATES
SECURITIES AND EXCHANGE COMMISSION
WASHINGTON, D.C. 20549

FORM 10-K

(Mark One)
x ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934
For the fiscal year ended December 31, 2018
or
o 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: 001-32598

Entegris, Inc.
(Exact name of registrant as specified in its charter)

Delaware	41-1941551
(State or Other Jurisdiction of Incorporation or Organization)	(I.R.S. Employer Identification No.)

129 Concord Road, Billerica, Massachusetts 01821
(Address of principal executive offices and zip code)
(978) 436-6500
(Registrant's telephone number, including area code)
Securities registered pursuant to Section 12(b) of the Act:

Title of Class	Name of Exchange on which Registered
Common Stock, $0.01 Par Value	The Nasdaq Global Select Market

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

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Indicate by check mark if the registrant is a well known seasoned issuer, as defined in Rule 405 of the Securities Act. x Yes o No
Indicate by check mark if the registrant is not required to file reports pursuant to Section 13 or 15(d) of the Act. o Yes x 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 x No o
Indicate by check mark whether the registrant has submitted electronically and posted on its corporate Web site, if any, every Interactive Data File required to be submitted and posted 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 and post such files). Yes x No o
Indicate by check mark if disclosure of delinquent filers pursuant to Item 405 of Regulation S-K (§229.405) is not contained herein and will not be contained, to the best of registrant's knowledge, in definitive proxy or information

statements incorporated by reference in Part III of Form 10-K or any amendment to this Form 10-K. o

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

Large Accelerated Filer x	Accelerated Filer o
Non-Accelerated Filer o (Do not check if a smaller reporting company)	Smaller reporting company o
	Emerging growth company o

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If an emerging growth company, indicate by check mark if 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 is a shell company (as defined in Rule 12b-2 of the Exchange Act). Yes ¨ No ý

The aggregate market value of voting stock held by non-affiliates of the registrant, based on the last sale price of the Common Stock on June 30, 2018, the last business day of registrant's most recently completed second fiscal quarter, was $4,768,870,172. Shares held by each officer and director of the registrant and by each person who owned 10 percent or more of the outstanding Common Stock have been excluded from this computation in that such persons may be deemed to be affiliates of the registrant. This determination of affiliate status for this purpose is not necessarily a conclusive determination for other purposes.

As of February 4, 2019, 134,942,439 shares of the registrant's Common Stock were outstanding.

DOCUMENTS INCORPORATED BY REFERENCE

Portions of the registrant's Definitive Proxy Statement for its 2019 Annual Meeting of Stockholders scheduled to be held on April 30, 2019, or the 2019 Proxy Statement, which will be filed with the Securities and Exchange Commission, or SEC, not later than 120 days after December 31, 2018, are incorporated by reference into Part III of this Annual Report on Form 10-K. With the exception of the portions of the 2019 Proxy Statement expressly incorporated into this Annual Report on Form 10-K by reference, such document shall not be deemed filed as part of this Annual Report on Form 10-K.

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PART I

Item 1. Business.

OUR COMPANY

Entegris, Inc. (“Entegris”, “the Company”, “us”, “we”, or “our”) is a leading global developer, manufacturer and supplier of microcontamination control products, specialty chemicals and advanced materials handling solutions for manufacturing processes in the semiconductor and other high-technology industries. Our mission is to leverage our unique breadth of capabilities to create value for our customers by developing mission-critical solutions to maximize manufacturing yields, reduce manufacturing costs and enable higher device performance.

Semiconductors, or integrated circuits, are key components in modern electronic devices. Smartphones, cloud computing, the Internet of Things, artificial intelligence and other applications require faster, more powerful and more energy efficient semiconductors. In response to these requirements and the growing demand from these applications, semiconductor makers have been adding more capacity and semiconductor manufacturing technology has rapidly been moving to smaller dimensions, adopting new device architectures, such as FinFET transistors and 3D-NAND, and utilizing new and innovative manufacturing materials to increase transistor and bit density. As the technology node becomes increasingly complex, to enable improvements and to maximize yields, manufacturers require the effective development and application of new materials, a reliable and consistent supply of high-value materials, and contamination-free transportation, storage and delivery of these materials, seamlessly integrated into the semiconductor manufacturing process, at ever-increasing levels of purity and contaminant control. Additionally, the effective management and maintenance of the entire materials handling system, from initial production of process chemistry, to transportation and dispensing onto the wafer, has grown in importance to enhanced device yield.

Entegris is uniquely positioned to rapidly respond to these challenges and to help our customers solve problems throughout their advanced manufacturing processes. We deliver advanced materials and high-purity chemistries, free from contamination, with optimized packaging and delivery solutions and in-process filtration and purification solutions that ensure high-value liquid chemistries and gases are free from contaminants before reaching the wafer. Our technology portfolio includes approximately 21,000 standard and customized products and solutions to achieve the highest levels of purity and performance that are essential to the manufacture of semiconductors, flat panel displays, light emitting diodes, or LEDs, high-purity chemicals, solar cells, gas lasers, optical and magnetic storage devices, and critical components for aerospace, glass manufacturing and biomedical applications. The majority of our products are consumed at various times throughout the manufacturing process, with demand driven in part by the level of semiconductor and other manufacturing activity.

Our business is organized and operated in three operating segments, which align with the key elements of the advanced semiconductor manufacturing ecosystem. The Specialty Chemicals and Engineered Materials, or SCEM, segment provides high-performance and high-purity process chemistries, gases, and materials, and safe and efficient delivery systems to support semiconductor and other advanced manufacturing processes. The Microcontamination Control, or MC, segment offers solutions to filter and purify critical liquid chemistries and gases used in semiconductor manufacturing processes and other high-technology industries. The Advanced Materials Handling, or AMH, segment develops solutions to monitor, protect, transport, and deliver critical liquid chemistries, wafers and other substrates for a broad set of applications in the semiconductor industry and other high-technology industries. While these segments have separate products and technical know-how, they share a global generalist sales force, common business systems and processes, technology centers, and strategic and technology roadmaps. We leverage our expertise from these three segments to create new and increasingly integrated solutions for our customers.

PROPOSED MERGER

On January 27, 2019, we entered into a definitive Agreement and Plan of Merger (“Merger Agreement”) with Versum Materials, Inc., a Delaware corporation (“Versum”), a leading specialty materials supplier to the semiconductor industry. Pursuant to and subject to the terms and conditions of the Merger Agreement, upon completion of the transaction, Versum will merge with and into Entegris (the “Proposed Merger”), with Entegris surviving and continuing as the surviving corporation, and retaining its name and headquarters. At the effective time of the Proposed Merger, each outstanding share of common stock of Versum (with certain exceptions set forth in the Merger Agreement) will be converted into the right to receive 1.120 shares of common stock of Entegris. The transaction is subject to certain

conditions, including a majority of the outstanding shares of common stock of both Entegris and Versum approving the Merger Agreement and the receipt of approvals under U.S. and certain foreign antitrust and competition laws. We have agreed to operate our business in the ordinary course during the period between the execution of the Merger Agreement and the effective time of the Proposed Merger, subject to specific exceptions set forth in the Merger Agreement, and have agreed to certain other customary restrictions on operations, as set forth in the Merger Agreement.

THE SEMICONDUCTOR ECOSYSTEM

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The manufacture of semiconductors requires hundreds of highly complex and sensitive manufacturing steps, during which a variety of materials are repeatedly applied to a silicon wafer to build integrated circuits on the wafer surface. We serve the semiconductor ecosystem by providing specialty materials and chemicals utilized in many process steps, offering a broad range of products to monitor, protect, transport, and deliver these critical process materials during the manufacturing process and providing systems to purify liquid chemistry and gases throughout the manufacturing process. The areas of the semiconductor ecosystem that rely most heavily on our products and solutions are described below.

Deposition. Deposition processes include physical vapor deposition (PVD), where a thin film is deposited on a wafer surface in a low-pressure gas environment, chemical vapor deposition (CVD), where a thin film is deposited on a wafer surface by exposing it to one or more volatile precursors which react with the wafer surface, atomic-layer deposition (ALD), where a thin film is deposited on a wafer surface by exposing it to one or more precursors which react through a series of sequential, self-limiting reactions, and electro-plating, where a metal layer, such as copper, is deposited using chemical baths. Our advanced precursor materials and electro-plating chemicals are utilized to meet the semiconductor industry's composition, uniformity and thickness needs of deposited films. Our filtration and purification products are used to remove contaminants during the deposition process, consequently reducing defects on wafers. These products are critical to ensuring device performance and the manufacturing yields of semiconductor manufacturers.

Chemical Mechanical Planarization (CMP). CMP is a polishing process used by semiconductor manufacturers to planarize, or flatten, many of the layers of material that have been deposited upon silicon wafers. We offer a broad range of products used by semiconductor manufacturers during and immediately following the CMP process. Our formulated cleaning chemistries remove residue from wafer surfaces after the CMP process, and prevent subsequent corrosion. Our filtration and purification systems are used to filter liquid slurries and cleaning chemistries in order to remove select particles and contaminants that can cause defects on a wafer's surface. Our roller brushes are used in conjunction with our cleans chemistries to clean the wafer after completion of the CMP process in order to prepare the wafer for subsequent operations and our pad conditioners are used to prepare the surface of the CMP polishing pad prior to every polishing cycle.

Photolithography. Photolithography is a process repeated many times throughout the semiconductor manufacturing process that uses light to print complex circuit patterns onto the wafer. To print the projected optical pattern, the wafer is coated with a thin film of light-sensitive material, called photoresist. Light is projected to expose the photoresist, which is then developed (somewhat like photographic film) to create a stenciled image pattern. Our liquid filtration and liquid packaging and dispense systems play a vital role in assuring the pure, accurate and uniform dispense of photoresists onto the wafer so that manufacturers can achieve acceptable yields in the manufacturing process, and our gas microcontamination control systems eliminate airborne contaminants that can disrupt effective photolithography processes.

Etch and Resist Strip. During the etch process, specific areas of the thin film that have been deposited on the surface of a wafer are removed to leave a desired circuit pattern. After the etch process, the hardened resist needs to be completely removed. Our formulated chemical solutions remove photo resists and post-etch residues and our gas filters and purifiers help assure the purity of the process gas streams used in the etch process. Our precision-engineered coatings provide barriers to corrosive chemistries in the etch environment, protect surfaces from erosion and minimize particle generation.

Ion Implant. Ion implantation is a key technology for forming transistors and is used many times during semiconductor fabrication. During ion implantation, wafers are bombarded by a beam of electrically-charged ions, called dopants, which change the electrical properties of the exposed surface films. Our Safe Delivery Source® (SDS®) and VAC® (Vacuum Actuated Cylinders) gas delivery systems assure the safe, effective and efficient delivery of the toxic gases necessary for the implant process. In addition, our proprietary low temperature plasma coating processes for core components are critical elements of ion implantation equipment.

Wet Cleaning. Ultra-high purity chemicals of precise composition are used to clean the wafers before and after several of the processes described above, to pattern circuit images and to remove photoresists after etch. The cleaning chemicals must be maintained at very high purity levels without the presence of foreign material such as particles,

ions or organic contaminants in order to maintain manufacturing yields and avoid defective products. Our proprietary formulated cleaning chemistries are used in these wet cleaning processes and our liquid filters and purifiers ensure the purity of these chemicals.

Wafer Solutions. Our wafer and reticle carriers are high-purity “micro-environments” that carry wafers between manufacturing process steps. These products protect wafers from damage or abrasion and minimize contamination during transportation and automated processing. Front-end wafer processing can involve hundreds of steps and take several weeks. Protection of the processed wafer is essential, as a batch of fully processed 200 mm or 300 mm wafers transported in one of our products can be worth over a million dollars.

Chemical Containers. Semiconductor manufacturing and other high-technology processes utilize large volumes of high-purity, corrosive and hazardous chemicals. Our ultrahigh purity chemical container products, such as drums, flexible packaging and

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associated coded connection systems, maintain chemical purity, maximize utilization and ensure safe transport, containment and dispense of valuable, ultraclean process fluids, from storage by the chemical manufacturer to point-of-use. Our FluoroPure® containers and NOWPak® liner-based systems maximize chemical retrieval and minimize chemical waste, which lowers our semiconductor manufacturer customers' costs. Our portfolio of bottles, canisters, closures and accessories enhance tool productivity, increase yields and reduce operating costs. Relatedly, our ultrapure valves, fitting, tubings, and sensing and control products are used to distribute these chemicals around the fab and in wet process tools.

Other Markets. Many of the processes used to manufacture semiconductors are also used to manufacture photovoltaic cells, LEDs, flat panel displays and magnetic storage devices resulting in the need for similar filtration, purification, control and measurement capabilities. We seek to leverage our products, technologies and expertise to address these important market opportunities.

INDUSTRY TRENDS

Emerging Applications. The market for semiconductors has grown significantly over the past few decades and we expect this trend to continue. We believe that the smartphone, Internet of Things and emerging applications in cloud computing, machine learning and artificial intelligence, autonomous vehicles, and virtual reality will drive growth in the demand for semiconductors, drive wafer starts and create significant opportunities for our products. Existing applications in data processing, wireless communications, broadband infrastructure, personal computers, handheld electronic devices and other consumer electronics, are also expected to drive demand for semiconductors, and in turn, our products.

Manufacturing Complexity and Architecture. The emerging applications described above require more powerful, faster and more energy efficient semiconductors. Semiconductor architectures are changing, with transistor design increasing in complexity, the use of multilayered patterning, vertical structures such as FinFET and 3D-NAND, and shrinking dimensions. These advanced architectures require an increase in the number of process steps required to manufacture these semiconductors. We believe that demand for our materials and consumable products will be driven by the increase in process steps and the associated lithography, deposition, CMP, and etch and clean required to manufacture leading edge semiconductors. Additionally, new materials have played a significant role in enabling improved devices performance and we expect this trend to continue. As dimensions get smaller, new materials will be required for transistor connectivity. For example, leading edge semiconductor manufacturers are moving towards atomic layer scale, where the precision of the manufacturing process and purity of the materials is extremely important to maintain the device integrity. These materials need to be supplied and delivered at ever-increasing levels of purity and control, from point-of-production to point-of-use and dispense on the wafer. We expect the trend for new materials supplied at high levels of purity to drive the demand for our advanced materials and our products and solutions designed to purify, monitor, protect, transport, and deliver critical materials. To address the challenges of the advanced technology nodes, we collaborate with our customers to develop new materials, to enhance our filtration and purification capabilities and to introduce advanced materials packaging and monitoring capabilities.

Material Handling Solutions. Our semiconductor customers have become increasingly focused on materials handling solutions that enable them to safely store, handle, process and transport critical materials throughout the manufacturing process to minimize the potential for damage or degradation to their materials and to protect their investment in processed wafers. We believe that these trends provide opportunities for us to utilize our unique breadth of capabilities to provide innovative materials, materials management, purification, wafer transport, and process solutions to semiconductor customers to enable them to successfully manage this growing complexity.

Reliance on Trusted Suppliers. Our customers require that their key materials suppliers demonstrate greater capabilities, such as sustainability, scalability, flexible manufacturing, quality control, supply chain management, and the ability to effectively collaborate on solutions to problems. We have responded to these demands by deploying resources to enable us to align with their requirements and drive operational excellence. For example, in 2016 and 2017, we expanded our technology centers in South Korea and Taiwan and we are currently building a technology center in Shanghai, China, adding to our research and development capabilities to enhance local development and collaboration and to strengthen relationships with our key customers. We believe these trends will allow us to leverage our manufacturing, operational and technical capabilities, along with our broad technology portfolio, to become an

increasingly important strategic supplier to our customers.

Continued Consolidation. Our customer base within the semiconductor industry has consolidated through mergers and acquisitions. As a result, the importance of maintaining and developing strong and close relationships with our customers becomes even more essential. While continuing to strengthen these relationships, we also seek to further broaden our customer base by leveraging our products, technologies and expertise in serving semiconductor applications to address adjacent market opportunities, including in manufacturing processes for flat panel displays, high-purity chemicals, solar cells, optical magnetic storage devices and products for life sciences.

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Manufacturing in China. An additional factor that could spur future industry growth is sustained semiconductor industry development in China, which has experienced recent growth in semiconductor production. Construction on an historic number of fabs has been commenced in recent years, and we expect that heavy investment in the semiconductor sector in China will continue, with more than 10 new fab projects expected to ramp in the next several years by local and multinational companies. As a result, we expect that China will remain one of the fastest growing regions in semiconductor industry. Additionally, existing fabs in China are working to rapidly enhance their capabilities to manufacture the latest generation advanced node products, targeting both leading-edge and mainstream applications. However, as Chinese fabs have been facing difficulty in obtaining the necessary technology and products, we expect some uncertainty on the time of some these fab ramps. Expansion and growth of the semiconductor industry in China could increase the need and demand for our products.

OUR COMPETITIVE STRENGTHS

Technology Leadership. We are committed to being able to provide our customers with innovative solutions for their manufacturing needs. For example, we have introduced sub-10 nanometer and 7 nanometer filtration products, advanced deposition materials for next generation transistor and interconnect technologies, advanced reticle pods for extreme ultra-violet, or EUV, photolithography applications, advanced 300 mm wafer carriers and advanced coatings to meet the rigorous demands of the advanced technology nodes faced by our customers. As described in further detail below in “Engineering, Research and Development”, this commitment to technology leadership is demonstrated by our ER&D expenditures in 2018, 2017 and 2016 of $118.5 million, $107.0 million and $107.0 million, respectively.

Comprehensive and Diverse Product Offerings. As semiconductor manufacturers are driving towards more advanced technology nodes, our customers are seeking suppliers who can provide a broad range of reliable, flexible and cost-effective products and materials, as well as the technological and application design expertise necessary to enhancing their productivity, quality, and yield. We believe our comprehensive offering of materials and products creates a competitive advantage as it enables us to meet a broad range of customer needs and provide a single source of product offerings for semiconductor device and equipment manufacturers as they seek to consolidate their supplier relationships and pursue advanced technology nodes. Additionally, our broad product and solution portfolio allows us to serve many aspects of the semiconductor manufacturing ecosystem and to create synergies among certain of our products. For example, our microenvironment and fluidics products are utilized when a fab is being built to move wafers and materials throughout the fab, our chemistries and gas products are consumed during operation of the fab, and our contamination control products ensure the purity of chemistries and gases throughout the fab and its supply chain.

Global Presence. We have established a global infrastructure of design, manufacturing, distribution, service and technical support facilities to meet the needs of our global customers. We have, for example, expanded our manufacturing operations and increased our investment in advanced technology centers in Taiwan and South Korea to support our important customers in these regions, established new sales and service offices in China and are currently building a technology center in Shanghai, China to serve a growing semiconductor manufacturing base in that country, and expanded our presence in Singapore to enhance our global and regional management of supply chain and manufacturing processes. We service our customer relationships in Asia, North America, Europe and the Middle East predominantly via direct sales and support personnel and to a lesser extent through selected independent sales representatives and distributors.

Advanced Manufacturing. We have established leading-edge manufacturing plants located in the United States, Malaysia, Japan, South Korea and Taiwan that possess the advanced manufacturing capabilities described under “Manufacturing” below.

Strong Relationships with Broad Customer Base. We have strong relationships with our customers, which include leading semiconductor manufacturers, original equipment manufacturers, or OEMs, and semiconductor materials suppliers. These relationships provide us with significant collaboration opportunities at the product design stage, which facilitate our ability to introduce new products and applications. For example, we work with our key customers in the development of advanced manufacturing processes to identify and respond to their requests for current and future generations of products for emerging applications requiring cleaner materials, as well as systems that maintain the integrity and stability of materials during transport through the manufacturing process. We believe that our

customer base will continue to be an important source of new product development opportunities. Due to the specialized nature of our products, manufacturing complexity, qualification requirements in customers' fabrication processes, high customer re-formulation and qualification change costs, and extensive proprietary products, we believe our supply position with our customers is strong.

Strong Financial Performance and Cash Flow Generation. We have a strong financial profile with net income of $240.8 million, operating margin of 18.9% and Adjusted EBITDA margin of 28.1% for the fiscal year ended December 31, 2018. In addition to servicing our debt obligations and effecting our capital allocation strategy, we expect that our financial profile will allow us to invest in the research and development and advanced manufacturing capabilities necessary to maintain and expand our technology leadership and to drive organic growth. Additionally, as we have done in the past, we expect that our cash flow generation will enable us to grow inorganically through smaller acquisitions of product lines or technology that expand upon

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our product portfolio or through larger acquisitions where we act as a consolidator in the industry and increase our scale and strengthen our position as a leading supplier to our customers. For an explanation of Adjusted EBITDA and Adjusted EBITDA Margin and a reconciliation to GAAP net income, see “Non-GAAP Information” in Management’s Discussion and Analysis of Financial Condition and Results of Operations in Part II, Item 7 of this Annual Report on Form 10-K.

OUR BUSINESS STRATEGY

We intend to build upon our position as a leading worldwide developer, manufacturer and supplier of advanced specialty materials, filtration and purification solutions, delivery systems, and materials packaging solutions to expand our core business and to grow in other high value-added manufacturing process markets. Our strategy includes the following key elements:

Commitment to Technology Leadership. We continuously improve our products and develop new products as our customers’ needs evolve. As semiconductor devices become smaller and more powerful, and new materials and processes are deployed to produce them, we seek to expand our technological capabilities by developing advanced products that address the requirements for greater purification, protection and transport of high value-added materials and by developing advanced chemical materials for use in critical fabrication processes.

Leveraging our Expertise. We leverage our broad expertise across our portfolio of advanced materials, materials handling and purification capabilities to create innovative new solutions to address unmet customer needs. For example, our industry-leading post-CMP cleaning chemistry is developed and manufactured by our SCEM segment, with collaboration from our MC segment, packaged with our ultra clean container and connector system made by our AMH segment, and delivered to the process tools through fluid handling systems also made by our AMH segment. Furthermore, in the process tool, these chemistries may go through one or several purification systems made by our MC segment to eliminate particles and contaminants. Another example of the results of this strategy is our advanced deposition materials business, where we leverage our ability to synthesize unique molecules, our knowledge of how to purify these materials, and our capability to safely transport these materials and deliver them onto the wafer at the highest throughput. We seek to utilize our diverse and unique expertise in areas of increasing importance to semiconductor manufacturers, such as developing advanced materials and ensuring the purity of high-value materials, and our ability to work collaboratively across our three segments, which enables us to quickly and effectively develop optimized and complimentary solutions for our customers.

Operational Excellence. Our strategy is to continue to develop our advanced manufacturing capabilities into a competitive advantage with our customers by focusing on the following priorities:

- use of manufacturing equipment and facilities incorporating leading-edge technology including advanced cleanroom and cleaning procedures;
- implementation of standardized manufacturing systems stressing optimization of equipment effectiveness, predictive maintenance, and direct labor productivity;
- implementation of automated quality systems that provide both process monitoring and process control throughout the manufacturing process as well as predictive quality data to mitigate against potential quality excursions;
- implementation of supply chain management systems that assure a reliable and responsive supply of high-quality raw materials;
- conduct of manufacturing operations to assure the safety of our employees and of the individuals using our products; and
- maintaining an agile manufacturing organization that is capable of rapid design and development of prototypes of new and derivative products, as well as promptly responding to customer feedback concerning prototypes so that we quickly commercialize and ramp production acceptable to our customers.

Continued Focus on Customers. We view the strong relationships we have with our customers, which include leading semiconductor manufacturers, OEMs, and semiconductor materials suppliers, as critical to our long term success. We intend to reinforce and further strengthen these relationships, through, among other things, collaborations and joint development. Customer intimacy enables us to respond rapidly and thoroughly to their manufacturing challenges and enables us to bring forth new products that serve an existing need.

Adjacent Markets. We leverage our expertise in the semiconductor industry by developing products for other industries that employ similar technologies and production processes and that utilize materials integrity management, high-purity fluids and integrated dispense systems. For example, outside of the semiconductor industry, our products are used in manufacturing processes for flat panel displays, high-purity chemicals, solar cells, optical magnetic storage devices and products for life sciences. We plan to continue to identify and develop products that address needs in adjacent markets. We believe that by utilizing our technology to provide manufacturing solutions across multiple industries, we are able to increase the total available market for our products and reduce, to an extent, our exposure to the cyclicality of the semiconductor industry.

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Strategic Acquisitions, Partnerships and Related Transactions. We will continue to pursue strategic acquisitions and business partnerships that enable us to address gaps in our product offerings, secure new customers, diversify into complementary product markets, broaden our technological capabilities and product offerings, access local or regional markets and achieve benefits of increased scale. For example, in June 2018, we acquired from SAES Getters S.p.A. the SAES Pure Gas business, a leading provider of high-capacity gas purification systems used in semiconductor manufacturing and adjacent markets, which now reports into our Microcontamination Control division, enabling us to offer a complete portfolio of gas purifications solutions for both bulk and specialty gases to our customers. In January 2018, we acquired Particle Sizing Systems, LLC, a company focused on particle sizing instrumentation for liquid applications in both semiconductor and life science industries, which enables customers to perform particle size analysis online and in real time, directly in fluid stream process, preventing costly yield excursions. In April 2017, we acquired the water and chemical filtration product line for microelectronics applications from W. L. Gore & Associates, Inc., or Gore, where we acquired a synergistic product line that leverages our existing platform and expands our served markets. Our 2014 acquisition of ATMI, Inc., or ATMI, brought a whole new portfolio of technologies and materials products to serve our semiconductor customers. Further, as the dynamics of the markets that we serve shift, we will reevaluate our existing businesses and in the event that we conclude that a business is not able to provide value-added solutions to its markets in a manner that contributes to achieving our financial objectives, we expect to restructure or replace that business, such as the sale of our small cleaning business in France. Finally, we are continuously evaluating opportunities for strategic alliances, such as our strategic alliance with Enthone, joint development programs and collaborative marketing efforts with key customers and other industry leaders. For example, in connection with our strategic commitment to support the growing semiconductor and related microelectronics industries in China, in 2017, we entered into agreements with local partners to expand our capability to manufacture our specialty chemical and deposition products locally and shorten our supply chain for our customers in China.

OUR SEGMENTS

As discussed, our business is organized and operated in three operating segments which align with the key elements of the advanced semiconductor manufacturing ecosystem: Specialty Chemicals and Engineered Materials, or SCEM; Microcontamination Control, or MC; and Advanced Materials Handling, or AMH. We leverage our expertise from these three segments to create new and increasingly integrated solutions for our customers. The following is a detailed description of our three segments:

SPECIALTY CHEMICALS AND ENGINEERED MATERIALS SEGMENT

The SCEM segment provides high-performance and high-purity process chemistries, gases, and materials that enable enhanced device performance. These materials are utilized in critical semiconductor manufacturing processes such as deposition, cleaning, and integration of complex materials. Advanced materials, delivered at high purity, are critical to enabling the performance of leading-edge logic and memory applications. We believe the growing demand in the 3D-NAND market, challenges with metallization schemes and the need for specialized cleaning solutions will drive consumption for materials in our SCEM segment. In conjunction with products from our MC and AMH segments, the materials in our SCEM segment provide unique solutions to safely and efficiently deliver critical materials to support semiconductor and other advanced manufacturing processes.

Specialty Gas Products. Our specialty gas solutions provide advanced safety and process capabilities to semiconductor, display and solar panel manufacturers. Our SDS cylinders store and deliver hazardous gases, such as arsine, phosphine, germanium tetrafluoride and boron trifluoride, at sub-atmospheric pressure through the use of our proprietary carbon-based adsorbent materials. These products minimize potential leaks during transportation and use and allow more gas to be stored in the cylinder, features which provide significant safety, environmental and productivity benefits over traditional high-pressure cylinders. New generations of SDS products further increase the gas storage capacity, reducing tool down time, therefore, resulting in significant cost savings for our customers. We also offer VAC, a complementary technology to SDS, where select implant gases and gas mixtures are stored under high pressure but delivered sub-atmospherically.

Specialty Materials Products. Our specialty materials include specialized graphite, silicon carbide, thermally conductive foam and a variety of unique, high purity coatings for dry or plasma etch, chemical vapor deposition and

ion implant applications. Our POCO® premium graphite is used to make precision consumable electrodes for electrical discharge machining, hot glass contact materials for glass product manufacturing and forming, and other consumable products for various industrial applications, including aerospace, optical, medical devices, air bearings and printing. Our high-performance specialty coatings, such as our Pegasus™ and our latest development Cearus™ coatings, provide erosion resistance, minimize particle generation and prevent contamination on critical components in semiconductor environments and other high-technology manufacturing operations. Our specialty materials provide customized solutions for applications challenged with unique temperature, corrosive, chemical or process environments, such as electrostatic chucks used to hold wafers during processing, plasma etch chamber components, aircraft bearings, and ultrasonic transducers.

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Advanced Deposition Materials Products. Our advanced deposition materials include advanced liquid, gaseous and solid precursors which are incorporated in chemical vapor deposition (CVD) and atomic layer deposition (ALD) processes by the semiconductor industry, including organometallic precursors for the deposition of tungsten, titanium, cobalt and aluminum containing films and organosilane precursors for the deposition of silicon oxide and silicon nitride films. These precursors are designed in close collaboration with OEM process tool manufacturers as well as device makers to produce application specific solutions that are compatible with complex integrations of material solutions used to build the semiconductor device. We offer containers that allow for reliable storage and delivery of low volatility solid and liquid precursors required in ALD processes. When combined with our proprietary corrosion resistant coatings and filtration solutions from our MC segment, our advanced deposition materials enable the industry's highest purity levels, resulting in improved device performance.

Surface Preparation and Integration Products. We offer a range of materials used to prepare the surface of a semiconductor wafer during the manufacturing process and to integrate with materials being used on the wafer. We also provide advanced plating solutions, such as our Viaform® product (a trademark of and exclusively licensed from Enthone Inc., or Enthone, a subsidiary of Platform Specialty Products Corporation), which includes inorganic and proprietary organic molecules that provide the wiring for copper interconnects. We also offer CMP cleaning solutions for applications such as semiconductor post-etch residue removal, wafer etching, organics removal, negative resist removal, edge bead removal, and corrosion prevention. Our wet chemistries solutions, combined with filtration solutions from our MC segment and fluid handling solutions from our AMH segment, provide enhanced purity, which results in improvements in our customers' processes. Our consumable PVA roller brush products are used to clean the wafer following the CMP process and our pad conditioners, based on our silicon carbide capabilities, lengthen CMP pad life.

MICROCONTAMINATION CONTROL SEGMENT

The MC segment offers solutions to purify critical liquid chemistries and gases used in semiconductor manufacturing processes and other high-technology industries. The design and performance of our liquid and gas filtration and purification products are important to the semiconductor manufacturing process because they remove contamination and directly reduce defects and improve manufacturing yield. Our proprietary filters remove organic and inorganic nanometer-sized contaminants from the different fluids and gases used in the manufacturing process, including photolithography, deposition, planarization and surface etching and cleaning. As our customers leverage leading edge lithography tools and multi-patterning technology to enable each subsequent generation of products, our filtration and purification products are utilized to achieve necessary levels of purity and contamination control. We believe demand for purification and filtration products is being driven by the continuous node shrink in logic semiconductors and the ramp in the 3D-NAND market, as the risk of yield loss grows with the incremental manufacturing steps needed for the production of these devices. We utilize expertise from the AMH segment in polymer science and from the SCEM segment in chemical manufacturing to develop differentiated filtration and purification solutions for our customers.

Liquid Microcontamination Control Products. We offer a variety of unique products that are optimized to control contaminants in our customers' liquid processes. For example, our Torrento® series of filters is used for the filtration of aggressive acid and base chemistries for both semiconductor fabs as well as specialty chemical manufacturers including our SCEM segment. Manufacturers of high purity chemicals as well as semiconductor fabs use our Trinzik® products for the filtration of chemicals as well as ultra-pure water. Our Impact® series of filters are used in point-of-use photochemical dispense applications, including those provided by our AMH segment, where the delivery of superior flow rate performance and reduced microbubble formation is critical.

Gas Microcontamination Control Products. We offer a complete portfolio of products designed to remove particulate and molecular contaminates from gas streams from the point of creation on the gas pads to the point of use at the wafer in semiconductor, flat panel display and LED fabs. In addition, we provide products used to eliminate airborne molecular contamination from critical process tool areas or cleanrooms in the fab. Our Waferguard® gas filters reduce outgassing and remove particle contamination. Our GateKeeper® gas purifiers and large facility wide gas purification systems provide continuous purified gas supply to customer fabs by chemically reacting and absorbing contaminants, effectively removing gaseous contaminants down to part-per-trillion levels. Our Chambergard™ gas diffusers provide semiconductor equipment manufacturers with the capability to rapidly vent their tools to atmosphere to dramatically

reduce process cycle times without adding particles to the wafers. These products are used in, or alongside, critical processing tools to improve yield and reduce tool downtime. In addition, we provide filters used to eliminate airborne molecular contamination from critical process tool areas or cleanrooms in the fab, improving process yield.

ADVANCED MATERIALS HANDLING SEGMENT

The AMH segment develops solutions to monitor, protect, transport, and deliver critical liquid chemistries, wafers and substrates for a broad set of applications in the semiconductor industry and other high-technology industries. These systems and products improve our customers' yields by protecting wafers from abrasion, degradation and contamination during

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manufacturing and transportation and by assuring the consistent, clean and safe delivery of advanced chemicals from the chemical manufacturer to the point-of-use in the semiconductor fab. As advanced semiconductor fabs are built, demand is driven for our wafer handling and fluid handling products. As those fabs move into production, we see demand for wafer carrying and fluid containment solutions offered by this segment. The AMH segment collaborates closely with the semiconductor chemical manufacturers segment in developing products that are compatible with advanced chemistries to enhance yield, and integrates liquid filtration technology from our MC segment to deliver consistent and pure chemistry.

Wafer Solutions. We lead the market with our high-volume line of Ultrapak® and Crystalpak® products for wafers ranging from 100 to 200 mm, which ensure the clean and secure transport of wafers from the wafer manufacturers to the semiconductor fab. We also offer a front-opening shipping box, or FOSB, for the transportation and automated interface of 300 mm wafers. We lead the market for 300mm front opening unified pods, or FOUPs, wafer transport and process carriers, and standard mechanical interface pods, or SMIF pods, for 200mm wafer applications. These microenvironment products safely and accurately deliver wafers within the semiconductor fab environment to the various process fabrication steps. We are a leader in reticle protection products for photolithography. This includes products that protect the high-value EUV (extreme ultraviolet) lithography masks during both the mask manufacturing process and their use in the semiconductor fab.

Chemical Containers. We have a broad portfolio of flexible and rigid polymer packaging and container products, from low-volume containers to transport high-value photoresist chemistries, such as our NOWPak® products, to large intermediate bulk containers (IBCs) to safely and efficiently transport chemicals in bulk, such as our FluoroPure® products. Our connection systems provide for safe and efficient chemical dispense from the container in the fab. Chemical companies utilize our packaging products to ensure the purity of chemistries shipped to semiconductor fabs, resulting in enhance yields.

Fluidics. We are a leader in high-purity fluid transfer products such as valves, measurement, fittings, tubing, pipe, custom fabricated products and associated connection systems, such as our PrimeLock® connections, for high-purity chemical applications and our proprietary digital flow control technology improves the uniformity of chemicals applied on wafers. Our IntelliGen® integrated high-precision liquid dispense systems enable the uniform application of advanced chemistries during the wafer fabrication process, integrating our valve control expertise with filter device technologies from our MC segment, so that filtering and dispensing of photochemicals can occur at different rates, conserving high-value chemistry and reducing defects on wafers. Our comprehensive product lines provide our semiconductor manufacturers, process tool makers and chemical customers with a single-source provider for their high-purity chemical management needs throughout the manufacturing process.

OUR CUSTOMERS AND MARKETS

Our most significant customers include semiconductor device manufacturers, semiconductor equipment makers, gas and chemical manufacturing companies, leading wafer grower companies and manufacturers of high-precision electronics. We also sell our products to flat panel display equipment makers, materials suppliers and panel manufacturers, and manufacturers of hard disk drive components and devices.

Our other high-technology markets include manufacturers and suppliers in the solar and life science industries, electrical discharge machining customers, glass and glass container manufacturers, aerospace manufacturers and manufacturers of biomedical implantation devices.

In 2018, 2017 and 2016, net sales to our top ten customers accounted for 44%, 47% and 45%, respectively, of combined net sales. In 2018, 2017 and 2016, Taiwan Semiconductor Manufacturing Company Limited, accounted for $154 million, $168 million and $162 million of net sales, respectively, or approximately 10%, 13% and 14% of our net sales, respectively, including sales from each of our three reporting segments. In addition, in 2018 and 2017, Samsung Electronics Co. accounted for $164 million and $141 million of net sales, respectively, or approximately 11% and 10% of our net sales, respectively, including sales from all of the Company’s segments, respectively. International net sales represented 78%, 79% and 78%, respectively, of net sales in 2018, 2017 and 2016. Approximately 3,100 customers purchased products from us during 2018. For the fiscal year ended December 31, 2018, our revenue breakdown by customer segment was as follows: semiconductor manufacturers 46%; OEMs 13%; electronic materials customers 14%; other semiconductor customers 15%; and non-semiconductor customers 12%.

We may enter into supply agreements with our customers. These agreements generally have a term of one to three years, but do not contain any long-term purchase commitments. Instead, we work closely with our customers to develop non-binding forecasts of the future volume of orders. However, customers may cancel their orders, change production quantities from forecasted volumes or delay production for a number of reasons beyond our control.

SALES, MARKETING AND SUPPORT

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We sell our products worldwide, primarily through our direct sales force and strategic independent distributors located in all major semiconductor markets. Independent distributors are also used in other semiconductor market territories and for specific market segments. As of December 31, 2018, our sales and marketing force consisted of approximately 560 employees worldwide.

Our unique capabilities and long-standing industry relationships have provided us with the opportunity for significant collaboration with our customers at the product design stage, which has facilitated our ability to introduce new materials and new solutions that meet our customers' needs. We are constantly identifying for our customers a variety of materials, purification and process control challenges that may be addressed by our product solutions. Our sales representatives provide our customers with worldwide technical support and information about our products and materials.

We believe that our technical support services are important to our sales and marketing efforts. These services include assisting in defining a customer's needs, evaluating alternative products and materials, designing a specific system to perform the desired operation, training users and assisting customers in compliance with relevant government regulations. Additionally, our field applications engineers, located in all of the major markets we serve, work directly with our customers on product qualification and process improvements in their facilities. We maintain a network of service centers, applications laboratories and technology centers located in all key markets internationally and in the United States to support our products and our customers with their advanced development needs, provide local technical service and ensure fast turnaround time.

COMPETITION

The market for our products is highly competitive. While price is an important factor, we compete primarily on the basis of the following factors:

- technical expertise;
- product quality and performance;
- advanced manufacturing capabilities;
- total cost of ownership;
- historical customer relationships;
- breadth of product line;
- breadth of geographic presence;
- customer service and support; and
- after-sales service.

We believe that we compete favorably with respect to all of the factors listed above. We believe that our key competitive strengths include our broad product line, our strong research and development infrastructure and investment, our manufacturing excellence, our advanced quality control systems, the low total cost of ownership of our products, our ability to provide our customers with quick order fulfillment and our applications expertise in semiconductor manufacturing processes. However, our competitive position varies depending on the market segment and specific product areas within these segments. While we have longstanding relationships with a number of semiconductor and other electronic device manufacturers, we also face significant competition from companies that also have longstanding relationships with other semiconductor and electronic device manufacturers and, as a result, have been able to have their products specified by those customers for use in manufacturers' fabrication facilities. The competitive landscape is varied, from multinational companies to small regional or regionally-focused companies. While product quality and technology remain critical, overall, industry trends are indicating a shift to localized, cost-competitive and consolidated supply chains.

Because of the unique breadth of our capabilities, we believe that there are no global competitors that compete with us across the full range of our product offerings. Many of our competitors are local companies that participate in only a few products or in specific geographies. While there are other larger, broad-based materials suppliers, many are concentrated in specific product areas, such as filtration, specialty chemicals or materials handling. Notable competitors with respect to certain specific product areas include Pall Corporation (part of Danaher Corporation), Shin-Etsu Polymer Co., Ltd., Gemu Valves, Inc., Tokyo Keiso Co., Ltd., Mersen, Versum Materials, Inc., E. I. du Pont de Nemours and Company and The Dow Chemical Company (each a subsidiary of DowDupont Inc.), Air Liquide, Praxair, Inc. (a subsidiary of Linde plc.), Donaldson Company, Inc. and Parker Hannifin Corp.

ENGINEERING, RESEARCH AND DEVELOPMENT

We believe that technology is important to the success of our businesses, and we plan to continue to devote significant resources to engineering, research and development (R&D), balancing efforts between shorter-term market needs and

longer-term investments. Our aggregate engineering, research and development expenses in 2018, 2017 and 2016 were $118.5 million, $107.0 million and $107.0 million, respectively. As of December 31, 2018, we had approximately 500 employees in engineering, research and development. We have supplemented and may continue to supplement our internal research and development efforts by licensing technology from unaffiliated third parties and/or acquiring rights with respect to products

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incorporating externally owned technologies. Our R&D expenses consist of personnel and other direct and indirect costs for internally funded project development, including the use of outside service providers.

We believe we have a rich pipeline of development projects. For example, our engineering, research and development efforts have been focusing on growth opportunities in areas such as bulk photochemical filtration, new boron mixtures for ion implant, new precursors for deposition, specialty coatings for key applications and new cleans chemistries. Our engineering, research and development efforts are directed toward developing and improving our technology platforms for semiconductor and advanced processing applications and identifying and developing products for new applications, often working directly with our customers to address their particular needs.

We have engineering, research and development capabilities in California, Colorado, Connecticut, Massachusetts, Minnesota, Texas, Japan, South Korea, Taiwan, Singapore and Malaysia to meet the global needs of our customers. We use sophisticated methodologies to research, develop and characterize our materials and products. Our capabilities to test and characterize our materials and products are focused on continuously reducing risks and threats to the integrity of the critical materials that our customers use in their manufacturing processes.

We participate in Semiconductor Equipment and Materials International (SEMI®), an association of semiconductor equipment suppliers, as well as collaborate with leading universities and industry consortia, such as the University of California and the Interuniversity Microelectronics Centre (imec®). We undertake this work to extend the reach of our internal R&D and to gain access to leadership ideas and concepts beyond the time horizon of our internal development activities.

PATENTS AND OTHER INTELLECTUAL PROPERTY RIGHTS

As of December 31, 2018, we own approximately 2,284 active patents worldwide, of which about 644 are United States patents. Additionally, Entegris owns about 1,098 that are pending patent applications globally. In addition, we license certain patents owned by third parties. We rely on a combination of patent, copyright, trademark and trade secret laws and license agreements to establish and protect our proprietary rights. We refresh our intellectual property on an ongoing basis through continued innovation. While we license and will continue to license technology used in the manufacture and distribution of products from third parties, we do not consider any particular patent or license to be material to our business.

We vigorously protect and defend our intellectual property. 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 made while employed by us. We also require all outside scientific collaborators, sponsored researchers, and other advisors and consultants who are provided confidential information to execute confidentiality agreements upon the commencement of the consulting or collaboration relationship in question. These agreements generally provide that all confidential information developed or made known to the entity or individual during the course of the entity’s or individual’s relationship with the Company is to be kept confidential and not disclosed to third parties except in specific limited circumstances.

MANUFACTURING

Our customers rely on our products and materials to assure the integrity of the critical materials used in their manufacturing processes by providing purity, cleanliness, consistent performance, dimensional precision and stability. Our ability to meet our customers’ expectations, combined with our substantial investments in worldwide manufacturing capacity, position us to respond to the increasing demands from our customers for yield-enhancing materials and solutions.

To meet our customers’ needs worldwide, we have established an extensive global manufacturing network with facilities in the United States, Japan, Taiwan, Malaysia and South Korea. Because we work in an industry where contamination control is paramount, we maintain Class 100 to Class 10,000 cleanrooms for manufacturing and assembly. We believe that our worldwide advanced manufacturing capabilities are important competitive advantages. These include:

- engineered polymer conversion and processing;
- advanced membrane modification and cleaning;
- chemical distillation, synthesis and purification;
- gas delivery systems;
- specialty coating capabilities;
- solids and powders compounding and handling;
- graphite synthesis;
- blow molding;

high-purity gas handling and transfilling;
high-purity materials packaging;
membrane casting;
cartridge manufacturing and assembly;
rotational molding;
machining; and
assembly.

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We have made significant investments in systems and equipment to create innovative products and tool designs, including metrology and 3D printing capabilities for rapid analysis and production prototype of products. In addition, we use contract manufacturers for certain of our gas purification systems and certain electronic materials products both in the U.S. and Asia.

RAW MATERIALS

Our products are made from a wide variety of raw materials that are generally available from multiple sources of supply. However, while we seek to have several sources of supply for all of these materials, certain materials included in our products, such as certain filtration membranes in our MC segment, petroleum coke and specialty and commodity chemicals in our SCEM segment and polymer resins in our AMH segment, are obtained from a single source or a limited group of suppliers or from suppliers in a single country. We have entered into multi-year supply agreements with a number of suppliers for the purchase of raw materials in the interest of supply assurance and to control costs.

GOVERNMENTAL REGULATION

Our operations are subject to federal, state and local regulatory requirements relating to environmental, waste management and health and safety matters, including measures relating to the release, use, storage, treatment, transportation, discharge, disposal and remediation of contaminants, hazardous substances and wastes, as well as practices and procedures applicable to the construction and operation of our plants. Although some risk of costs and liabilities related to these matters is inherent in our business, as with many similar businesses, we believe that our business is operated in substantial compliance with applicable regulations. However, new, modified or more stringent requirements or enforcement policies could be adopted, which could adversely affect us. While we expect that capital expenditures will be necessary to assure that any new manufacturing facility is in compliance with environmental and health and safety laws, we do not expect these expenditures to be material.

EMPLOYEES

As of December 31, 2018, we had approximately 4,900 employees. Given the variability of business cycles in the semiconductor industry and the quick response time required by our customers, it is critical that we be able to quickly adjust the size of our production staff to maximize efficiency. Therefore, we use skilled temporary labor as required. None of our employees are represented by a labor union or covered by a collective bargaining agreement other than statutorily mandated programs in certain European countries.

FINANCIAL INFORMATION ABOUT OUR OPERATING SEGMENTS

For a discussion of revenue and segment profitability with respect to each of our reporting segments, see Item 7. Management’s Discussion and Analysis of Financial Condition and Results of Operations - Segment Analysis below, which is incorporated herein by reference. See also note 16 to our consolidated financial statements. Approximately 78%, 79% and 78% of our net sales were made to customers outside North America in 2018, 2017 and 2016, respectively. Industry and geographic segment information is also discussed in note 16 to the Entegris, Inc. consolidated financial statements included in response to Item 8 below, which is incorporated herein by reference.

OUR HISTORY

The Company was incorporated in Delaware on March 17, 2005 in connection with a merger between Entegris, Inc., a Minnesota corporation, and Mykrolis Corporation, a Delaware corporation. On April 30, 2014, the Company acquired ATMI, based in Danbury, CT. Entegris has been helping its customers solve their critical materials challenges and enhance their manufacturing yields for over 50 years, tracing its corporate origins back to Fluoroware, Inc., which began operating in 1966.

AVAILABLE INFORMATION

Our Internet address is www.entegris.com. On this web site, under the “Investors-Financial Information-SEC Filings” section, we post the following filings as soon as reasonably practicable after they are electronically filed with, or furnished to, the U.S. Securities and Exchange Commission (SEC): our annual, quarterly, and current reports on Forms 10-K, 10-Q, and 8-K; our proxy statements; any amendments to those reports or statements, and Form SD. All such filings are available on our web site free of charge. The SEC also maintains a web site (www.sec.gov) that contains reports, proxy and information statements, and other information regarding issuers that file electronically with the SEC. The content on our website, and any other website, as referred to in this Form 10-K is not incorporated

by reference into this Form 10-K unless expressly noted.

Item 1A. Risk Factors.

In addition to the other information in this Annual Report on Form 10-K, the following risk factors should be carefully considered in evaluating us and our common stock. Any of the following risks, many of which are beyond our control, could

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materially and adversely affect our financial condition, results of operations or cash flows, or cause our actual results to differ materially from those projected in any forward-looking statements. While we believe that the following list identifies our most significant risk factors, there may be additional risks and uncertainties that are not presently known, are not currently believed to be material, or are not identified below because they are common to all businesses. Past financial performance may not be a reliable indicator of future performance and historical trends should not be used to anticipate results or trends in future periods. For more information, see “Cautionary Statement” in Item 7 of this Annual Report on Form 10-K.

Risks Related to Our Business and Industry

WORLDWIDE ECONOMIC AND INDUSTRY CONDITIONS MAY CAUSE DEMAND FOR OUR PRODUCTS TO DECREASE AND MAY ADVERSELY AFFECT OUR BUSINESS.

Worldwide economic and industry conditions may adversely affect our business. Our revenue is primarily dependent upon demand from semiconductor manufacturers, which is largely driven by the current and anticipated business and consumer demand for electronic products that utilize semiconductors. Despite the broadening of semiconductor demand drivers to including applications such as smartphones, cloud computing, the Internet of Things, and artificial intelligence, amongst others, the semiconductor industry has historically been, and may in the future be, highly cyclical with periodic significant downturns, resulting in significantly decreased expenditures by semiconductor manufacturers. We are unable to predict the ultimate duration or severity of any future downturns for the semiconductor industry. We have in the past experienced significant revenue deterioration and operating losses due to a severe downturn in the semiconductor industry. During downturns, our revenue is reduced and there is likely to be an increase in pricing pressure and shifts in product and customer mix, all of which may affect gross margin and net income. Additionally, the semiconductor industry is affected by seasonal shifts in demand. Even moderate cyclicality or seasonality can cause our operating results to fluctuate significantly from one period to the next.

Uncertain and volatile economic conditions and other factors can exacerbate negative trends in business and consumer spending, causing our customers to push out, cancel, or refrain from purchasing our products and solutions, which may have an adverse impact on our revenues, results of operations and financial condition. Changes in order patterns have an immediate impact on our revenues because we typically do not have significant backlog. Uncertain economic and industry conditions make it more challenging for us to forecast our operating results, make business decisions, and identify and prioritize business risks. If we do not appropriately respond to changing economic and industry conditions, it could have a significant negative impact on its business performance and financial condition. We may be required to implement additional cost reduction efforts, including restructuring activities, which may adversely affect our ability to capitalize on opportunities. Furthermore, since we must continue to maintain a satisfactory level of engineering, research and development expenditures, continue to invest in our infrastructure and maintain the ability to respond to any significant increases in demand, if they occur, lower sales volume in periods of reduced demand can have a large impact on our profitability.

OUR DEPENDENCE ON SINGLE AND LIMITED SOURCE SUPPLIERS OR AN INTERRUPTION IN OUR ORDINARY SOURCES OF SUPPLY COULD AFFECT OUR ABILITY TO MANUFACTURE OUR PRODUCTS AND HAVE AN ADVERSE EFFECT ON OUR RESULTS OF OPERATIONS.

We rely on single or limited source suppliers for raw materials, such as plastic polymers, filtration membranes, petroleum coke and other materials, which are critical to the manufacturing of our products. If we lost one of these sources, it may be difficult for us to find an alternative supplier and we would need to qualify this new source through our customers’ rigorous qualification processes. Although we seek to reduce dependence on these sole and limited source suppliers, the partial or complete loss of these sources could interrupt our manufacturing operations and result in an adverse effect on our results of operations.

At times, we have experienced a limited supply of certain raw materials and have had to substitute raw materials, which have resulted in delays, increased costs and risks associated with qualifying products made from such new raw materials with our customers. Events such as an industry-wide increase in demand for, or the discontinuation of, raw materials used in our products could affect our ability to acquire sufficient quantities and our manufacturing operations may be interrupted. For example, global demand for fluoropolymers increased unexpectedly in 2017 due to greater requirements from certain markets. While we were able to maintain our supply of this raw material and

prevent delays in customer shipments by holding forecast reviews with our key suppliers and securing higher levels of fluoropolymers inventory, future raw materials shortages may adversely affect our operations. Additionally, our suppliers may not have the capacity to meet increases in our demand for raw materials, in turn, making it difficult for us to meet demand from our customers. Furthermore, prices for our raw materials can vary widely. While we have long-term arrangements with certain key suppliers that fix our price for the purchase of certain raw materials, if the cost of our raw materials increases and we are unable to correspondingly increase the sales price of our products or find other cost savings, our profit margins will decline.

WE ARE EXPOSED TO THE RISKS OF OPERATING A GLOBAL BUSINESS AS A SIGNIFICANT AMOUNT OF OUR SALES AND MANUFACTURING ACTIVITY OCCUR OUTSIDE THE UNITED STATES.

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Sales to customers outside the United States accounted for approximately 78%, 79% and 78% of our net sales in 2018, 2017 and 2016, respectively. We anticipate that international sales will continue to account for a majority of our net sales. In addition, a number of our key domestic customers derive a significant portion of their revenues from sales in international markets. We also manufacture a significant portion of our products outside the United States and are dependent on international suppliers for many of our parts and raw materials. We intend to continue to pursue opportunities in both sales and manufacturing internationally. Our international operations are subject to a number of risks and potential costs that could adversely affect our revenue and profitability, including:

- unanticipated government actions, laws, rules, regulations and policies, such as “trade wars” or changes in international trade requirements and sanctions and/or tariffs that affect our business and that of our customers and suppliers, that could impose additional costs on our operations, or that could limit our ability to operate our business;
- challenges in hiring and integrating workers in different countries;
- management of a diverse workforce with different experience levels, languages, cultures, customs, business practices and worker expectations, along with differing employment practices and labor issues;
- maintenance of appropriate business processes, procedures and internal controls, and compliance with legal, environmental, health and safety, anti-corruption and other regulatory requirements;
- development of relationships with local customers, suppliers and governments;
- fluctuating pricing and availability of raw materials and supply chain interruptions;
- expense and complexity of complying with U.S. and foreign import and export regulations, including the ability to obtain required import and export licenses;
- fluctuations in interest rates and currency exchange rates, including the relative strength or weakness of the U.S. dollar against foreign currency including Japanese yen, euro, Taiwanese dollar, Korean won, Chinese yuan or Singapore dollar, which could cause our sales and profitability to decline;
- liability for foreign taxes assessed at rates higher than those applicable to our domestic operations;
- customer or government efforts to encourage operations and sourcing in a particular country, such as Korea and China or that favor domestic companies over nondomestic companies, including efforts to provide for the development and growth of local competitors; and
- political and economic instability and uncertainty.

In the past, we have incurred costs or experienced disruptions due to the factors described above and we expect to do so in the future. For example, effective October 30, 2018, the U.S. Department of Commerce restricted exports to a Chinese semiconductor manufacturing company and may in the future impose further restrictions on this or other semiconductor manufacturers or industry participants. While this particular event is not expected to have an adverse effect on our revenue, other restrictions could impact our ability to serve customers in China and in other countries. In addition, the import of gas canisters and chemicals viewed as dangerous have come under increased regulatory scrutiny by governmental officials in China. As a result, we have established partnerships with local suppliers. However, this increased regulation may impair the ability of our SCEM segment to import those products into China and may cause us to lose sales. Also, in the past, our operations in Asia, and particularly South Korea, Taiwan and Japan, have been negatively impacted as a result of regional economic instability. There have historically been strained relations between China and Taiwan and there are continuing tensions between North Korea and other countries, including South Korea and the United States. Any adverse developments in those relations could significantly disrupt the worldwide production of semiconductors, which may lead to reduced sales of our products.

A SIGNIFICANT AMOUNT OF OUR SALES IS CONCENTRATED ON A LIMITED NUMBER OF KEY CUSTOMERS AND, THEREFORE, OUR NET SALES AND PROFITABILITY MAY MATERIALLY DECLINE IF WE LOST ONE OR MORE OF THESE CUSTOMERS.

Sales to a limited number of large customers constitute a significant portion of our overall revenue, shipments, cash flows, collections, and profitability. Our top ten customers accounted for 44%, 47% and 45% of our net sales in 2018, 2017 and 2016, respectively. Our customers could stop using our products in their manufacturing processes with limited advance notice to us and suffer little or no penalty for doing so. The cancellation, reduction or deferral of purchases of our products by even a single customer could significantly reduce our revenues in any particular quarter.

If we were to lose any of our significant customers, if our products are not specified for these customers' products or production processes, or if we suffer a material reduction in their purchase orders, our revenue could decline and our business, financial condition and results of operations could be materially and adversely affected. Due to the long design and development cycle and lengthy customer product qualification periods required for most of our new products, we may be unable to quickly replace these customers, if at all.

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Furthermore, the semiconductor industry has been undergoing, and is expected to continue to undergo, consolidation. If any of our customers merge or are acquired, we may experience lower overall sales from the merged or surviving companies. In addition, our principal customers also hold considerable purchasing power and may be able to negotiate requirements that result in decreased pricing, increased costs, and/or lower margins for us, and limitations on our ability to share jointly developed technology with others.

We could also lose our key customers or significant sales to our key customers because of factors beyond our control, such as a significant disruption in our customers' businesses generally or in a specific product line, a change in the manufacturing sourcing policies or practices of these customers or the timing of customer inventory adjustments. For example, our customers' aggressive management of inventory has adversely affected revenue in our SCEM segment in the past and may adversely affect future results of operations.

IF WE ARE UNABLE TO RESPOND TO RAPID TECHNOLOGICAL CHANGE BY CONTINUING TO INNOVATE AND INTRODUCE NEW AND ENHANCED PRODUCTS AND SOLUTIONS, OUR BUSINESS COULD BE SERIOUSLY HARMED.

The semiconductor industry is subject to rapid technological change, changing customer requirements and frequent new product introductions. As a result, the life cycle of our products is difficult to determine. We believe that our future success will depend upon our ability to continue to develop mission-critical solutions to maximize our customers' manufacturing yields and enable higher performance of end-market materials or devices. This requires that we successfully anticipate and respond to technological changes in manufacturing processes in a cost-effective and timely manner. A failure to develop new products or enhancements to our existing products or the inability to timely manufacture and ship these products or enhancements in sufficient volume could harm our business prospects and significantly reduce our sales. In addition, if new products have reliability or quality problems, we may experience reduced orders, higher manufacturing costs, delays in acceptance and payment, additional service and warranty expense, and damage to our reputation.

COMPETITION FROM NEW OR EXISTING COMPANIES COULD HARM OUR FINANCIAL CONDITION, RESULTS OF OPERATIONS AND CASH FLOW.

We operate in a highly competitive industry. Our competitors include many domestic and foreign companies, some of which have substantially greater manufacturing, financial, research and development, and marketing resources than we do. In addition, some of our competitors may have better-established customer relationships than we do, which may enable them to have their products specified for use more frequently and more quickly by these customers. We also face competition from smaller, regional companies, which focus on serving those customers in their same region. Another source of competition is from the manufacturing engineering teams of our customers, who continually evaluate the benefits of internal manufacturing versus outsourcing. If we are unable to maintain our competitive position, we could experience downward pressure on prices, fewer customer orders, reduced margins, the inability to take advantage of new business opportunities and a loss of market share, which could have a material adverse effect on our results of operations. Further, we expect that existing and new competitors will improve the design of their existing products and will introduce new products with enhanced performance characteristics. The introduction of new products or more efficient production of existing products by our competitors could diminish our market share and increase pricing pressure on our products.

IF OUR NEW PRODUCT INITIATIVES AND RELATED INVESTMENTS DO NOT RESULT IN FUTURE BUSINESS OPPORTUNITIES, OUR REVENUE AND PROFITABILITY MAY DECLINE.

In the semiconductor market, while the development period for a product can be very long, the first company to introduce an innovative product meeting an identified customer need will often have a significant advantage over offerings of competitive products. For this reason, we may make significant cash expenditures to research, develop, engineer and market new products and make significant capital investments in technology and manufacturing capacity in advance of future business developing and without any purchase commitment from our customers. For example, to support new product and technology development, we incurred $118.5 million, $107.0 million and $107.0 million for engineering, research and development expense in 2018, 2017 and 2016, respectively.

Following development, it may take a number of years for sales of a new product to reach a substantial level, if ever. A product concept may never progress beyond the development stage or may only achieve limited acceptance in the

marketplace. If this occurs, we do not receive a direct return on our expenditures, we may not realize any indirect benefits, we may lose market share and our revenue and profitability may decline. For example, from 2011 to 2014, our capital expenditures relating to developing the capability to manufacture shippers and FOUPs for 450 mm wafers were approximately $16.5 million. However, major semiconductor manufacturers have announced that they would not initiate 450 mm manufacturing in the foreseeable future. As a result, we incurred significant impairment charges in fiscal year 2017. We cannot assure you that the new products and technology we choose to develop and market in the ordinary course of our business will be successful.

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TARIFFS, TRADE RESTRICTIONS AND PROTECTIONIST MEASURES RESULTING FROM INTERNATIONAL TRADE DISPUTES COULD HAVE AN ADVERSE IMPACT ON OUR OPERATIONS.

We have significant sales to customers outside of the United States and we purchase a significant amount of raw materials from suppliers outside of the United States. The United States and other countries have levied tariffs and taxes on certain goods. While there is uncertainty as to the duration of these tariffs and scope of future tariffs, tariffs may increase the costs of certain raw materials that we import into the United States and may negatively impact our margins as we may not be able to increase the prices of our products. Retaliatory tariffs on goods manufactured in the United Stated could make the products we sell from the United States more expensive to customers outside the United States, reducing the competitiveness of our products, harming sales and inhibiting our ability to do business in these foreign countries. As a result of these ongoing trade disputes, our business, financial condition, results of operations and cash flow could be negatively impacted.

WE MAY ACQUIRE OTHER BUSINESSES, FORM JOINT VENTURES OR DIVEST BUSINESSES, WHICH COULD NEGATIVELY AFFECT OUR FINANCIAL PERFORMANCE.

As part of our business strategy, and as we have done in the past, we expect to address gaps in our product offerings, adjust our portfolio of businesses to meet our ongoing strategic objectives, diversify into complementary markets and increase our scale through acquisitions, joint ventures or other types of collaborations, including the Proposed Merger. As a result, we may enter markets in which we have no or limited prior experience and may encounter difficulties in divesting businesses that no longer meet our objectives. Competition for acquiring attractive businesses in our industry is substantial. We may experience difficulty in identifying suitable acquisition candidates or in completing selected transactions at appropriate valuations, in a timely manner, on a cost-effective basis or at all, and we may not realize the anticipated benefits of any such transaction. In addition, new legislation or regulations may increase the difficulty or impair our ability to invest or consummate transactions in certain countries or require us to obtain regulatory approvals to do so. Specifically, the Proposed Merger is subject to a number of closing conditions, many of which are outside of our control, including the receipt of approvals from our and Versum's shareholders, the receipt of approvals under U.S. and certain foreign antitrust and competition laws, and other conditions set forth in the Merger Agreement, and there can be no assurance that the Proposed Merger will be completed.

Alternatively, we may be required to undertake multiple transactions at the same time in order to take advantage of acquisition opportunities that do arise. This could strain our ability to effectively execute and integrate these transactions. In addition, the integration of certain operations following a transaction, including the Proposed Merger, requires the dedication of significant management resources, which may temporarily distract management's attention from our day-to-day business. Employee uncertainty and lack of focus during integration process may also disrupt our business. Further, we may not be able to successfully integrate any acquisitions that we do make into our existing business operations, including the Proposed Merger. For example, if we fail to successfully integrate and operate the gas purification business we acquired from SAES Getters S.p.A. in June 2018, we may not meet our revenue and bottom line objectives for the MC division or for the Company, and if we fail to successfully integrate the operations of Versum, we may not be able to achieve the anticipated operating and cost synergies or long-term strategic benefits of the Proposed Merger. An inability to realize the full extent of, or any of, the anticipated benefits of the Proposed Merger, as well as any delays encountered in the integration process, could have an adverse effect on our business and results of operations, which may affect the value of the shares of our common stock after the completion of the Proposed Merger. Additionally, we could assume unknown or contingent liabilities or experience negative effects on our reported results of operations from dilutive results from operations and/or from future potential impairment of acquired assets, including goodwill, related to future acquisitions. For example, despite our due diligence review, an acquired company may have inadequate or ineffective an internal financial controls, disclosure controls and procedures, cybersecurity, privacy policies and procedures, or environmental, health and safety, anti-corruption, human resource, or other policies or practices. We may experience difficulties in retaining key employees or customers of an acquired business, and our management's attention could be diverted from other business issues.

MANUFACTURING INTERRUPTIONS OR DELAYS, FAILURE TO RESPOND TO SHIFTS IN DEMAND, AND RISKS ASSOCIATED WITH THE USE AND MANUFACTURE OF HAZARDOUS MATERIALS COULD ADVERSELY AFFECT OUR BUSINESS, FINANCIAL CONDITION AND RESULTS OF OPERATIONS.

Our manufacturing processes are complex and require the use of expensive and technologically sophisticated equipment and materials. These processes are frequently modified to improve manufacturing yields and product quality. We have, on occasion, experienced manufacturing difficulties, such as occasional critical equipment breakdowns or the introduction of impurities in the manufacturing process, which could cause lower manufacturing yields, make our products unmarketable and/or delay deliveries to customers. In addition, modification to the manufacturing process of our products may require that the affected product be re-qualified by our customers, which can increase our costs and delay our ability to sell this product to our customers. These and other manufacturing difficulties may result in the loss of sales and exposure to warranty and product liability claims.

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A number of our product lines are manufactured at only one or two facilities in different countries. A disruption at these facilities could impact our sales until another facility could commence or expand production of such products. We have in the past moved, and we may in the future move, the manufacture of certain product lines from one of our plants to another, usually to enhance efficiency and cost effectiveness of our manufacturing operations and to better serve customers located in various countries. If we fail to efficiently and effectively transfer and re-establish the manufacturing processes in the destination plant, we may not be able to meet customer order, we may lose credibility with our customers and our business may be harmed. Even if we successfully move our manufacturing processes, there is no assurance that we will achieve anticipated cost savings and efficiencies.

Our ability to increase sales of our products, particularly our capital equipment products, depends in part upon our ability to timely ramp up our manufacturing capacity for such products, often in as little as a few months, and to quickly mobilize our supply chain. If we are unable to accurately foresee or anticipate rapid shifts in demand, expand our manufacturing capacity on a timely basis, manage such expansion effectively and obtain an increase in required raw materials from our supply chain, our customers could seek such products from our competitors, and our market share could be reduced. Additionally, we typically operate our business on a just-in-time shipment basis with a modest level of backlog, ordering supplies and planning production based on internal demand forecasts. The failure to accurately forecast demand for our products, in terms of both volume and product type, has in the past led to, and may in the future lead to, delays in product shipments, disappointment of customer expectations, and, alternatively, an increased risk of excess and obsolescence of our inventory. If we fail to accurately forecast demand for our products, our business, financial condition and operating results could be materially and adversely affected.

Our operations involve, and we are exposed to the risks associated with, the use and the manufacture of hazardous materials, in particular, specialty chemical manufacturing, and the related storage and transportation of raw materials, products and waste in our manufacturing facilities or distribution centers. In addition, a failure of one of our products at a customer site could interrupt the business operations of the customer. For example, while we believe that our SDS and VAC delivery systems are the safest available in the industry, as with any products involved in the transport, storage and delivery of toxic gases, if a leak were to occur during transport, during storage or during delivery at our customers' location, serious damage could result including injury or death to any person exposed to those toxic gases creating significant product liability for us. There can be no assurance that our insurance will be adequate to satisfy any such liabilities and our financial results or financial condition could be adversely affected.

LOSS OF OUR KEY PERSONNEL, WHO HAVE SIGNIFICANT EXPERIENCE IN THE SEMICONDUCTOR INDUSTRY AND TECHNOLOGICAL EXPERTISE, COULD HARM OUR BUSINESS, WHILE OUR INABILITY TO ATTRACT AND RETAIN NEW QUALIFIED PERSONNEL COULD INHIBIT OUR ABILITY TO OPERATE AND GROW OUR BUSINESS SUCCESSFULLY.

Many of our key personnel have significant experience in the semiconductor industry and deep technical expertise. The loss of the services of one or several of our key employees or an inability to attract, train and retain qualified and skilled employees, specifically research and development and engineering personnel, could inhibit our ability to operate and grow our business successfully. As the semiconductor industry has experienced growth in recent years, the competition between industry participants for qualified talent, particularly those with significant experience in the semiconductor industry, has intensified. As a result, the difficulty and costs associated with attracting and retaining key employees has risen and may rise further in the future rise.

IF WE FAIL TO OBTAIN, PROTECT AND ENFORCE INTELLECTUAL PROPERTY RIGHTS, OUR BUSINESS AND PROSPECTS COULD BE HARMED.

Our future success and competitive position depend in part upon our ability to obtain, maintain and enforce intellectual property rights. We rely on patent, trade secret and trademark law to protect many of our major product platforms. We have obtained a number of patents relating to our products and solution. While we have filed applications for additional patents, we cannot assure you that any of our pending patent applications will be approved, that we will develop additional patentable proprietary technology, that any patents owned by or issued to us will provide us with competitive advantages or that these patents will not be challenged, invalidated, circumvented, rendered unenforceable or otherwise compromised by third parties. In addition, if we do not obtain intellectual property protection in the international jurisdictions we serve, our competitiveness in these markets could be

significantly impaired, which could limit our growth and future revenue. While we routinely enter into confidentiality agreements with our employees and with third parties to protect our proprietary information and technology, these agreements may be breached by such employees or third parties, and we may not have adequate remedies for such breaches. Furthermore, our confidential and proprietary information and technology could be independently developed by or become otherwise known to third parties and third parties could design around our patents. Competitors may misappropriate our intellectual property rights, and disputes as to ownership of intellectual property rights may arise. We may institute litigation in order to enforce our patents, copyrights or other intellectual property rights, to protect our trade secrets, to determine the validity and scope of the proprietary rights of others or to defend against claims of

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infringement. Such litigation could result in substantial costs and diversion of resources and could negatively affect our sales, profitability and prospects regardless of whether we are able to successfully enforce our rights. For example, in January 2011, we settled multiple patent litigations with Pall Corporation (which was acquired by Danaher Corporation in 2015). We prosecuted and defended these cases vigorously and incurred substantial costs in pursuing them. It may become necessary for us to initiate other costly patent litigation against our competitors in order to protect and/or perfect our intellectual property rights. We cannot predict how any existing or future litigation will be resolved or what its impact will be on us.

Our commercial success depends, in part, on our ability to avoid infringing or misappropriating any patents or other proprietary rights owned by third parties. If we are found to infringe or misappropriate a third party's patent or other proprietary rights, we could be required to pay damages to such third party, alter our products or processes, obtain a license from the third party or cease activities utilizing such proprietary rights, including making or selling products utilizing such proprietary rights. If we are required to obtain a license from a third party, there can be no assurance that we will be able to do so on commercially favorable terms or at all.

OUR RESULTS OF OPERATIONS COULD BE ADVERSELY AFFECTED BY CLIMATE CHANGE OR NATURAL CATASTROPHES IN THE LOCATIONS IN WHICH WE, OUR CUSTOMERS OR OUR SUPPLIERS OPERATE, SUCH AS THE MARCH 2011 EARTHQUAKE AND TSUNAMI IN JAPAN, HURRICANE HARVEY IN EAST TEXAS, HURRICANE IRMA IN FLORIDA IN 2017 AND THE WILDFIRES IN COLORADO SPRINGS, COLORADO AND CALIFORNIA IN 2012, 2017 AND 2018.

We have manufacturing and other operations in locations subject to severe weather and natural catastrophes which could disrupt operations, such as typhoons in Taiwan and China, earthquakes and tsunamis in Japan in 2011, hurricanes in east Texas (Hurricane Harvey) and in Florida (Hurricane Irma), each in 2017, and wildfires in Colorado Springs, Colorado in 2012 and in California in 2017 and 2018. In addition, our suppliers and customers also have operations in such locations. A natural disaster that results in a prolonged disruption to our operations, or our customers' or suppliers' operations, may adversely affect our results of operations and financial condition. Also, climate change poses both regulatory and physical risks that could harm our results of operations or affect the way we conduct our businesses. While our business continuity plans enabled us to mitigate the impact to our operations of the events described above, there can be no assurance that such plans will be effective in the future or that such catastrophes will not disrupt our ability to manufacture and deliver products to our customers, resulting in an adverse impact on our business and results of operations.

WE MAY BE SUBJECT TO INFORMATION TECHNOLOGY SYSTEM FAILURES, NETWORK DISRUPTIONS AND BREACHES IN DATA SECURITY, WHICH COULD DAMAGE OUR REPUTATION AND ADVERSELY AFFECT OUR FINANCIAL CONDITION, RESULTS OF OPERATIONS AND CASH FLOWS.

In the ordinary course of our business, we collect and store sensitive data, including our financial information, intellectual property, confidential information, proprietary business information and that of our customers, suppliers and business partners and personally identifiable information of our employees in our data centers and on our networks. The secure processing, maintenance and transmission of this information is critical to our operations. Information technology system failures, network disruptions and breaches of data security from cyber-attacks, employee error or social media use on our computers, through failure of our internet service providers and other cloud computing service providers to successfully secure their own systems or from other causes could disrupt our operations, cause customer communication and order management issues, cause the unintentional disclosure of customer, employee and proprietary information, cause disruption in our transaction processing or lead to issues with maintaining our controls over our financial reporting, which could affect our reputation and reporting of financial results.

All information systems are subject to disruption, breach or failure. While our management has implemented network security procedures, virus protection software, intrusion prevention systems, access control, emergency recovery processes and internal control measures, we have experienced, and expect to continue to be subject to, cybersecurity threats and incidents ranging from employee error or misuse, to individual attempts to gain unauthorized access to our systems, to sophisticated and targeted measures known as advanced persistent threats, none of which have been material to the Company to date. Furthermore, there can be no assurance that a system failure or data security breach

will not occur and have a material adverse effect on our financial condition results of operations and cash flows. Relatedly, new laws and regulations, such as the European Union General Data Protection Regulation 2016 that became effective May 2018, add to the complexity of our compliance obligations, which may increase compliance costs, and a failure to comply with such laws and regulations could result in significant penalties.

WE ARE SUBJECT TO A VARIETY OF ENVIRONMENTAL LAWS AND REGULATIONS THAT COULD CAUSE US TO INCUR SIGNIFICANT LIABILITIES AND EXPENSES.

Failure to comply with the wide variety of federal, state, local and non-U.S. regulatory requirements relating to the release, use, storage, treatment, transportation, discharge, disposal and remediation, of, and human exposure to, hazardous chemicals, which

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have tended to become stricter over time, could result in future liabilities or the suspension of production or shipment. For example, the Frank R. Lautenberg Chemical Safety for the 21st Century Act modified the Toxic Control Substances Act, or TSCA, by requiring the Environmental Protection Agency, or the EPA, to prioritize and evaluate the environmental and health risks of existing chemicals and provides EPA with greater authority to regulate chemicals posing unreasonable risks. According to this statute, the EPA is required to make an affirmative finding that a new chemical will not pose an unreasonable risk before such chemical can go into production. As a result, TSCA has been updated so that it operates in a similar fashion to the Registration, Evaluation, and Authorization of Chemicals, or REACH, legislation in Europe. Regulations similar to REACH have been enacted in South Korea and Taiwan. These laws and regulations, among others, increase the complexity and costs of transporting our products from the country in which they are manufactured, to the location of our customer. Any further changes to these and similar regulations in the countries in which we operate or sell into could restrict our ability to expand our facilities or to build or acquire new facilities, require us to acquire costly control equipment, cause us to incur expenses associated with remediation of contamination, modify our manufacture or shipping processes, or otherwise increase our cost of doing business and have a negative impact on our financial condition, results of operations and cash flows.

The nature of our business exposes us to risk of liability for environmental contamination if hazardous materials are released into the environment, which could result in substantial losses, reputational harm, increase in our insurance cost or otherwise adversely impact our results of operations.

CHANGES IN TAXATION OR ADVERSE TAX RULINGS COULD ADVERSELY AFFECT OUR RESULTS OF OPERATIONS.

We have facilities in many foreign countries and, as a result, are subject to taxation at various rates and audit by a number of taxing authorities. Our results of operations could be affected by changes in applicable tax rates or audits by the taxing authorities in countries in which we operate or in the countries from which we purchase raw materials, changes in laws and regulations governing calculation and location of earned profit and taxation thereof, changes in laws and regulations affecting our ability to realize deferred tax assets on our balance sheet and changes in laws and regulations relating to the repatriation of cash into the United States. Each quarter we forecast our tax liability based on our forecast of our performance for the year. If that performance forecast changes, our forecasted tax liability may change.

We have undertaken a number of complex internal reorganizations of our foreign subsidiaries in order to rationalize and streamline our foreign operations, focus our management efforts on certain local opportunities and take advantage of favorable business conditions in certain localities. While we have exercised diligence in undertaking these internal reorganizations, there can be no assurance that these reorganizations, or any future internal reorganization, will not result in adverse tax consequences in the United States or in foreign countries in which we have operations. This could adversely impact our profitability from foreign operations and result in a material reduction in our results of operations.

The U.S. Tax Cuts and Jobs Act of 2017 (the “Tax Cuts and Jobs Act”) significantly changed how the U.S. taxes corporations, including limitations on the deductibility of interest expense and executive compensation, and the imposition or acceleration of taxation on certain foreign income, each of which may increase our tax expense. Both the Tax Cuts and Jobs Act and subsequent regulations and interpretations require complex computations to be performed that were not previously required in U.S. tax law, significant judgments to be made in interpretation of the provisions of the Tax Cuts and Jobs Act, significant estimates in calculations, and the preparation and analysis of information not previously relevant or regularly produced. The U.S. Treasury Department, the IRS, and other standard-setting bodies could interpret or issue guidance on how provisions of the Tax Cuts and Jobs Act will be applied or otherwise administered that is different from our interpretation. As additional clarification and guidance is issued regarding the Tax Cuts and Jobs Act, we may make adjustments to amounts that we have recorded, which may materially impact our provision for income taxes in the period in which the adjustments are made.

Various other jurisdictions, including members of the Organization for Economic Cooperation and Development, are considering changes to their tax laws, including provisions intended to address base erosion and profit shifting by taxpayers. Any tax reform adopted in these or other countries may exacerbate the risks described above.

UNCERTAINTY AND VOLATILITY IN THE GLOBAL ECONOMY COULD ADVERSELY AFFECT OUR RESULTS.

Financial markets in the United States, Europe and Asia have experienced extreme disruption in the recent past. Such disruption included, among other things, volatility in securities prices, severely diminished liquidity and credit availability, rating downgrades of sovereign debt, declining valuation of certain investments, declines in consumer confidence, declines in economic growth, volatility in unemployment rates, and uncertainty about economic stability. Such conditions have had a significant adverse impact on our industry, our financial condition and results of operations. There may be further changes in the global economy, which could lead to further challenges in our business and negatively impact our financial results. For example, the U.K. vote in favor of leaving the European Union may cause instability and uncertainty in European economies and may negatively impact the outlook for the global economy. Tightness of credit in financial markets could adversely affect the ability of our customers and suppliers to obtain financing for significant purchases and operations and could result in a

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decrease in orders and spending for our products and services. We are unable to predict the likely duration and severity of any disruption in regional or global financial markets and adverse economic conditions and the effects they may have on our business and financial condition. If uncertain economic conditions return or deteriorate, our business and results of operations could be further materially and adversely affected.

Risks Related to Our Indebtedness

WE HAVE A SUBSTANTIAL AMOUNT OF INDEBTEDNESS, WHICH COULD ADVERSELY AFFECT OUR FINANCIAL HEALTH AND OUR ABILITY TO OBTAIN FINANCING IN THE FUTURE AND REACT TO CHANGES IN OUR BUSINESS.

As of December 31, 2018, we have approximately an aggregate principal amount of $950.0 million of indebtedness outstanding, including our 4.625% senior unsecured notes due April 1, 2026 (the “Notes”, and the indenture that governs the Notes, the “Indenture”) and our senior secured term loan facility due 2025 (the “Term Loan Facility”). In addition, we have approximately $300 million of unutilized capacity under our senior secured revolving credit facility due 2023 (the “Revolving Facility”, and together with the Term Loan Facility, the “Credit Facilities”, and the credit agreement that governs the Credit Facilities, the “Credit Agreement”).

Our debt could have important consequences, including:

- making it more difficult for us to satisfy our obligations with respect to the Notes and the Credit Facilities;
- limiting our ability to obtain additional financing to fund future working capital, capital expenditures, acquisitions or other general corporate purposes;
- requiring a substantial portion of our cash flow to be dedicated to debt service payments instead of other purposes, thereby reducing the amount of cash flow available for working capital, capital expenditures, acquisitions and other general corporate purposes;
- increasing our vulnerability to adverse changes in general economic, industry and competitive conditions;
- exposing us to the risk of increased interest expense as certain of our borrowings, including borrowings under the Credit Facilities, include variable interest rates;
- limiting our flexibility in planning for and reacting to changes in the industry in which we compete;
- preventing us from raising funds necessary to repurchase all Notes tendered to us upon the occurrence of certain change of control repurchase events, which could constitute a default under the Indenture;
- placing us at a disadvantage compared to other, less leveraged competitors or competitors with comparable debt at more favorable interest rates; and
- increasing our cost of borrowing.

In addition, the Indenture and the Credit Agreement contain restrictive covenants that will limit our ability to engage in activities that may be in our long-term best interest. Our failure to comply with those covenants could result in an event of default which, if not cured or waived, could result in the acceleration of substantially all of our debt.

DESPITE OUR CURRENT LEVEL OF INDEBTEDNESS, WE MAY STILL BE ABLE TO INCUR SUBSTANTIALLY MORE DEBT, WHICH COULD FURTHER EXACERBATE THE RISKS TO OUR FINANCIAL CONDITION DESCRIBED ABOVE.

We may incur significant additional indebtedness in the future. Although the Indenture and the Credit Agreement restrict our ability to incur additional indebtedness, the restrictions are subject to a number of significant qualifications and exceptions, such as indebtedness to finance working capital, capital expenditures, investments and acquisitions, or other purposes, and the additional indebtedness that we may incur while remaining in compliance with these restrictions could be substantial. For example, the Credit Agreement provides that we have the right to request additional loans and commitments in an aggregate amount not to exceed the greater of $400 million and 100% of EBITDA and additional amounts if our secured net leverage ratio is less than a specified ratio or, in the case of unsecured loans or other unsecured debt, or loans or other debt secured by junior liens, if our total net leverage ratio is less than a specified ratio. The Indenture does not limit the Company’s ability to incur unsecured indebtedness. Moreover, the restrictions in the Indenture on our ability to incur additional secured indebtedness are subject to a number of significant exceptions and qualifications that may permit us to incur a substantial amount of additional secured indebtedness. Further, although the Indenture limits the ability of a non-guarantor subsidiary to incur indebtedness unless it also guarantees the Notes, this limitation is subject to a number of significant exceptions and

qualifications, and the amount of indebtedness incurred in compliance with the Indenture could be substantial. These restrictions do not prevent us from incurring monetary obligations that do not constitute indebtedness. If we add new indebtedness and other monetary obligations to our current debt levels, the related risks that we now face could intensify.

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WE MAY NOT BE ABLE TO GENERATE SUFFICIENT CASH TO SERVICE OUR INDEBTEDNESS AND MAY BE FORCED TO TAKE OTHER ACTIONS, WHICH MAY NOT BE SUCCESSFUL, TO SATISFY OUR OBLIGATIONS UNDER OUR INDEBTEDNESS.

We may be unable to maintain a level of cash flow from operating activities sufficient to permit us to pay the principal of, premium, if any, and interest on our indebtedness. Our ability to make scheduled payments on or to refinance our debt obligations depends on our financial condition and operating performance and the condition of the capital markets, which are subject to prevailing economic, industry and competitive conditions, as well as certain financial, business, legislative, political, regulatory and other factors beyond our control. If our cash flow and capital resources are insufficient to fund our debt service obligations, we could face substantial liquidity problems, be forced to reduce or delay investments and capital expenditures, dispose of material assets or operations, seek additional debt or equity capital or restructure or refinance our indebtedness, and our financial position and results of operations could be materially and adversely affected.

Any refinancing of our debt could be at higher interest rates and may require us to comply with more onerous covenants, which could further restrict our business operations. We may not be able to effect any such alternative measures on commercially reasonable terms or at all and, even if successful, those alternative actions may not allow us to meet our scheduled debt service obligations. Our ability to dispose of assets and use the proceeds from those dispositions is restricted by the agreements governing our indebtedness, and we may not be able to consummate those dispositions or to obtain proceeds in an amount sufficient to meet any debt service obligations then due.

If we cannot make scheduled payments on our debt, we will be in default, and holders of the Notes and lenders under the Credit Facilities could declare all outstanding principal and interest to be due and payable, the lenders under the Revolving Facility could terminate their commitments to advance further loans, our secured lenders could foreclose against the assets securing their borrowings, and we could be forced into bankruptcy or liquidation.

THE TERMS OF THE CREDIT AGREEMENT RESTRICT OUR CURRENT AND FUTURE OPERATIONS, PARTICULARLY OUR ABILITY TO RESPOND TO CHANGES OR TO CONDUCT OUR BUSINESS OR RAISE ADDITIONAL FUNDS.

The Credit Agreement contains a number of restrictive covenants that impose significant operating and financial restrictions on us and may limit our ability to take action that may be in our long-term best interest, including restrictions on our ability to:

- incur certain liens;
- incur additional indebtedness and guarantee indebtedness;
- pay dividends or make other distributions in respect of, or repurchase or redeem, capital stock;
- prepay, redeem or repurchase certain debt;
- make investments, loans, advances and acquisitions;
- sell or otherwise dispose of assets, including capital stock of our subsidiaries;
- enter into transactions with affiliates;
- alter the businesses we conduct;
- enter into agreements restricting our subsidiaries' ability to pay dividends; and
- merge or sell all or substantially all of our assets or incur a change of control in our capital stock ownership.

In addition, the restrictive covenants in the Credit Agreement may, at certain times based on the outstanding amount of revolving borrowings, unreimbursed letter of credit drawings and undrawn letters of credit, require us to maintain a secured net leverage ratio. Our ability to meet this financial ratio can be affected by events beyond our control.

Our failure to comply with these covenants could result in an event of default that, if not cured or waived, could result in the acceleration of some or all of our indebtedness, which could lead to bankruptcy, reorganization or insolvency.

These restrictions may affect our ability to grow in accordance with our plans and could adversely affect our ability to:

- finance our operations;
- make needed capital expenditures;
- make strategic acquisitions or investments or enter into joint ventures;
- withstand a future downturn in our business, the industry or the economy in general;

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- compete effectively and engage in business activities, including future opportunities, that may be in our best interest; and
- plan for or react to market conditions or otherwise execute our business strategies.

Risks Related to Owning our Common Stock

THE PRICE OF OUR COMMON STOCK HAS BEEN VOLATILE IN THE PAST AND MAY BE VOLATILE IN THE FUTURE.

The price of our common stock has been volatile in the past and may be volatile in the future. In 2018, the closing price of our stock on The NASDAQ Global Select Market, or NASDAQ, ranged from a low of $24.44 to a high of $38.85, and, as in past years, the price of our common stock may show greater volatility.

The trading price of our common stock is subject to significant volatility in response to various factors, some of which are beyond our control or may be unrelated to our operating results, and which may adversely affect the market price of our common stock, including the following: the failure to meet the published expectations of securities analysts; changes in financial estimates by securities analysts; press releases or announcements by, or changes in market values of, comparable companies; volatility in the markets for high-technology stocks, general stock market price and volume fluctuations, which are particularly common among securities of high-technology companies; stock market price and volume fluctuations attributable to inconsistent trading volume levels; the public perception of equity values of publicly traded companies and the other risks and uncertainties described in this Annual Report on Form 10-K and in our other filings with the SEC. Such fluctuations in our results could cause our stock price to decline significantly. We believe that period-to-period comparisons of our results of operations may not be meaningful, and you should not rely upon them as indicators of our future performance. Future decreases in our stock price may adversely impact our ability to raise sufficient additional capital in the future, if needed.

THERE CAN BE NO ASSURANCE THAT WE WILL CONTINUE TO DECLARE CASH DIVIDENDS OR REPURCHASE OUR SHARES AT ALL OR IN ANY PARTICULAR AMOUNTS

Our Board of Directors initiated a quarterly dividend in November 2017. Our intent to continue to pay quarterly dividends and to repurchase our shares is subject to capital availability and periodic determinations by our Board of Directors that such actions are in the best interest of our stockholders and are in compliance with all laws and applicable agreements. Future dividends and share repurchases may also be affected by, among other factors, our views on potential future capital requirements for investments in acquisitions and the funding of our research and development; legal risks; changes in federal and state income tax laws or corporate laws; contractual restrictions, such as financial or operating covenants in our debt arrangements; availability of onshore cash flow; and changes to our business model. Our dividend payments and share repurchases may change from time to time, and we cannot provide assurance that we will continue to declare dividends or repurchase shares at all or in any particular amounts. A reduction or suspension in our dividend payments could have a negative effect on the price of our common stock.

PROVISIONS IN OUR CHARTER DOCUMENTS AND DELAWARE LAW MAY DELAY OR PREVENT AN ACQUISITION OF US, WHICH COULD DECREASE THE VALUE OF YOUR SHARES.

Our restated certificate of incorporation and by-laws and Delaware law contain provisions that could make it harder for a third party to acquire us without the consent of our board of directors. These provisions include limitations on actions by our stockholders by written consent.

Our restated certificate of incorporation makes us subject to the anti-takeover provisions of Section 203 of the Delaware General Corporation Law. In general, Section 203 prohibits publicly held Delaware corporations to which it applies from engaging in a “business combination” with an “interested stockholder” for a period of three years after the date of the transaction in which the person became an interested stockholder, unless the business combination is approved in a prescribed manner. This provision could discourage others from bidding for our shares of common stock and could, as a result, reduce the likelihood of an increase in the price of our common stock that would otherwise occur if a bidder sought to buy our common stock.

Our restated certificate of incorporation provides that our board of directors is authorized to issue from time to time, without further stockholder approval, up to 5,000,000 shares of preferred stock in one or more series and to fix and designate the rights, preferences, privileges and restrictions of the preferred stock, including dividend rights, conversion rights, voting rights, redemption rights and terms of redemption and liquidation preferences. Such shares

of preferred stock could have preferences over our common stock with respect to dividends and liquidation rights. Our issuance of preferred stock may have the effect of delaying or preventing a change in control. Our issuance of preferred stock could decrease the amount of earnings and assets available for distribution to the holders of common stock or could adversely affect the rights and powers, including voting rights, of the holders of common stock. The issuance of preferred stock could have the effect of decreasing the market price of our common stock.

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YOUR PERCENTAGE OWNERSHIP IN US MAY BE DILUTED BY FUTURE ISSUANCES OF CAPITAL STOCK, WHICH COULD REDUCE YOUR INFLUENCE OVER MATTERS ON WHICH STOCKHOLDERS VOTE.

Subject to applicable NASDAQ standards, our board of directors has the authority, without action or vote of our stockholders, to issue all or any part of our authorized but unissued shares. Issuances of common stock or the exercise of employee stock options would dilute your percentage ownership interest, which will have the effect of reducing your influence over matters on which our stockholders vote. In addition, we may issue substantial quantities of our common stock in order to effect acquisitions which would also dilute your ownership interest. If the issuances are made at prices that reflect a discount from the then current trading price of our common stock, your interest in the book value of our common stock might be diluted.

Risks Related to Our Pending Merger with Versum Materials, Inc.

FAILURE TO COMPLETE OUR PENDING MERGER WITH VERSUM MATERIALS, INC. (VERSUM) COULD HAVE A MATERIALLY ADVERSE EFFECT ON OUR FINANCIAL CONDITION AND RESULTS AND COULD NEGATIVELY IMPACT OUR STOCK PRICE.

On January 27, 2019, we entered into an agreement and plan of merger pursuant to which Versum will merge with and into Entegris. We will incur significant transaction costs relating to the merger, including legal, accounting, financial advisory, regulatory and other expenses. In general, these expenses are payable by us whether or not the merger is completed. If the merger is not completed under specific circumstances provided in the agreement and plan of merger, we may be required to pay Versum a termination fee of $155 million. The payment of such transaction costs or termination fees could have an adverse effect on our financial condition, results of operations or cash flows. In addition, we could be subject to litigation in the event the merger is not consummated, which could subject us to significant liability for damages and result in the incurrence of substantial legal fees. The current market price of our stock may reflect an assumption that the pending merger will occur and failure to complete the merger could result in a decline in our stock price.

Item 1B. Unresolved Staff Comments.

Not Applicable.

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Item 2. Properties.

Our principal executive offices are located in Billerica, Massachusetts. We also have manufacturing, research and development facilities in the United States, Japan, France, Taiwan, South Korea, Singapore, China and Malaysia. Information about our principal facilities is set forth below:

Location	Principal Function	Approximate Square Feet	Leased/ Owned	Reporting Segment
Bedford, Massachusetts	Research & Manufacturing	80,000	Owned	MC & SCEM
Billerica, Massachusetts[(1)]	Executive Offices, Research & Manufacturing	175,000	Leased	MC & SCEM
Bloomington, MN	Research & Manufacturing	68,000	Leased	AMH
Burnet, TX	Research & Manufacturing	77,000	Owned	SCEM
Chaska, Minnesota	Executive Offices, Research & Manufacturing	186,000	Owned	AMH
Colorado Springs, CO	Manufacturing	82,000	Owned	AMH
Danbury, CT	Research & Manufacturing	73,000	Leased	SCEM
Decatur, Texas	Manufacturing	359,000	Owned	SCEM
Hsin-chu, Taiwan	Executive Offices, Sales Research & Manufacturing	146,330	Leased	MC, SCEM & AMH
Yangmei City, Taiwan	Manufacturing	40,000	Leased	AMH
JangAn, South Korea	Manufacturing	127,000	Owned	SCEM & AMH
Kulim, Malaysia	Manufacturing	195,000	Owned	SCEM & AMH
Russellville, Arkansas	Manufacturing	113,127	Leased	SCEM
San Luis Obispo, CA	Manufacturing	37,000	Owned	MC
San Luis Obispo, CA	Manufacturing	34,000	Leased	MC
Shanghai, China	Executive Offices & Research	24,000	Leased	MC, SCEM & AMH
Suwon, South Korea	Executive Offices & Research	42,000	Leased	MC & SCEM
Tokyo, Japan	Executive Offices, Sales & Research	28,623	Leased	MC, SCEM & AMH
Wonju City, South Korea	Manufacturing	39,000	Owned	AMH
Yonezawa, Japan	Manufacturing	185,000	Owned	MC & AMH

[(1)] This lease has been extended through September 30, 2026 and is subject to one five-year renewal option.

We lease approximately 13,000 square feet of research and development and manufacturing office space located in San Diego, CA, approximately 31,000 square feet of manufacturing space located in Franklin, MA, approximately 10,000 square feet of office space in Round Rock, TX, approximately 3,300 square feet of office space in Tempe, AZ, approximately 10,000 square feet of manufacturing space in Goleta, CA, approximately 4,000 square feet of manufacturing space in Logan, Utah, approximately 5,200 square feet of office and manufacturing space in Port Richey, FL, approximately 15,000 square feet of manufacturing space in Anseong, South Korea, approximately 9,000 square feet of office space in Moirans, France and approximately 10,000 square feet of office space in Dresden, Germany.

We lease approximately 12,000 square feet for our Asia manufacturing management offices in Singapore. In addition, we maintain a worldwide network of sales, service, repair or cleaning centers in the United States, Germany, France, Israel, Japan, Malaysia, Taiwan, Singapore, China and South Korea. Leases for our facilities expire through September 2026. We currently expect to be able to extend the terms of expiring leases or to find suitable replacement facilities on reasonable terms.

We believe that our facilities are well-maintained and suitable for their respective operations. All of our facilities are generally utilized within a normal range of production volume.

Item 3. Legal Proceedings.

As of December 31, 2018, we were not involved in any legal proceedings that we believe will have a material impact on our consolidated financial position, results of operations or cash flows. From time to time the Company may be a

party to litigation involving claims against the Company arising in the ordinary course of our business. We are not aware of any material potential litigation or claims against us which would have a material adverse effect upon our financial statements.

Item 4. Mine Safety Disclosures.

Not applicable.

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EXECUTIVE OFFICERS OF THE REGISTRANT

The following is a list of our Executive Officers and their ages, as of the date of this this Annual Report on Form 10-K.

Name	Age	Office	First Appointed To Office*
Bertrand Loy	53	President & Chief Executive Officer	2001
Gregory B. Graves	58	Executive Vice President, Chief Financial Officer & Treasurer	2002
Todd Edlund	56	Executive Vice President & Chief Operating Officer	2007
Sue Rice	60	Senior Vice President, Human Resources	2017
Corey Rucci	59	Senior Vice President, Business Development	2014
Gregory Marshall	61	Senior Vice President, Quality, EH&S and Entegris Business Support	2011
Stuart Tison	55	Senior Vice President & General Manager, Specialty Chemicals and Engineered Materials	2016
Clint Haris	46	Senior Vice President & General Manager, Microcontamination Control	2016
William Shaner	51	Senior Vice President & General Manager, Advanced Materials Handling	2007
Bruce W. Beckman	51	Senior Vice President, Finance	2018
Michael D. Sauer	53	Vice President, Controller & Chief Accounting Officer	2011

* With either the Company or a predecessor company

Bertrand Loy has been our Chief Executive Officer, President and a director since November 2012. Mr. Loy served as our Executive Vice President and Chief Operating Officer since 2008. From August 2005 until July 2008, he served as our Executive Vice President and Chief Administrative Officer in charge of our global supply chain and manufacturing operations. He served as the Vice President and Chief Financial Officer of Mykrolis from January 2001 until August 2005. Prior to that, Mr. Loy served as the Chief Information Officer of Millipore Corporation during 1999 and 2000. From 1995 until 1999, he served as the Division Controller and Head of Manufacturing for Millipore's Laboratory Water Division. From 1989 until 1995, Mr. Loy served Sandoz Pharmaceuticals (now Novartis) in a variety of financial, audit and controller positions located in Europe, Central America and Japan. Mr. Loy served as a director of BTU International, Inc. (supplier of advanced thermal processing equipment) until its acquisition in January 2015. He also serves as a director of Harvard Bioscience, Inc. (scientific equipment) since November 2014 and has been a director for SEMI (Semiconductor Equipment and Materials International) (global high-technology manufacturing trade association) since July 2013.

Gregory B. Graves has served as our Executive Vice President and Chief Financial Officer since July 2008. Prior to that he served as Senior Vice President and Chief Financial Officer since April 2007. Prior to April 2007, he served as Senior Vice President, Strategic Planning & Business Development since the effectiveness of the merger with Mykrolis. Mr. Graves served as the Chief Business Development Officer of Entegris Minnesota since September 2002 and from September 2003 until August 2004 he also served as Senior Vice President of Finance. Prior to joining Entegris Minnesota, Mr. Graves held positions in investment banking and corporate development, including at U.S. Bancorp Piper Jaffray from June 1998 to August 2002 and at Dain Rauscher from October 1996 to May 1998. Since May 2017, Mr. Graves has served as a director of Power Plug Inc. (energy solutions provider).

Todd Edlund has been our Executive Vice President and Chief Operating Officer since July 2016. Prior to that he was our Senior Vice President and Chief Operating Officer since November 2014. After the merger with ATMI, Mr. Edlund served as Senior Vice President and General Manager of our Critical Materials Handling business and prior to the merger with ATMI, he was the Vice President and General Manager of our Contamination Control Solutions division since December 2007. He served as the Vice President and General Manager of our Liquid Systems business unit from 2005 to 2007, and prior to that as Entegris Minnesota's Vice President of Sales for semiconductor markets from 2003 to 2005. Prior to 2003, Mr. Edlund held a variety of positions with our predecessor companies since 1995.

Sue Rice joined us as our Senior Vice President of Human Resources in September 2017. Prior to that, Ms. Rice served as Senior Vice President and Chief Human Resources Officer for Thermo Fisher Scientific from 2013 to

2017, Region Vice President HR Asia Pacific & Emerging Markets from 2009 to 2013 and Group Vice President, HR Analytical Technologies Group from 2006 to 2009. Prior to that, Ms. Rice held senior human resource positions with Fidelity Human Resources Services Company and Sherbrooke Associates.

Gregory Marshall has been our Senior Vice President, Quality, EH&S and Entegris Business Support since August 2016. Prior to that Mr. Marshall served as our Vice President, Quality and EH&S since March 2010 and our Global Director of Quality since

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the merger with Mykrolis Corporation, prior to which he served as the Director of Quality for Mykrolis. Prior to joining Mykrolis, Mr. Marshall served as the Director of US Quality for Kokusai Semiconductor Equipment Corporation.

Corey Rucci has served as our Senior Vice President, Business Development since January 2018, having served as Vice President, Business Development since February 2014. Prior to that he served as Vice President and General Manager of our Specialty Materials Division since 2011 and as General Manager of Poco Graphite, Inc. (POCO) since 2008 when we acquired POCO. Prior to joining Entegris, Mr. Rucci served POCO as the President and Chief Operating Officer since 2007, Chief Operating Officer since 2005, Chief Financial Officer since 2001 and Vice President of Business Development since 1998. Prior to that he worked at UNOCAL Corp. for 17 years in a variety of accounting, marketing and business development roles.

Stuart Tison has been our Senior Vice President, Specialty Chemicals and Engineered Materials since July 2016. Prior to that, Mr. Tison served as Vice President, Specialty Gas Solutions since February 2015, as Vice President, Business Development since January 2010 and as Vice President, Corporate Development since July 2007. Prior to that he served Celerity, Inc. as Vice President, Engineering and served Entegris predecessor companies Mykrolis and Millipore in a variety of sales, marketing, business development and engineering roles.

Clint Haris has been our Senior Vice President, Microcontamination Control since July 2016. Prior to that, Mr. Haris served as our Vice President, Liquid Microcontamination Control since August 2014. Prior to joining Entegris, Mr. Haris served in a variety of executive roles at Brooks Automation Inc. including Senior Vice President, Life Science Systems from 2010 to 2014 and Senior Vice President and General Manager, Systems Solutions from 2009 to 2010.

William Shaner has been our Senior Vice President, Advanced Materials Handling since July 2016. Prior to that, Mr. Shaner served as our Senior Vice President, Global Operations since February 2014 and as our Vice President and General Manager, Microenvironments division since 2007. He has served in a variety of sales, marketing, business development and engineering roles since joining Entegris in 1995.

Bruce W. Beckman has been our Senior Vice President, Finance since February 2018. Prior to that, Mr. Beckman served as Vice President, Finance since joining Entegris in 2015. From 1990 to 2015, Mr. Beckman worked in numerous capacities for General Mills, Inc., including Vice President, Finance, Meals Division, Director of Corporate Planning & Analysis and Director of Internal Controls.

Michael D. Sauer has been our Vice President, Controller and Chief Accounting Officer since June 2012. Prior to that, he served as the Corporate Controller since 2008. From the time of the merger with Mykrolis until April 2008, Mr. Sauer served as Director of Treasury and Risk Management. Mr. Sauer joined Fluoroware, Inc., a predecessor to Entegris Minnesota in 1988 and held a variety of finance and accounting positions until 2001 when he became the Director of Business Development for Entegris Minnesota, the successor to Fluoroware, serving in that position until the merger with Mykrolis.

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PART II

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

Market Information and Holders:

Entegris' Common Stock, $0.01 par value, trades on the NASDAQ Global Select Market under the symbol "ENTG". As of February 4, 2018, there were 1,057 shareholders of record. On February 4, 2018, the last sale price reported on the Nasdaq Global Select Market for our common stock was $33.64 per share.

Dividend Policy:

Holders of the Company's common stock are entitled to receive dividends when and if they are declared by the Company's Board of Directors. The Company's Board of Directors declared a cash dividend of $0.07 per share during the first, second, third and fourth quarters of 2018, which totaled $39.7 million.

On January 16, 2019, the Company's Board of Directors declared a quarterly cash dividend of $0.07 per share to be paid on February 20, 2019 to shareholders of record as of January 30, 2019.

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. Furthermore, the credit agreements governing the New Credit Facilities contain restrictions that may limit our ability to pay dividends.

Issuer Sales of Unregistered Securities During the Past Three Years:

None

Comparative Stock Performance

The following graph compares the cumulative total shareholder return on the common stock of Entegris, Inc. from December 31, 2013 through December 31, 2018 with the cumulative total return of (1) The NASDAQ Composite Index, and (2) The Philadelphia Semiconductor Index, assuming $100 was invested at the close of trading December 31, 2013 in Entegris, Inc. common stock, the NASDAQ Composite Index and the Philadelphia Semiconductor Index and that all dividends are reinvested.

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	December 31, 2013	December 31, 2014	December 31, 2015	December 31, 2016	December 31, 2017	December 31, 2018
Entegris, Inc.	$100.00	$113.98	$114.50	$154.44	$263.30	$243.34
NASDAQ Composite	100.00	114.75	122.74	133.62	173.22	168.30
Philadelphia Semiconductor Index	100.00	131.40	129.29	167.18	234.97	220.76

Issuer Purchases of Equity Securities:

On February 13, 2018, the Company's Board of Directors authorized a repurchase program covering up to an aggregate of $100 million of the Company's common stock in open market transactions and in accordance with one or more pre-arranged stock trading plans to be established in accordance with Rule 10b5-1 under the Securities Exchange Act of 1934, as amended, over a period of twenty-four months. This repurchase program represents a further renewal of the repurchase program originally authorized by the Board of Directors on February 5, 2016, which had been subsequently renewed on February 15, 2017. On November 19, 2018, the Company's Board of Directors authorized the repurchase of up to an additional $250 million in aggregate principal amount of the Company's common stock. The authorization is in addition to the amount remaining under the share repurchase program previously authorized in February 2018.

The following table provides information concerning shares of the Company's Common Stock $0.01 par value purchased during the three months ended December 31, 2018:

Period	(a) Total Number of Shares Purchased	(b) Average Price Paid per Share	(c) Total Number of Shares Purchased as Part of Publicly Announced Plans or Programs	(d) Maximum Number (or Approximate Dollar Value) of Shares that May Yet Be Purchased Under the Plans or Programs
September 29 through November 3, 2018	1,110,600	$26.95	1,110,600	$45,508,371
November 4 through December 1, 2018	2,045,271	$27.31	2,045,271	$239,657,590
December 2 through December 31, 2018	2,394,518	$26.53	2,394,518	$176,127,662
Total	5,550,389		5,550,389	

The Company issues restricted stock unit awards (RSUs) under its equity incentive plans. In the consolidated financial statements, the Company treats shares of common stock withheld for tax purposes on behalf of its employees in connection with the vesting of RSUs as common stock repurchases because they reduce the number of shares that would have been issued upon vesting. These withheld shares of common stock are not considered common stock repurchases under the Company's authorized common stock repurchase plan and accordingly are not included in the common stock repurchase totals in the preceding table.

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Item 6. Selected Financial Data.

The table that follows presents selected financial data for each of the last five years from the Company's consolidated financial statements and should be read in conjunction with the Company's Consolidated Financial Statements and the related Notes and with "Management's Discussion and Analysis of Financial Condition and Results of Operations" included elsewhere in this Annual Report on Form 10-K. The selected financial data set forth below as of December 31, 2018 and 2017 and for the years ended December 31, 2018, 2017 and 2016 are derived from our audited financial statements included in this Annual Report on Form 10-K. All other selected financial data set forth below is derived from our audited financial statements not included in this Annual Report on Form 10-K. The selected financial data set forth below as of December 31, 2018 and for the year ended December 31, 2018 includes the results of operations of our 2018 acquisitions, see footnote 3 for additional discussion. Our historical results are not necessarily indicative of our results of operations to be expected in the future.

(In thousands, except per share amounts)	Year ended December 31, 2018	Year ended December 31, 2017	Year ended December 31, 2016	Year ended December 31, 2015	Year ended December 31, 2014
Operating Results					
Net sales	$1,550,497	$1,342,532	$1,175,270	$1,081,121	$962,069
Gross profit	719,831	608,985	508,691	470,231	376,683
Selling, general and administrative expenses	246,534	216,194	201,901	198,914	231,833
Engineering, research and development expenses	118,456	106,951	106,991	105,900	87,711
Amortization of intangible assets	62,152	44,023	44,263	47,349	37,067
Contingent consideration fair value adjustment	—	—	—	—	(1,282)
Operating income	292,689	241,817	155,536	118,068	21,354
Income (loss) before income taxes and equity in net loss of affiliate	254,432	184,731	119,999	92,185	(13,392)
Income tax expense (benefit)	13,677	99,665	22,852	10,202	(21,572)
Net income	240,755	85,066	97,147	80,296	7,887
Earnings Per Share Data					
Diluted earnings per share	$1.69	$0.59	$0.68	$0.57	$0.06
Weighted average shares outstanding – diluted	142,610	143,518	142,050	141,121	140,062
Operating Ratios – % of net sales					
Gross profit	46.4 %	45.4 %	43.3 %	43.5 %	39.2 %
Selling, general and administrative expenses	15.9	16.1	17.2	18.4	24.1
Engineering, research and development expenses	7.6	8.0	9.1	9.8	9.1
Amortization of intangible assets	4.0	3.3	3.8	4.4	3.9
Contingent consideration fair value adjustment	—	—	—	—	(0.1)
Operating income	18.9	18.0	13.2	10.9	2.2
Income (loss) before income taxes and equity in net loss of affiliate	16.4	13.8	10.2	8.5	(1.4)
Effective tax rate	5.4	54.0	19.0	11.1	161.1
Net income	15.5	6.3	8.3	7.4	0.8
Cash Flow Statement Data					
Depreciation and amortization	$127,268	$102,231	$99,886	$101,654	$83,704
Capital expenditures	110,153	93,597	65,260	71,977	57,733
Net cash provided by operating activities	312,576	293,373	207,555	120,918	126,423
Net cash used in investing activities	(485,944)	(112,455)	(66,686)	(63,638)	(860,295)
Net cash provided by (used in) financing activities	34,411	27,251	(81,747)	(92,787)	747,648

Balance Sheet and Other Data					
Current assets	$1,029,338	$1,057,608	$800,131	$708,787	$763,604
Current liabilities	269,668	290,971	261,571	175,550	262,520
Working capital	759,670	766,637	538,560	533,237	501,084
Current ratio	3.82	3.63	3.06	4.04	2.91
Long-term debt, including current maturities	938,863	674,380	584,677	656,044	753,012
Shareholders' equity	1,012,025	993,018	899,218	802,883	748,441
Total assets	2,317,641	1,976,172	1,699,532	1,646,697	1,748,307
Return on average shareholders' equity – %	24.0 %	9.0 %	11.4 %	10.4 %	1.0 %
Shares outstanding at end of year	135,977	141,283	141,320	140,716	139,793

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

The following discussion and analysis of the Company's consolidated financial condition and results of operations should be read along with the consolidated financial statements and the accompanying notes to the consolidated financial information included elsewhere in this Annual Report on Form 10-K. This discussion contains forward-looking statements that involve numerous risks and uncertainties, including, but not limited to, those described in the "Cautionary Statements" sections of this Item 7 below. The Company's actual results may differ materially from those contained in any forward-looking statements. You should review the Item 1A "Risk Factors" of this Annual Report on Form 10-K for a discussion of important factors that could cause actual results to differ materially from the results described in or implied by the forward-looking statements contained in the following discussion and analysis.

Cautionary Statements

This Annual Report on Form 10-K and the documents incorporated by reference in this Annual Report on Form 10-K contain "forward-looking statements" within the meaning of the Private Securities Litigation Reform Act of 1995. The words "believe," "expect," "anticipate," "intends," "estimate," "forecast," "project," "should," "may," "will," "would" or the n and similar expressions are intended to identify such forward-looking statements. These forward-looking statements include those about future period guidance; projected sales, net income, net income per diluted share, non-GAAP EPS, non-GAAP net income and other financial metrics; our performance relative to our markets; market and technology trends, including the duration and drivers of any growth trends; the development of new products and the success of their introductions; the focus of our engineering, research and development projects; our ability to execute on our business strategies; our capital allocation strategy, which may be modified at any time for any reason, including share repurchases, dividends, debt repayments and potential acquisitions; the effect of the Tax Cuts and Jobs Act; future capital and other expenditures; the Company's expected tax rate; the impact of accounting pronouncements; and other matters. These forward-looking statements are based on current management expectations and assumptions only as of the date of this Annual Report on Form 10-K, are not guarantees of future performance and involve substantial risks and uncertainties that are difficult to predict and that could cause actual results to differ materially from the results expressed in, or implied by, these forward-looking statements. These risks and uncertainties include, but are not limited to, the risk factors and additional information described in this Annual Report on Form 10-K under the caption "Risk Factors," elsewhere in this Annual Report on Form 10-K and in our other periodic filings. Except as required under the federal securities laws and the rules and regulations of the SEC, we undertake no obligation to update publicly any forward-looking statements contained herein.

Overview

This overview is not a complete discussion of the Company's financial condition, changes in financial condition and results of operations; it is intended merely to facilitate an understanding of the most salient aspects of its financial condition and operating performance and to provide a context for the detailed discussion and analysis that follows, and must be read in its entirety in order to fully understand the Company's financial condition and results of operations.

The Company is a leading global developer, manufacturer and supplier of microcontamination control products, specialty chemicals and advanced materials handling solutions for manufacturing processes in the semiconductor and other high-technology industries. Our mission is to leverage our unique breadth of capabilities to create value for our customers by developing mission-critical solutions to maximize manufacturing yields, reduce manufacturing costs and enable higher device performance.

Our technology portfolio includes approximately 21,000 standard and customized products and solutions to achieve the highest levels of purity and performance that are essential to the manufacture of semiconductors, flat panel displays, light emitting diodes, or LEDs, high-purity chemicals, solar cells, gas lasers, optical and magnetic storage devices, and critical components for aerospace, glass manufacturing and biomedical applications. The majority of our products are consumed at various times throughout the manufacturing process, with demand driven in part by the level of semiconductor and other manufacturing activity. The Company's customers consist primarily of semiconductor manufacturers, semiconductor equipment and materials suppliers as well as thin film transistor-liquid crystal display (TFT-LCD) and hard disk manufacturers, which are served through direct sales efforts, as well as sales and

distribution relationships, in the United States, Asia, Europe and the Middle East.

Our business is organized and operated in three operating segments which align with the key elements of the advanced semiconductor manufacturing ecosystem. The Specialty Chemicals and Engineered Materials, or SCEM, segment provides high-performance and high-purity process chemistries, gases, and materials, and safe and efficient delivery systems to support semiconductor and other advanced manufacturing processes. The Microcontamination Control, or MC, segment offers solutions to filter and purify critical liquid chemistries and gases used in semiconductor manufacturing processes and other high-technology industries. The Advanced Materials Handling, or AMH, segment develops solutions to monitor, protect, transport, and deliver critical liquid chemistries, wafers and other substrates for a broad set of applications in the semiconductor

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industry and other high-technology industries. While these segments have separate products and technical know-how, they share a global generalist sales force, common business systems and processes, technology centers, and strategic and technology roadmaps. We leverage our expertise from these three segments to create new and increasingly integrated solutions for our customers. See note 16 to the consolidated financial statements for additional information on the Company's three segments.

Key operating factors Key factors, which management believes have the largest impact on the overall results of operations of the Company, include:

- Level of sales Since a significant portion of the Company's product costs (except for raw materials, purchased components and direct labor) are largely fixed in the short-to-medium term, an increase or decrease in sales affects gross profits and overall profitability significantly. Also, increases or decreases in sales and operating profitability affect certain costs such as incentive compensation and commissions, which are highly variable in nature. The Company's sales are subject to the effects of industry cyclicality, technological change, substantial competition, pricing pressures and foreign currency fluctuation.
- Variable margin on sales The Company's variable margin on sales is determined by selling prices and the costs of manufacturing and raw materials. This is affected by a number of factors, which include the Company's sales mix, purchase prices of raw material (especially polymers, membranes, stainless steel and purchased components), domestic and international competition, direct labor costs, and the efficiency of the Company's production operations, among others.
- Fixed cost structure The Company's operations include a number of large fixed or semi-fixed cost components, which include salaries, indirect labor and benefits, facility costs, lease expenses, and depreciation and amortization. It is not possible to vary these costs easily in the short-term as volumes fluctuate. Accordingly, increases or decreases in sales volume can have a large effect on the usage and productivity of these cost components, resulting in a large impact on the Company's profitability.

Overall Summary of Financial Results for the Year Ended December 31, 2018

Total net sales for the year ended December 31, 2018 were $1,550.5 million, up $208.0 million, or 15%, from sales of $1,342.5 million for the year ended December 31, 2017.

Exclusive of sales associated with acquisitions of $80.0 million and favorable foreign currency translation effects of $8.2 million, the Company's sales increased 9%, reflecting an increase in overall demand for the Company's products from semiconductor industry customers, particularly in the sale of fluid handling products, liquid chemistry filtration solutions and certain specialty materials products. The sales increase in 2018 was driven primarily by higher volume and the effect of selling price erosion was nominal. Semiconductor industry demand in 2018 was driven by improved demand from device makers, as wafer starts and semiconductor unit production increased, higher industry fab utilization rates, and node transitions. The Company believes sales of its products in 2018 exceeded the overall semiconductor industry growth rate.

The Company's gross profit rose by $110.8 million for the year ended December 31, 2018, to $719.8 million, up from $609.0 million for the year ended December 31, 2017. Accordingly, the Company reported a 46.4% gross margin rate compared to 45.4% in 2017. The gross profit and gross margin figures for 2018 include an incremental cost of sales charge of $6.9 million associated with the sale of inventory acquired in the SAES Pure Gas business (SPG) and $0.4 million severance related to organization realignment charges. In addition, the gross profit and gross margin figures for 2017 included impairment charges of $6.1 million related to certain equipment-related impairment and severance related to organizational realignment charges. Excluding those charges, the Company's gross margin for 2018 was 46.9% and for 2017 was 45.8%.

The Company's selling, general and administrative (SG&A) and engineering, research and development (ER&D) expenses increased moderately in 2018, mainly reflecting higher compensation costs and the inclusion in SG&A and ER&D expenses of SPG's infrastructure, deal costs and the cost of integration activities.

The Company's income tax expense decreased significantly in 2018, primarily due to the reduction of the U.S. corporate tax rate from 35% in 2017 to 21% in 2018, a $34.5 million tax benefit associated with legal entity restructuring and the absence of a one-time charge of $66.7 million related to the impact of the Tax Cuts and Jobs Act incurred in 2017.

As a result of the aforementioned and other factors discussed below, net income for 2018 was $240.8 million, or $1.69 per diluted share, compared to net income of $85.1 million, or $0.59 per diluted share, in 2017.

On January 22, 2018, the Company acquired Particle Sizing Systems, LLC, or PSS, which provides particle sizing instrumentation for liquid