AMTECH SYSTEMS INC
Form 10-K
November 30, 2016

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: September 30, 2016
OR
[ ] TRANSITION REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934
For the transition period from _____ to _____

Commission File Number: 0-11412

AMTECH SYSTEMS, INC.
(Exact name of registrant as specified in its charter)

Arizona (State or other jurisdiction of incorporation or organization)	86-0411215 (I.R.S. Employer Identification No.)
131 South Clark Drive, Tempe, Arizona (Address of principal executive offices)	85281 (Zip Code)

Registrant's telephone number, including area code:
480-967-5146

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

None

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

Common
Stock, $0.01
Par Value
(Title of Class)

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

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

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. [X] Yes [ ] No

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 (§229.405 of this chapter) during the preceding 12 months (or for such shorter period that the registrant was required to submit and post such files). [X] Yes [ ] No

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 this Form 10-K or any amendment to this Form 10-K. [X]

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

Large accelerated filer [ ] Accelerated filer [X] Non-accelerated filer [ ] (do not check if a smaller reporting company) [ ] Smaller Reporting Company

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

As of March 31, 2016, the aggregate market value of the voting and non-voting stock held by non-affiliates of the registrant was approximately $56,195,833, based upon the closing sales price reported by the NASDAQ Global Market on that date.

As of November 22, 2016, the registrant had outstanding 13,179,535 shares of Common Stock, $0.01 par value.

DOCUMENTS INCORPORATED BY REFERENCE

Portions of the Definitive Proxy Statement related to the registrant's 2016 Annual Meeting of Shareholders, which Proxy Statement will be filed under the Securities Exchange Act of 1934, as amended, within 120 days of the end of the registrant's fiscal year ended September 30, 2016, are incorporated by reference into Items 10-14 of Part III of this Form 10-K.

AMTECH SYSTEMS, INC. AND SUBSIDIARIES

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FORWARD-LOOKING STATEMENTS

Certain information contained or incorporated by reference in this Annual Report on Form 10-K is forward-looking in nature. All statements included or incorporated by reference in this Annual Report on Form 10-K, or made by management of Amtech Systems, Inc. and its subsidiaries ("the Company" or "Amtech"), other than statements of historical fact, are hereby identified as "forward-looking statements" (as such term is defined in Section 27A of the Securities Act of 1933, as amended, and Section 21E of the Securities Exchange Act of 1934, as amended). The forward-looking statements in this Annual Report on Form 10-K relate only to events or information as of the date on which the statements are made in this Annual report on Form 10-K. Examples of forward-looking statements include statements regarding Amtech's future financial results, operating results, business strategies, projected costs, products under development, competitive positions and plans and objectives of the Company and its management for future operations. In some cases, forward-looking statements can be identified by terminology such as "may," "will," "should," "would," "expects," "plans," "anticipates," "intends," "believes," "estimates," "predicts," "potential," "continue," or the negati terms or other comparable terminology. Any expectations based on these forward-looking statements are subject to risks and uncertainties and other important factors, including those discussed in the section entitled "ITEM 1A. RISK FACTORS." These and many other factors could affect Amtech's future operating results and financial condition, and could cause actual results to differ materially from expectations based on forward-looking statements made in this document or elsewhere by Amtech or on its behalf.

You should not place undue reliance on these forward-looking statements. Except as required by law, we undertake no obligation to update or revise publicly any forward-looking statements, whether as a result of new information, future events, changes in assumptions, or otherwise, after the date on which the statements are made or to reflect the occurrence of unanticipated events. You should read this report and the documents that we reference in this report, including documents referenced by incorporation, completely and with the understanding that our actual results may be materially different from what we expect or project.

All references to "we," "our," "us," or "Amtech" refer to Amtech Systems, Inc. and its subsidiaries.

PART I

ITEM 1. BUSINESS

OUR COMPANY

We are a leading, global manufacturer of capital equipment, including thermal processing, silicon wafer handling automation, and related consumables used in fabricating solar cells, LED and semiconductor devices. Semiconductors, or semiconductor chips, are fabricated on silicon wafer substrates, sliced from ingots, and are part of the circuitry, or electronic components, of many products including solar cells, computers, telecommunications devices, automotive products, consumer goods, and industrial automation and control systems. The Company's wafer handling, thermal processing and consumable products currently address the diffusion, oxidation, and deposition steps, including atomic layer deposition used in the fabrication of solar cells, LEDs, semiconductors, microelectromechanical systems ("MEMS") and the polishing of newly sliced silicon wafers.

Our major emphasis in the solar industry is the development of thermal processes, and deposition for solar cell manufacturing, which we believe, collectively, are key to driving higher cell efficiencies. The markets we serve are experiencing rapid technological advances and are, historically, cyclical. Therefore, future profitability and growth depend on our ability to develop or acquire and market profitable new technology products, and on our ability to adapt to cyclical trends.

We believe our product portfolio, developed through a track record of technological innovation as well as the successful integration of key acquisitions, reduces the cost of solar cell manufacturing by increasing solar cell efficiency, increasing throughput and increasing yields. We have been providing manufacturing solutions to the semiconductor industry for over 30 years and have leveraged our semiconductor technology and industry presence to

capitalize on growth opportunities in the solar industry. Our customers use our equipment to manufacture solar cells, semiconductors, silicon wafers and MEMS, which are used in end markets such as solar power, telecommunications, consumer electronics, computers, automotive and mobile hand-held devices. Through the acquisition of BTU International, Inc. ("BTU") in fiscal 2015, we expanded our thermal processing capability with the supply of solder reflow systems used for surface

mount and semiconductor packaging applications in the electronics assembly market, and custom equipment for multiple industrial markets. Also in fiscal 2015, we expanded our participation in the solar market through the acquisition of a controlling interest in SoLayTec B.V. ("SoLayTec"), which provides Atomic Layer Deposition ("ALD") systems used in high efficiency solar cells. To complement our research and development efforts, we also sell our equipment to, and coordinate certain development efforts with, research institutes, universities and customers.

For fiscal 2016, we recognized net revenue of $120 million, which included $61 million of solar revenue or approximately 51% of our total revenue. These results compare to $105 million of net revenue for fiscal 2015, which included $57 million of solar revenue or approximately 54% of our total revenue. Our order backlog as of September 30, 2016 and 2015 was $49 million and $35 million, respectively, a 41% increase. Our backlog as of September 30, 2016 included approximately $34 million of orders and deferred revenue from our solar industry customers compared to $23 million from our solar industry customers as of September 30, 2015. Because our orders are typically subject to cancellation or delay by the customer, our backlog at any particular point in time is not necessarily representative of actual sales in subsequent periods, nor is backlog any assurance that we will realize revenue or profit from completing these orders.

Orders from the solar industry totaled $76 million during fiscal 2016, compared to $61 million and $38 million in fiscal 2015 and 2014, respectively. The solar book to bill ratio for fiscal years 2016 and 2015 was 1.2:1 and 1.1:1, respectively.

Following the Company's acquisition of BTU, an evaluation was conducted of the Company's organizational structure. Beginning with the second quarter of fiscal 2015, the Company made changes to its reportable segments. Prior period amounts have been revised to conform to the current period segment reporting structure. The Company operates in three business segments: (i) solar, (ii) semiconductor and (iii) polishing. For information regarding net revenue, operating income and identifiable assets attributable to each of our three business segments for each of the past three fiscal years, see Note 7 of the Notes to Consolidated Financial Statements included herein and "ITEM 7, MANAGEMENT'S DISCUSSION AND ANALYSIS OF FINANCIAL CONDITION AND RESULTS OF OPERATIONS" in this Annual Report. For information on the products of each segment, see "Solar and Semiconductor Equipment Products" and "Polishing Supplies Products" within this "ITEM 1. BUSINESS" section. For information regarding risks to our business, see “ITEM 1A. RISK FACTORS.”

GROWTH STRATEGY

Capitalize on Growth Opportunities in the Solar Industry by Leveraging Our Diffusion Furnace Market Share, Top-Tier Customer Relationships, and Track Record of Technological Innovation. We believe that long-term growth in the solar industry will be driven by several macro-economic factors, such as volatile energy prices, limited non-renewable energy resources, government incentives for solar generated electricity, increasing environmental awareness, energy security concerns and the expected decrease in the cost of solar energy. As the solar market continues to develop, advances in process technology will be vital to remaining competitive. We intend to continue leveraging our market position, relationships with leading global solar cell customers and demonstrated track record of technical innovation to maximize sales of our current and next-generation technology solutions.

Develop Multi-Product Solutions to Expand Our Addressable Market. We are focused on acquiring, developing and licensing new products across our business in response to customer needs in the solar market. As we add to our product portfolio, we plan to continue expanding our offerings within the solar cell production process, thus capturing a greater percentage of capital spent on building global solar cell manufacturing capacity. Our successful development of PECVD (“Plasma-Enhanced Chemical Vapor Deposition”) equipment is a recent example of meeting our customers' needs and expanding the size of our addressable market.

Pursue Strategic Acquisitions That Complement Our Strong Platform. Over the course of our history, we have developed an acquisition strategy consistent with our focus of maintaining market leadership and a technology roadmap leading to higher efficiency and lower cost solar cells. Based on our acquisition strategy, we continue to evaluate potential technology, product and business acquisitions or joint ventures that are intended to increase our existing market share in the solar, semiconductor and LED industries and expand our addressable market. In evaluating these opportunities, our objectives include: enhancing our earnings and cash flows, adding complementary product offerings, actively expanding our geographic footprint, improving our production efficiency and enhancing our customer base.

Contribute to the Solar Industry's Mission of Reaching Grid Parity. We believe next-generation process technology for solar cell manufacturing is the driver to increasing efficiency and lowering manufacturing costs and is key to enabling

grid parity, where the cost of solar generated electricity is on parity with traditional, non-renewable sources of energy such as coal and natural gas. Our next-generation solar cell process technology has a demonstrated track record of increasing our customers' solar cell conversion efficiency. We will continue to develop next-generation solar cell manufacturing process technology that will enable our customers to displace non-renewable energy.

ACQUISITIONS AND DISPOSITIONS

In December 2014, the Company expanded our participation in the solar market by acquiring a 51% controlling interest in SoLayTec, based in Eindhoven, the Netherlands, which provides ALD systems used in high efficiency solar cells. The acquisition of the controlling interest in SoLayTec supports our business model of growth through strategic acquisition.

In January 2015, the Company completed its acquisition of BTU, a Delaware corporation, pursuant to which BTU became a wholly owned subsidiary of the Company. Amtech acquired all of the outstanding stock of BTU in an all-stock transaction. BTU stockholders received 0.3291 shares of Amtech common stock for every share of BTU stock.

The addition of BTU supports our business model of growth through strategic acquisition and continuous innovation. The combination with BTU further positions the Company as a leading, global supplier of solar and semiconductor production and automation systems. The acquisition also further advances our strategy to expand our technology portfolio in adjacent markets and creates a strong platform to drive the growth of our solar business. With the addition of BTU, the Company has a more diversified and profitable revenue base, allowing the Company to better scale production and distribution of our solar technology to meet accelerating demand for next-generation technology solutions.

In September 2015, we sold a portion of our interest in Kingstone Technology Hong Kong Limited (“Kingstone Hong Kong”) that is the parent company of Shanghai Kingstone (collectively with Kingstone Hong Kong, “Kingstone”), a Shanghai-based technology company specializing in ion implant solutions for the solar and semiconductor industries (in which we acquired a 55% ownership in February 2011), to a China-based venture capital firm. Proceeds from the sale of shares were paid to Amtech and used to support the company's core strategic initiatives. We now own 15% of the holding company, Kingstone Hong Kong, following consummation of the transaction, which effectively represents an 8% beneficial ownership interest in the Shanghai operating entity, Shanghai Kingstone.

SOLAR INDUSTRY

We provide process equipment and related cell manufacturing equipment to many of the world's leading solar cell manufacturers.

Within process equipment, our primary focus is on our existing solar diffusion furnace and the development of next-generation diffusion furnaces, including our proprietary N-type, PECVD systems. Our N-type technology has been developed through a three-party research collaboration agreement with the Energy Research Centre of the Netherlands, or ECN, a leading solar research center in Europe and Yingli Green Energy Holding Company Limited, or Yingli, one of the world's leading vertically integrated photovolataic (“PV”) product manufacturers. In 2012, we launched our PECVD system. Through our acquisition of SoLayTec, we produce, develop, and deliver and service worldwide machines for ultrafast ALD Equipment used in high efficiency solar cells.

We also offer furnace automation and wafer handling systems used within the diffusion processing step of solar cell manufacturing. Our automation equipment includes mass wafer transfer systems, sorters, long-boat transfer systems, load station elevators, buffers and conveyers, which we sell both in connection with our diffusion furnaces and on a standalone basis.

Most solar cell manufacturers sell their products to manufacturers of solar modules or solar panels. Others are vertically integrated and use their cells in the production of solar modules and panels. Solar cells are the critical component of solar modules and solar panels, which are sold to the end user and used in residential homes, industrial applications, remote pumping, lighting and heating uses and central power stations.

Although the solar market has experienced tremendous growth over the past five years, it is characterized by short-term periods of rapid capacity expansion followed by periods of rapid contraction in our customers' capital spending. When actual and expected end-user demand outstrips available capacity, this triggers the beginning of the next period of expansion.

SEMICONDUCTOR INDUSTRY

We provide diffusion equipment as well as handling, storage and automation equipment and related services to leading semiconductor manufacturers. Our products include horizontal and vertical diffusion furnaces used to produce semiconductors, silicon wafers and MEMS, as well as lapping equipment, polishing templates and wafer insert carriers, mass wafer transfer systems, loaders and sorters.

Although the semiconductor market has experienced significant growth over the past fifteen years, it remains cyclical by nature. The market is characterized by short-term periods of under or over utilization of capacity for most semiconductors, including microprocessors, memory, power management chips and other logic devices. When capacity utilization decreases due to the addition of excess capacity, semiconductor manufacturers typically slow their purchasing of capital equipment. Conversely, when capacity utilization increases, so does capital spending.

Most semiconductor chips are built on a silicon wafer, and include multiple layers of circuitry that connect a variety of circuit components, such as transistors, capacitors and other components. To build a chip, the transistors, capacitors and other components are first created on the surface of the wafer by performing a series of processes to deposit and remove selected film layers, including insulators. Similar processes are then used to build the layers of wiring structures on the wafer. These are all referred to as “front-end” processes.

As demand for increasingly sophisticated electronic devices continues; new technologies such as wireless networks, next generation cellular phones and tablets will help to drive future growth. Electronic equipment continues to become more complex, yet end users are still demanding smaller, lighter and less expensive devices. This, in turn, requires increased performance and reduced cost, size, weight and power requirements of electronic assemblies, printed circuit boards and semiconductors. In response to these developments, manufacturers are increasingly employing more sophisticated production and assembly techniques requiring more advanced manufacturing equipment, such as that supplied by BTU.
In the printed circuit board assembly process, semiconductor discrete-devices and various other components are attached to printed circuit boards. The attachment process, which creates a permanent physical and electrical bond, is called solder reflow or surface mount reflow. Manufacturers rely on high throughput and highly reliable equipment to get the maximum efficiency in their production process. Die level semiconductor packaging processes include precision thermal processing steps. Advancements in the semiconductor industry toward higher chip speeds, smaller form factors and reduced costs are driving the transition to wafer level packaging from the traditional wire bonding technique.

SOLAR AND SEMICONDUCTOR EQUIPMENT PRODUCTS

Our furnace and automation equipment is manufactured in our facilities in The Netherlands, France, Massachusetts, and China. The following paragraphs describe the products that comprise our solar, semiconductor and electronics assembly equipment business:

Horizontal Diffusion Furnaces. Through our subsidiaries, Tempress and Bruce Technologies, we produce and sell horizontal diffusion furnaces. Our horizontal furnaces currently address several steps in the solar and semiconductor manufacturing processes, including diffusion, phosphorus tetrachloride doping, or POCl3, boron tribromide, or BBR_3, low-pressure chemical vapor deposition, or LPCVD, oxidation, and annealing.

Our horizontal furnaces generally consist of three large modules: the load station where the loading of the wafers occurs; the furnace section, which is comprised of one to five thermal reactor chambers; and the gas distribution cabinet where the flow of gases into the reactor chambers is controlled, and often customized to meet the requirements of our customers' particular processes. The horizontal furnaces utilize a combination of existing industry and proprietary technologies and are sold primarily to solar customers and semiconductor customers who do not require the advanced automation of, or cannot justify the higher expense of, vertical furnaces for some or all of their diffusion processes. Our models are capable of processing all currently existing wafer sizes.

Automation Products - Solar & Semiconductor. Our automation technology products are used in several of the diffusion steps and in the anneal processing step of solar cell manufacturing. Our R2D Automation equipment includes mass wafer transfer systems, sorters, long-boat transfer systems, load station elevators, buffers and conveyers. We use a vacuum technology in our Comet Standalone and our Comet Full Automation solar wafer transfer systems designed to ensure high throughput, reduced breakage and thereby increased yield.

Chemical Vapor Deposition (CVD). We have two applications in the solar device technology. Our solar PECVD product applies an anti-reflective coating to solar wafers; a coating critical to the efficiency of solar cells. PECVD layers are also used for passivation of the front and/or back side of the solar cell. We also offer the combination of tunnel oxide with a LPCVD of poly-layer, this is a new application in our solar roadmap towards efficiencies above 21%. These solar products add two solar cells processing step to Amtech's offerings. We are exploring next-generation high-efficiency technology and dedicating our efforts to that process development.

Atomic Layer Deposition. We produce, develop, deliver and service worldwide machines for ultrafast, spatial (ALD)equipment, a promising technology for ultrathin Al2O3 passivation layers on solar cells. The ALD machines from SoLayTec are intended for industrial production in the solar market. As such, following the acquisition of the majority interest in SoLayTec, the Company is now able to use ALD in the industrial production and solar market due to technology that was previously unavailable to the Company prior to the acquisition due to the very low speed of ALD and the associated high cost. The unique feature of the SoLayTec machines is the breakthrough speed that enables industrial application.

Automation Products - Semiconductor. Use of our automation products reduces human handling and, therefore, reduces exposure of wafers to particle sources during the loading and unloading of the process tubes and protects operators from heat and chemical fumes. The top reactor chamber of a horizontal furnace can be as much as eight feet from the floor on which the operator stands when manually loading wafer boats. Typical boats of 150mm to 300mm wafers weigh three to six pounds. Given these two factors, automating the wafer loading and unloading of a diffusion furnace improves employee safety and ergonomics in silicon wafer, solar cell and semiconductor manufacturing facilities.

S-300. Our patented S-300 model provides a very efficient method of automatically transporting a full batch of up to 300 wafers to the designated tube level and automatically placing them directly onto the cantilever loader of a diffusion furnace at one time. This product is suitable for the production of nearly all semiconductors manufactured using a horizontal furnace. The S-300 can be used in conjunction with all current wafer sizes and is particularly well suited for manufacturers of 300mm wafers.

Comet. Our Comet and Gemini series of wafer transfer systems include a wide range of throughputs and footprints to meet the needs of our customers who serve the semiconductor industry. Comet Sorter with Optical Character Recognition (OCR) is used in sorting, randomizing, compacting or tracking. The Comet Sorter is cassette to cassette with OCR front and back scribe functions, notch alignment and SECSII Gem communication. Comet ID Readers check tag carriers then read each wafer scribe. The Comet ID Reader sends the information to the host with SECSII Gem commands.

Small Batch Vertical Furnace. Our small batch, two-tube vertical furnace was developed internally with the active support from a large semiconductor manufacturer and long-term customer. The specifications for this furnace include a two-tube vertical furnace for wafer sizes of up to 200mm, with each tube having a small flat zone capable of processing 25-50 wafers per run. We are targeting niche applications, including research and development, while we continue to develop additional processes, since the competition in the large batch vertical furnace market is intense and our competitors are much larger and have substantially greater financial resources, processing knowledge and advanced technology.

Continuous Thermal Processing Systems. Through our BTU subsidiary, we produce and sell thermal processing systems used in the solder reflow and curing stages of printed circuit board assembly as well as systems for the thermal processes used in advanced semiconductor packaging. Our printed circuit board assembly products are used primarily in the advanced, high-density segments of the market that utilize surface mount technology.
Flip-chip reflow provides the physical and electronic bond of the semiconductor device to its package. Our range of convection reflow systems, utilizing patented closed loop convection technology, rated at up to 400°C and operate in air or nitrogen atmospheres. These products utilize forced impingement convection technology to transfer heat to the substrate. Using thermal power arrays of up to five-kilowatts, they can process substrates in dual lane, dual speed

configurations, thereby enabling our customers to double production without increasing the machine's footprint. These products are available in four models based on the heated lengths of thermal processing chambers. Heated length is based on the required production rate and loading requirements.

POLISHING SUPPLIES PRODUCTS

Our polishing supplies division provides solutions to the lapping and polishing marketplace. Lapping is the process of abrading components with a high degree of precision for flatness, parallelism and surface finish. Common applications for this technology are silicon wafers for semiconductor products, sapphire substrates for LED lighting and mobile devices, silicon carbide wafers for LED and power device applications, various glass and silica components for 3D image transmission, quartz and ceramic components for telecommunications devices, medical device components and computer hard disks. We manufacture the products described below in Pennsylvania and sell them under our PR Hoffman brand name.

Wafer Carriers. Carriers are work holders into which silicon and sapphire wafers or other materials are inserted for the purpose of holding them securely in place during the lapping and polishing processes. We produce carriers for our line of lapping and polishing machines, as well as for those machines sold by our competitors. Substantially all of the carriers we produce are customized for specific applications. Insert carriers, our most significant category of carriers, contain plastic inserts molded onto the inside edge of the work-holes of the carrier, which hold the wafers in place during processing. Although our standard steel carriers are preferred in many applications because of their durability, rigidity and precise dimensions, they are typically not suited for applications involving softer materials or when metal contamination is an issue. Insert carriers, however, are well suited for processing large semiconductor wafers, up to 450mm in diameter, and other fragile materials or where contamination is an issue, because they provide the advantages of steel carriers while reducing the potential for damage to the edges of such sensitive materials. Our insert carriers are used for double-sided lapping or polishing of wafers up to 450mm in diameter.
Semiconductor Polishing Templates. Our polishing templates are used to securely hold sapphire or other wafer materials in place during single-sided polishing processes. Polishing templates are customized for specific applications and are manufactured to exacting tolerances. We manufacture polishing templates for most brands of tools and various processes. In addition to silicon wafers, these products are used in polishing silicon carbide wafers and sapphire crystals used in LEDs, power devices as well as mobile communication applications.
Double-Sided Planetary Lapping and Polishing Machines. Double-sided lapping and polishing machines are designed to process thin and fragile materials, such as semiconductor, sapphire and other wafer-like materials, precision optics, computer disk media and ceramic components for wireless communication devices, to exact tolerances of thickness, flatness, parallelism and surface finish. On average, we believe that we offer our surface processing systems with a lower cost of ownership than systems offered by our competitors. We target the LED, mobile device, semiconductor, optics, quartz, ceramics, medical, computer disk and metal working markets.

MANUFACTURING, RAW MATERIALS AND SUPPLIES

Our solar, semiconductor and electronics assembly equipment manufacturing activities consist primarily of engineering design to meet specific and evolving customer needs, and procurement and assembly of various commercial and proprietary components into finished thermal processing systems and related automation in Vaassen, The Netherlands, Clapiers, France, North Billerica, Massachusetts, and Shanghai, China.

Our manufacturing activities in the polishing supplies and equipment business include laser-cutting and other fabrication steps in producing lapping and polishing consumables, including carriers, templates, gears, wear items and spare parts in Carlisle, Pennsylvania, from raw materials manufactured to our specifications by our suppliers. These products are engineered and designed for specific applications and to meet the increasingly tight tolerances required by our customers. Many items, such as proprietary components for our solar and semiconductor equipment and

lapping plates, are also purchased from suppliers who manufacture these items to our specifications.

Final assembly and tests of our equipment and machines are performed within our manufacturing facilities. Quality control is maintained through inspection of incoming materials and components, in-process inspection during equipment

assembly, testing of assemblies and final inspection and, when practical, operation of manufactured equipment prior to shipment.

Since much of our polishing supplies know-how relates to the manufacture of its products, this business' facility is equipped to perform a significantly higher percentage of the fabrication steps required in the production of its products. However, injection molding for our insert carriers and the manufacture of raw cast iron plates are subcontracted out to various third parties. Our polishing supplies business relies on key suppliers for certain materials, including two steel mills in Germany and Japan, an injection molder, a single-sourced pad supplier from Japan and an adhesive manufacturer. To minimize the risk of production and service interruptions and/or shortages of key parts, we maintain appropriate inventories of key raw materials and parts. If for any reason we were unable to obtain a sufficient quantity of parts in a timely and cost-effective manner to meet our production requirements, our results of operations would be materially and adversely affected.

RESEARCH, DEVELOPMENT AND ENGINEERING

The markets we serve are characterized by evolving industry standards and rapid technological change. To compete effectively in our markets, we must continually maintain or exceed the pace of such change by improving our products and our process technologies and by developing new technologies and products that compete effectively on the basis of price and performance. To assure that these technologies and products address current and future customer requirements, we obtain as much customer cooperation and input as possible, thus increasing the efficiency and effectiveness of our research and development efforts. In addition, we look for strategic acquisitions, such as the acquisition of SoLayTec, which will provide us with new technologies to compete effectively in the markets in which we operate.

From time to time we add functionality to our products or develop new products during engineering and manufacturing to fulfill specifications in a customer's order, in which case the cost of development, along with other costs of the order, are charged to cost of sales. We periodically receive research grants for research and development of products, which are netted against our research, development and engineering costs. Our expenditures (net of grants earned) that have been accounted for as research and development were $8.0 million (7% of net revenue) for fiscal 2016, $6.9 million (7% of net revenue) for fiscal 2015, and $6.3 million (11% of net revenue) for fiscal 2014.

PATENTS

The following table shows our material patents, the patents licensed by us, and the expiration date of each patent and license:

Product	Countries	Expiration Date or Pending Approval
Multiple methods for manufacturing a solar cell and related equipment	Various	Various
Method for manufacturing a solar cell; N-type cells with reverse flow and metal wrap-through	Netherlands	2032
Method for manufacturing a solar cell; N-type cells with reverse flow and metal wrap-through	United States	2033
Wafer boat and use thereof	Netherlands	2034
Wafer boat loader assembly, furnace system, use thereof and method for operating said assembly	Netherlands	2035
IBAL (Individual Boats with Automated Loading) Model S-300	United States	Various
Systems and methods for charging solar cell layers	Various	Various
Gas-bearing-based Atomic Layer Deposition (ALD)	Europe	2028
Carrier-less gas bearing ALD	Europe	2029
Reciprocal and helical-scan multi-nozzle ALD configurations	Europe	2030
Ultrafast gas bearing-based reactive ion etching	Europe	2030
Contactless ALD patterning process	Europe	2030
Maskless patterned fast ALD	Europe	2030
Modular furnace system	United States	2021
Convection furnace thermal profile enhancement	United States	2023
Lapping machine adjustable mechanism	United States	2027