UNITED STATES SECURITIES AND EXCHANGE COMMISSION

Washington, D.C. 20549

Form 10-K

(Mark One)

☒ **ANNUAL REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934**
For the fiscal year ended December 31, 2021

or

☐ **TRANSITION REPORT PURSUANT TO SECTION 13 OR 15(d) OF THE SECURITIES EXCHANGE ACT OF 1934**
For the transition period from to

000-31311
(Commission file number)

PDF SOLUTIONS, INC.

(Exact name of registrant as specified in its charter)

Delaware *(State or other jurisdiction of Incorporation or organization)*	**25-1701361** *(I.R.S. Employer Identification No.)*
2858 De La Cruz Blvd. Santa Clara, California *(Address of Registrant's principal executive offices)*	**95050** *(Zip Code)*

(408) 280-7900
(Registrant's telephone number, including area code)

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

Title of each class	Trading Symbol(s)	Name of each exchange on which registered
Common Stock, $0.00015 par value	PDFS	The Nasdaq Stock Market LLC

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

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

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

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

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

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

☐ Large accelerated filer	☐ Accelerated filer
☒ Non-accelerated filer	☒ Smaller reporting company
	☐ Emerging growth company

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

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

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

The aggregate market value of the voting stock held by non-affiliates of the Registrant was approximately $515 million as of the last business day of the Registrant's most recently completed second fiscal quarter, based upon the closing sale price on the Nasdaq Global Market reported for such date. Shares of Common Stock held by each officer and director and by each person who owns 10% or more of the outstanding Common Stock have been excluded in that such persons may be deemed to be affiliates. This determination of affiliate status is not necessarily a conclusive determination for other purposes.

There were 37,707,111 shares of the Registrant's Common Stock outstanding as of February 25, 2022.

DOCUMENTS INCORPORATED BY REFERENCE

Part III incorporates certain information by reference from the definitive Proxy Statement to be filed within 120 days from December 31, 2021.

TABLE OF CONTENTS

		Page
	PART I	
Item 1.	Business	4
Item 1A.	Risk Factors	17
Item 1B.	Unresolved Staff Comments	30
Item 2.	Properties	30
Item 3.	Legal Proceedings	30
Item 4.	Mine Safety Disclosures	30
	PART II	
Item 5.	Market For Registrant’s Common Equity, Related Stockholder Matters and Issuer Purchases of Equity Securities	31
Item 6.	Selected Financial Data	32
Item 7.	Management’s Discussion and Analysis of Financial Condition and Results of Operations	33
Item 7A.	Quantitative and Qualitative Disclosures About Market Risk	46
Item 8.	Financial Statements and Supplementary Data	47
Item 9.	Changes in and Disagreements with Accountants on Accounting and Financial Disclosure	83
Item 9A.	Controls and Procedures	83
Item 9B.	Other Information	83
Item 9C.	Disclosure Regarding Foreign Jurisdictions that Prevent Inspections	83
	PART III	
Item 10.	Directors, Executive Officers and Corporate Governance	84
Item 11.	Executive Compensation	84
Item 12.	Security Ownership of Certain Beneficial Owners and Management and Related Stockholder Matters	84
Item 13.	Certain Relationships and Related Transactions, and Director Independence	84
Item 14.	Principal Accountant Fees and Services	84
	PART IV	
Item 15.	Exhibits and Financial Statement Schedules	85
Item 16.	Form 10-K Summary	87
Signatures		88

SPECIAL NOTE REGARDING FORWARD LOOKING STATEMENTS

This Annual Report on Form 10-K, particularly in Item 1 "Business" and Item 7 "Management's Discussion and Analysis of Financial Condition and Results of Operations," includes forward-looking statements within the meaning of Section 27A of the Securities Act of 1933, as amended (the "Securities Act") and Section 21E of the Securities Exchange Act of 1934, as amended (the "Exchange Act"). These statements include, but are not limited to, statements concerning: expectations about the effectiveness of our business and technology strategies; expectations regarding global economic trends; the impact of inflation, expectations regarding recent and future acquisitions; current semiconductor industry trends; expectations of the success and market acceptance of our intellectual property and our solutions; the continuing impact of the coronavirus (COVID-19) on the semiconductor industry and our business and our ability to obtain additional financing if needed. Our actual results could differ materially from those projected in the forward-looking statements as a result of a number of factors, risks and uncertainties discussed in this Form 10-K, especially those contained in Item 1A of this Form 10-K. The words "may," "anticipate," "plan," "continue," "could," "projected," "expect," "believe," "intend," and "assume," the negative of these terms and similar expressions are used to identify forward-looking statements. All forward-looking statements and information included herein is given as of the filing date of this Form 10-K with the Securities and Exchange Commission ("SEC") and based on information available to us at the time of this report and future events or circumstances could differ significantly from these forward-looking statements. Unless required by law, we undertake no obligation to update publicly any such forward-looking statements.

The following information should be read in conjunction with the Consolidated Financial Statements and notes thereto included in this Annual Report on Form 10-K. All references to fiscal year apply to our fiscal year that ends on December 31. All references to "we", "us", "our", "PDF", "PDF Solutions" or "the Company" refer to PDF Solutions, Inc.

PART I

Item 1. *Business*

Business Overview

We provide comprehensive data solutions designed to empower organizations across the semiconductor ecosystem to improve the yield and quality of their products and operational efficiency for increased profitability. Our offerings include proprietary software, professional services based on proven methodologies and using third-party cloud-hosting platforms for software-as-a-service ("SaaS"), electrical measurement hardware tools, and physical intellectual property ("IP") for integrated circuit ("IC") designs. We derive revenues from two sources, Analytics and Integrated Yield Ramp, by monetizing our offerings through contract fees for on-premise licenses, SaaS, and other professional services and a value-based, variable fee or royalty, which we call Gainshare, on our historical integrated yield ramp ("IYR") engagements. Our products and services have been sold to integrated device manufacturers ("IDMs"), fabless semiconductor companies, foundries, equipment manufacturers, electronics manufacturing suppliers ("EMS"), original device manufacturers ("ODMs"), out-sourced semiconductor assembly and test ("OSATs"), and system houses. We are headquartered in Santa Clara, California and also operate worldwide with offices in Canada, China, France, Germany, Italy, Japan, Korea, and Taiwan.

Our products and services are used by many Fortune 500 companies across the semiconductor ecosystem to achieve smart manufacturing goals by connecting and controlling equipment, collecting data generated during manufacturing and test operations, and performing advanced analytics and machine learning to enable profitable, high-volume manufacturing. For example, our foundry customers generate and analyze key manufacturing data using our solutions to shorten the time necessary for technology development and to provide their fabless customers with a higher yielding process with improved electrical performance, which are both critical metrics for market success. Higher yields in less time can also mean less total raw materials and process runs, which help lower customers' total cost and minimize environmental impact. Also, for example, equipment manufacturers and factories use our connectivity products to implement evolving industry standards for their equipment or operations, respectively, with required quality and stability. By way of further example, our IDM and fabless customers use our solutions to generate unique, differentiated data that can be analyzed with our machine learning (or ML) and artificial intelligence (or AI) algorithms to predict downstream manufacturing issues, resulting in shorter time for designs to meet performance requirements with fewer iterations and faster time-to-market. For final example, our foundry and OSAT customers use the AI and ML applications of our software to optimize for process control, assembly, and/or test.

Our long-term business strategy is to be the data solutions provider of choice for the semiconductor and electronics ecosystems. To achieve this, we intend to:

- *Offer a Common, Flexible Platform for a Broad Group of Customers Across the Supply Chain*. As semiconductor and electronics products are made with the efforts of equipment manufacturers, front end foundries, chip and system designers, design automation, IP providers, and OSATs, there is a need to analyze the data across this whole chain to optimize yields, operational efficiencies, time to market, quality, and reliability. The Exensio platform is designed to provide a common platform - whether deployed in the cloud (SaaS) or on premise - to enable these different participants to analyze the relevant end-to-end data in near real-time, with data stores from 10s to 100s of terabytes (TBs) and flexible configurations for IDM, foundry, fabless, and OSAT specific needs. Our ML solutions combine professional services with the Exensio platform to further enable our customers to push their analytics "to the edge" of their global supply chains and shift the analysis and decision-making processes closer to where their data is being generated. We believe enabling edge analytics will further increase our customers' ability to improve product yield, quality, performance, and profitability, and therefore, should drive the market for our products and services.

- *Drive Tool-Level Software Installations to Create an Infrastructure of Connected Equipment and Enable Smart Factories*. We believe that driving installation of our software products at the tool level will provide an infrastructure of connected equipment and help to enable smart factories. In July 2020, we entered into a strategic partnership with Advantest Corporation through its wholly-owned subsidiary, Advantest America, Inc., (which

we collectively refer to as Advantest) that includes the development of cloud-based applications for Advantest tools that leverage our Exensio software analytics. We believe this will allow us to increase the network of tools connected with PDF software and provide Advantest tool customers with increased data management and analytics. In December 2020, we acquired Cimetrix Incorporated (or Cimetrix) and began providing software products based on open standards for equipment control and connectivity to equipment manufacturers and factories. We believe that in the smart manufacturing era, the industry will demand the increased equipment connectivity and control our products and solutions offer. Further, we believe that the benefits from integration between analytics on equipment, the factory, and in the cloud will provide synergies with our existing end-to-end analytics offerings.

- *Create Differentiated Data Sources for Better Analytics*. Historically, companies have only used data that was generated from their manufacturing and test process to drive improvements. We offer unique IP (such as Characterization Vehicle® (CV®) test chips) that is not part of an IC’s functionality, but significantly improves the manufacturing process by improving yield learning and reducing time to market. Also, our Design-for-Inspection™ (DFI™) system provides on-chip instrumentation and measurement applications from 28 nanometer (nm) down to 7nm and smaller - designed to identify blockers that impact product yield and quality months earlier than any other hardware- or software-based methodology. We believe that in the More-than-Moore (MtM) era, the differentiated data we provide can play an important role in enabling our customers to bring new products to market faster and with higher quality and performance, and, ultimately, more profitability.

Brief History

PDF Solutions was incorporated in Pennsylvania in November 1992, and we reincorporated in California in November 1995. In July 2000, we reincorporated in Delaware, and in July 2001, we completed an initial public offering. Our shares of common stock are currently traded on the Nasdaq Global Market as PDFS. We do not have any multi-class voting stock or any non-voting stock.

From 2000 through 2009, we expanded our technology footprint and our operations in various countries through acquisitions. From 2009 to 2019, we primarily focused on the pervasive application of our technology to leading edge logic manufacturing and achieving yield targets with our clients that maximized Gainshare royalties. In 2013, we leveraged our extensive experience in yield simulation software and CV® test chip development and started research and development on an e-beam solution for non-contact, inline electrical characterization and process control for wafer inspection. The first-generation e-beam tool for DFI™ was completed in 2015, and the second generation was commercially deployed in 2019. In a parallel effort, starting in 2014, we re-architected our point-solution software tools into a new generation, highly-integrated data analytics Exensio platform, which resulted in accelerated growth in software through 2019. In December 2020, we completed the acquisition of Cimetrix and began providing software products based on open standards for equipment control and connectivity to equipment manufacturers and factories.

Industry Background

Rapid technological innovation with increasingly shorter product life cycles has fueled the economic growth of the semiconductor industry since the days of the PC revolution. IC companies have historically ramped production slowly, produced at high volume once a product gained market acceptance, and slowly reduced production volume when price and demand started to decrease near the end of the product’s life cycle. Today there are many different business models across the semiconductor industry: products that follow the traditional life cycle just described, products targeted towards fast-moving market segments like Internet of Things (or IoT) – which utilize mature process nodes and requires a fast ramp to volume with a relatively short life cycle –, and products focused on long term market segments like automotive and industrial where product life cycles can last a decade or longer. There is a lot of variation across these business models depending on the level of design complexity and the maturity of the process node used for product implementation. Processors, memory and field-programmable gate arrays (FPGA) continue to leverage the most advanced process nodes and experience significant challenges to achieve competitive initial yields and optimized performance. Some products and market segments, however, are content to utilize older process nodes. Regardless of the process node used for implementation or how long the product will be sold in the market, success for every semiconductor company is predicated, among other things, on fast product yield ramp and the ability to optimize manufacturing and test metrics, such as yield

reclamation, product quality, and test efficiency, throughout a product's life cycle. Thus, technologies or capabilities that can accelerate yield ramp, improve product quality, and optimize production efficiencies are highly sought after because they typically lead to cost reduction and revenue generation concurrently, causing a leveraged effect on profitability.

Technology and Intellectual Property Protection

Our success is largely dependent upon our proprietary software. We believe the creative skills and technological ability of our personnel, product enhancements, and new product development are necessary to maintaining our position as a leading provider. We rely primarily on trade secret rights, copyright and trademark laws, and nondisclosure and other contractual agreements to protect our technology. We seek to protect our IP under patent laws and as of December 31, 2021, we held 185 U.S. patents. Our issued patents have expiration dates from 2022 through 2039. We intend to prepare additional patent applications when we feel it is beneficial. We also employ protection of our trademarks, with registration of marks, including Characterization Vehicle, Cimetrix, CV, eProbe, Exensio, pdFasTest, PDF Solutions, and the PDF Solutions and Cimetrix logos. We have common law rights to additional trademarks, including ALPS, DFI, DirectProbe, DirectScan, FIRE, and VarScan. We also enter into confidentiality and inventions assignment agreements with our employees and confidentiality and license agreements with our customers and the various parties we partner with to resell, distribute, and, in some cases, integrate our products. Further, we limit access to and distribution of our software, documentation and other proprietary information. Third parties could in any case develop competing technologies that include similar functionality or features, or otherwise are substantially equivalent or superior to our technologies. In addition, effective patent, copyright, trademark and trade secret protection may be unavailable or limited in certain foreign countries where we operate. Our business could suffer significantly if we fail to protect our proprietary technology.

In addition, through yield, performance, and reliability improvement services over more than 20 years, we have accumulated a vast library of physical IP in the form of test structures. As part of our DFI and CV systems, our engineers create designs of experiments (or DOEs) and layouts for targeted fail modes. We have also developed electrical measurement hardware tools and proprietary extraction, design, and analysis software. In addition, our technology embodies many production-proven and patented algorithms. Further, our IP includes proven methodologies that our implementation teams use as guidelines to drive our customers' use of our technology. We strive to continually enhance our core technologies through the codification of knowledge that we gain in the use of our products and delivery of services.

Products and Services

Products

Our primary software products and software and hardware systems include the following:

Exensio Platform. Our separately-offered Exensio software products address the big data manufacturing challenge of today's advanced process nodes and highly integrated products, by providing a common environment throughout the supply chain for different data types, including inline and end-of-line metrology, yield, parametric, performance, manufacturing consumables, tool-level sensor data, test floor data, logistical data, as well as custom data types. Exensio products are designed to enable real-time rapid diagnosis and understanding of key manufacturing and test metrics during both inline and end-of-line wafer processing, helping customers reduce product variability and cost simultaneously. By integrating silos of data and applying AI and ML, Exensio products resolve the limitation of local optimization and provide better foresight across the entire production process, reducing the time it takes to make critical decisions that can drive higher product yield, quality and reliability. Exensio products are available as either an on-premise license or SaaS and are offered in four main, separately-offered Exensio products targeting the needs of the customer's business model: Exensio IDM, Exensio Fabless, Exensio Foundry, and Exensio OSAT. Each of these products are comprised of two or more modules to provide specific capabilities to address a particular type of company's needs and requirements; however, there are common features, functionality, and purpose across some of the key modules as follows:

- *Manufacturing Analytics (formerly Exensio Yield)* – This module uses our proprietary database schema to store collected data in a common environment with a consistent view. For example, product engineers use it to identify and analyze production yield, performance, reliability and other issues. Elements of this module are designed to

handle very large and complex data sets that are commonplace in the semiconductor industry. To support the multi-dimensional product requirements of our customers, the powerful, interactive visualization and analysis capabilities in this product are highly flexible and user-configurable.

- *Process Control (formerly Exensio Control)* – This module provides failure detection and classification (or FDC) capabilities for monitoring, alarming, and control of manufacturing tool sets. These capabilities include proprietary data collection and analysis of tool sensor trace data and summary indicators designed to rapidly identify sources of process variations and manufacturing excursions. When used together with Manufacturing Analytics and related modules, the accretive data mining and correlation capabilities are designed to enable identification of tool level sources of yield loss and process variation and enable predictive and proactive optimization decisions for process control, process adjustments, PM scheduling, tool corrective actions, wafer dispatching, and wafer level and final test to impact end of line product yield, performance, and reliability.

- *Test Operations (formerly Exensio Test)* – This module provides comprehensive data collection and analysis capabilities for data generated during manufacturing test operations designed to optimize test operations management overall, including improving test productivity, performing part average test, supporting test floor operations, and implementing adaptive test. Test Operations is also designed to provide predictive insights based on proprietary analytics during test, assembly and packaging to maximize the efficiency of test operations, productivity improvements and yield reclamation.

- *Assembly Operations (formerly Exensio ALPS)* – This module provides the capability to link assembly and packaging data with other product lifecycle data, including fabrication and characterization data, across the product life cycle. Data sources could include manufacturing, wafer acceptance test, wafer sort, test and assembly, final test, and field use. The proprietary data linkage enabled by Assembly Operations is also designed to enable device manufacturers to maintain full traceability of their finished products back to the source wafer without the need for Electronic Chip IDs (or ECIDs). This capability is becoming an essential requirement for safety-critical market segments such as automotive and military-aerospace.

Design-for-Inspection (or DFI) System. Our DFI System is designed to enable customers to achieve non-contact, inline electrical characterization and more effective process control. This system also enables electrical characterization of customers' product chip layout structures, contactless measurement, and powerful data processing and analysis of relevant product patterns. The electrical measurements augment and enhance existing inline defect inspection and metrology methods. The DFI system leverages our production-proven design and analysis infrastructure. The primary software and hardware elements of the DFI system are as follows:

- *DFI On-Chip Instruments* – Our on-chip measurement instruments are developed using our proprietary FIRE™ layout analysis software and are tuned to capture key features of our customers' product layouts. As part of the system offering, we generally provide design services to create these instruments. These DFI instruments are designed to be placed in test chips, scribe lines, or in product die, without any area penalty, and to exhibit specific electrical responses

- *eProbe® Non-Contact E-Beam Tool* – Our eProbe e-beam tools are designed to measure the electrical response of the DFI instruments and suitable product layout structures. As part of the system offering, we generally provide tool support services to customers to operate this tool. The second generation tool includes orders of magnitude advances in throughput and accuracy that now enable DFI on-chip instruments to be used for inline control for leading-edge semiconductor process nodes.

- *Exensio Characterization Software* – This software, which is also a part of our Exensio platform, is designed to analyze the billions of measurements collected using the eProbe tool. As part of the system offering, we generally provide analysis services to customers to perform this analysis and provide summary findings and recommendations.

Characterization Vehicle (CV) System. Our CV system is a combination of CV test chips, hardware to test such products, software to analyze the test results, and related services. This system is designed to accelerate the efficiency of yield learning by shortening the learning cycle, learning more per cycle, and reducing the number of silicon wafers required in manufacturing processes. This system includes physical IP in the form of test structures and DOEs that are tuned to our customers' product and/or process specifics, tester hardware, data analysis, and training. The primary software and hardware products included in the CV system are as follows:

- *CV Test Chips* – Our proprietary test chips are designed by our professional engineers using our proprietary FIRE™ layout analysis software. These test chips are run through a customer's manufacturing process, with intentional process modifications, to provide unique, differentiated data to explore the effects of potential process improvements given natural manufacturing variations. Our custom-designed CV test chips are optimized for our test hardware and analysis software and include DOEs tuned to each customer's process. Types of CV test chips include:
    - Our full-reticle and shared-reticle CV test chips are designed to provide a fast learning cycle and are fully integrated with third-party failure analysis and inspection tools for a complete diagnosis to understand root causes. Our full-reticle CV test chips use a shortened process flow to provide a faster learning cycle for specific process modules:
    - Our Scribe CV test chip are inserted directly on customers' product wafers to collect data about critical layers.
    - Our DirectProbe™ CV test chips are designed to enable ultra-fast yield learning for new product designs by allowing our clients to measure components of actual product layout.
    - Our VarScan™ CV test chips are designed for front-end or through-silicon via (or TSV) application with a focus on high resolution resistance variation analysis for mass production.
- *pdFasTest® Electrical Tester* – Our proprietary test hardware is optimized to quickly test our CV test chips, enabling fast defect and parametric characterization of manufacturing processes. As part of the system offering, we provide test programs for each CV test chip that are tuned to the customer's process. This automated system provides parallel functional testing, thus minimizing the time required to perform millions of electrical measurements to test our CV test chips. We provide services to analyze the unique, differentiated data output of this tester using the Exensio Characterization software to provide actionable insights to our customers.
- *Exensio Characterization software* – This software, which is also a part of our Exensio platform, collects the data generated from our CV test products, generating models of the performance effects of process variations on these design building blocks. As part of the system offering, we also offer analysis services, if the customer elects not to do such analysis itself.

Cimetrix® Software Products. Our Cimetrix software products enable equipment manufacturers to provide industry standard interfaces on their products for efficient equipment communication, control, and collection of equipment data. There are numerous industry standards that have been established for equipment connectivity and control, including the SEMI defined SECS (SEMI Equipment Communication Standard), GEM (Generic Equipment Model), and PV2 (new photovoltaic equipment communication standard based on SECS/GEM) standards. By providing software products that fully support these industry standards, equipment manufacturers can implement robust, turnkey support for these connectivity and control standards without needing to invest engineering resources to develop their own interfaces to these standards. Factories that purchase manufacturing equipment enabled with Cimetrix-supported interfaces, benefit from consistent and robust implementations of industry standards, enabling faster and more efficient implementation of smart manufacturing initiatives that depend on the collection and analysis of manufacturing and product data. There are two separate Cimetrix product lines targeting the needs of factory equipment connectivity and control. The products are sold via perpetual licenses and runtime royalties.

- *Equipment Factory Connectivity* – Our products for equipment connectivity primarily include the following:

- *CIMConnect*™ is designed for general purpose equipment connectivity and enables production equipment in the semiconductor and electronics industries to communicate data to the factory's host computer through the SECS/GEM and PV2 standards. CIMConnect can also support other emerging communications standards for maximum flexibility. In addition, it supports multiple-host interfaces simultaneously, which allows customers to support legacy, custom, and GEM interfaces. CIMConnect is used in semiconductor wafer fabrication, semiconductor back-end (test, assembly, and packaging), PV, HB-LED, disk drive, flat panel displays, printed circuit boards and other electronics manufacturing.

- *CIM300*™ is a software development kit (or SDK) used by manufacturers of 300mm semiconductor equipment that is designed to enable quick implementation of the required 300mm SEMI standards, including E39, E40, E87, E90, E94, E116, E148, and E157. These SEMI standards allow for the full automation required in manufacturing 300mm wafers. The CIM300 SDK includes CIMConnect, TESTConnect, and SECSConnect.

- *CIMPortal*™ *Plus* is an SDK for equipment manufacturers that allows for quick implementation of the Interface A, also known as EDA (Equipment Data Acquisition), and other SEMI standards, including E120, E125, E132, E134, E138, E147, and E164. Interface A specifies a new port on equipment that provides detailed structured data that can be used for advanced process control, e-diagnostics, and other equipment engineering service applications. These software applications are becoming critical to the fabs as shorter ramp times are required.

- *Equipment Control* – Our primary equipment control product is the *CIMControlFramework*™ software, which is based on the latest Microsoft.NET technology. It is designed to enable equipment manufacturers to meet the supervisory control, material handling, platform and process control, and factory automation requirements of the fabrication facilities or fabs. Developers can leverage framework components through configuration and extension or customize when unique requirements exist. CIMControlFramework, unlike one-off solutions, is supported and maintained with upgrades, improvements, and performance enhancements. With a data-driven architecture at the core of the framework, data generated at any point on the equipment is designed to be quickly and easily accessed by any other module or external application.

Services

Our services are almost always sold together with, or to support, our products and include the following:

Software-as-a-Service (SaaS) – We provide services to make our Exensio software available to our customers via the Internet, generally hosted by third-party providers. SaaS is considered part of cloud computing since the software is hosted on the Internet, or the "cloud." Since our SaaS applications are accessed from a remote server rather than installed on individual machines, it is easier to maintain. For example, when the remote software is updated, the customer's interface is also updated for all users. Cloud computing is designed to eliminate incompatibilities between different software versions and allow us to make incremental updates without requiring software downloads. Additionally, our customers can save data to a central online location, which is designed to allow increased project collaboration. As part of these services, we also typically provide hosted management services for the licensed software and the customer's data stored in our cloud. These services include environment set-up and configuration, system health monitoring, data integration maintenance, integration monitoring, system updates, security, and data upload/download, and license administration.

Software Related Services – We provide software maintenance and support (or M&S), data management services, various value-added services (or VAS) to install, configure, or create analysis templates, and other professional services to achieve customers' specific outcomes using our software. We call this last type of services our solutions offering and, in these cases, we tailor the use of one or more Exensio products to achieve a desired result. For example, our AIM YieldAware™ FDC solution offering is designed to identify the process control variables that have the greatest impact on product yield through professional services that analyze the data from both Exensio Process Control and elements of Exensio Manufacturing Analytics and make recommendations for the customer to implement. VAS are provided by our professional service personnel with expertise that enhances and complements the engineering teams at our customers. For example, VAS includes our data cleaning and monitoring services. One requirement of big data analytics is to have clean,

harmonized data to analyze. This service offering outsources the data wrangling and management effort to free the customer to focus their efforts on analysis, which has a greater ROI to the company than data management.

Characterization Services – These services are designed to characterize key product and/or process elements, primarily into CV test structures or DFI on-chip measurement instruments, and typically do not include performance incentives based on the customers' yield achievement. We provide these services, typically together with all of the elements of our CV system, to foundry customers in connection with new process technology development and/or yield ramp. In Characterization engagements, we generally provide the analysis of our CV test chips and provide summary findings and recommendations to the customer. Characterization engagements can include DFI systems.

Customers

Our existing customers include foundries, IDMs, fabless semiconductor design companies, OSATs, equipment manufacturers, EMS, and ODMs, including those that embed and distribute our Assembly Operations modules in their equipment. Our semiconductor customers' targeted product segments vary significantly, including microprocessors, memory, graphics, image sensor solutions, and communications. We believe that the adoption of our solutions by such companies for usage in a wide range of products validates the application of our solutions to the broader semiconductor market. We often have multiple contracts with a single customer or customer group, with no interdependent performance obligations. In general, our customer contracts are non-cancellable.

Two customers accounted for 27% of our revenues for 2021, and one customer accounted for 23% of our revenues for 2020. No other customer accounted for 10% or more of our revenues in 2021 and 2020. See the discussion in "Risk Factors" under Item 1A for more information about risks associated with customer concentration and contractual provisions.

International revenues accounted for approximately 55% and 58% of our total revenues for 2021 and 2020, respectively. We base these calculations on the geographic location of where the work is performed or where the customer is located. Revenues from customers by geographic area based on the location of the customers' work sites for our last two fiscal years can be found in Note 13, "Customer and Geographic Information" to the consolidated financial statements. Additional discussion regarding the risks associated with international operations can be found under Item 1A, "Risk Factors".

See our "Notes to Consolidated Financial Statements", included under Part II, Item 8. "Financial Statements and Supplementary Data" for additional geographic information.

Sales and Marketing

Our sales strategy is primarily to pursue targeted accounts through a combination of our direct sales force, our service teams, and strategic alliances. After we are engaged by a customer and early in the services process, our engineers seek to establish relationships in the organization and gain an understanding of our customers' business issues. Our direct sales and service teams combine their efforts to deepen our customer relationships by expanding our penetration across customers' products, processes, and technologies. This close working relationship with each customer has the added benefit of helping us to identify new product areas and technologies in which we should next focus our research and development efforts. From time-to-time, we use sales representatives/agents in various locations to augment direct sales in certain territories. We expect to continue to establish strategic alliances with process licensors, vendors in the electronic design automation software, capital equipment for IC production, and test silicon IP and mask-making software segments to create and take advantage of sales channel and co-marketing opportunities. Additionally, we expect to form relationships with key value chain participants, including foundries and OSATs, to provide services and value across the manufacturing supply chain.

Research and Development

Our research and development focuses on developing and introducing new proprietary technologies, including our Exensio platform, Cimetrix connectivity and control products, and DFI and CV systems, as well as other software products

and enhancements to our existing solutions, such as field applications for DFI and CV. We use a rapid-prototyping paradigm in the context of the customer engagement to achieve these goals. We have made, and expect to continue to make, substantial investments in research and development. The complexity of our technologies requires expertise in standards, physical IC design and layout, transistor design and semiconductor physics, semiconductor process integration, numerical algorithms, e-beam technology, hardware, statistics and software development. We believe that our team of engineers will continue to advance our market and technological leadership. We conduct in-house training for our engineers in certain technical areas. Our training also extends to focusing on ways to enhance client service skills. Although it fluctuates, we can have up to one quarter of our research and development engineers operating in the field, partnered with solution services engineers, in a deliberate strategy to provide direct feedback between technology development and customer needs. We also utilize a variety of skilled independent contractors for specialized development.

Competition

The semiconductor industry is highly competitive and driven by rapidly changing design and process technologies, evolving standards, short product life cycles, and decreasing prices. We expect market competition to continue to develop and increase as the market for data and analytics continues to evolve. We believe IC companies benefit from a combination of big data management infrastructure, AI/ML-based analytics engines, and products that generate and collect differentiated data that enrich the analytics process. Currently, we are a leading provider of comprehensive commercial hardware, software and IP solutions for optimizing and improving design, manufacturing and test operations processes through the application of differentiated data and advanced analytics. We face indirect competition from internal groups at IC companies that offer tools with varying degrees of optimization to accelerate process-design integration or test operations. Some providers of semiconductor manufacturing software, inspection equipment, electronic design automation, or design IP may seek to broaden their product offerings and compete with us. In each of the market segments we compete in, we face competition from established and potential competitors, some of whom may have greater financial, research, engineering, manufacturing and marketing resources than we have.

We currently face indirect competition from the internal groups at IC companies and direct competition from providers of (i) yield management and/or prediction systems, such as KLA-Tencor, Siemens AG (or Siemens), Onto Innovation, Inc. (or Onto), and Synopsys, Inc. (“Synopsys”); (ii) semiconductor manufacturing software, such as Applied Materials, Synopsys, Invantest, Inc., NI, Inc., Onto, and Siemens; (iii) inline inspection, metrology and electrical test equipment providers, such as Applied Materials and Keysight Technologies, Inc.; and, (iv) connectivity software or integration products/services supporting factory equipment connectivity or control needs of customers, such as PEER Group, Inc., Kontron AIS, GmbH, Yokogawa Electric Corp., and Kornic Automation Co. Ltd. There may be other providers of competitive commercial solutions of which we are not aware, and we may compete with the products or offerings of these named companies or additional companies if we expand our offerings through acquisition or development. For example, through our acquisition of Cimetrix in late 2020, we now face competition in the connectivity and integration products/services supporting factory equipment connectivity or control. The demand for solutions that address the need for better integration between the silicon design and manufacturing processes may encourage direct competitors to enter into our market. For example, in 2020, two of our competitors were acquired by larger entities, Synopsys, Inc. acquired Qualtera and NI, Inc. acquired Optimal+, which may enable greater investment or marketing of these competitive applications. This competition in our market may intensify in the future, which could lead to increased pricing pressure, negatively impacting our revenues, and slow our ability to grow or execute our strategy. Also, our current and potential customers may choose to develop their own solutions internally, particularly if we are slow in deploying our solutions or improving them to meet market needs. These and other competitors may be able to operate with a lower cost structure than our engineering organization, which would give any such competitor’s products a competitive advantage over our solutions.

We believe that our solutions compare favorably with respect to competition because we have demonstrated results and reputation, strong core technology, ability to create innovative technology, and ability to implement solutions for new technology and product generations. See the discussions in “Risk Factors” under Item 1A for more information about risks associated with our competition.

Information Security and Risk Oversight

We are heavily reliant on our technology and infrastructure, as well as the public cloud to an increasing degree, to provide our products and services to our customers. As a result, we have developed an information security program (referred to as our InfoSec Program) to enhance our network security measures, identify and mitigate information security risk, and protect and preserve the confidentiality, integrity, and continued availability of critical information owned by us and that of our customers and suppliers that is in our care. Our InfoSec Program includes development, implementation, and continual improvement of policies and procedures to safeguard information and ensure availability of critical data and systems. The program also includes annual information security awareness training for employees involved in our systems and processes that handle customer data and audits of our systems and enhanced training for specialized personnel and we have instituted regular phishing email simulations for all employees and all contractors with access to corporate email systems to enhance awareness and responsiveness to such possible threats Our InfoSec Program further includes review and assessment by external, independent third-parties, who certify and report on our weaknesses and internal response preparedness with respect to the entire company. Accordingly, we have instituted periodic network access penetration (or PEN) testing no less than once per year both for our corporate network resources and our SaaS cloud-based offerings. In May 2021, we successfully completed our Type II System and Organization Control (SOC 2) audit of our cloud-based offerings under the framework put forth by the American Institute of Certified Public Accountants (AICPA) in which independent, third-party auditors assess and test controls relating to the Trust Services Criteria (TSC) of Security, Availability, and Confidentiality and no qualified findings were found during the audit period. In February 2022, we started our next Type II SOC 2 audit with external auditors and started the audit process leading to ISO 27001 certification. To date, we have not managed ITAR-designated data, technology, or information. In accordance with our InfoSec Program, we also actively monitor known threats that could affect our products and services and work with our suppliers to provide us with real-time reports of threats or vulnerabilities that may affect our enterprise-wide systems. Our InfoSec Program also includes a data security incident response plan that provides controls and procedures for timely and accurate reporting of any material cybersecurity incident.

As described in the Audit Committee Charter, the Audit Committee is tasked with oversight of certain risk issues, including cybersecurity. This Committee is comprised entirely of independent directors, two of whom have significant work experience related to information security issues or oversight. Management reports security instances to the Committee as they occur, if material, and provides a summary multiple times per year to the Committee as well as the full Board about periodic assessment of our InfoSec Program, our internal response preparedness, and assessments led by outside advisors. We carry insurance that provides some protection against the potential losses arising from a cybersecurity incident. In the last three years, the expenses we have incurred from information security breach incidences, including penalties and settlements, of which there were none, were immaterial.

Environmental, Social & Governance (ESG) Initiatives

We have assembled a cross-functional team of leaders representing operations, human resources, supply chain, regulatory compliance, finance, marketing communications, investor relations, facilities, and the legal department with a focus on ESG issues relevant to the Company or that we can impact as a Company. In 2021, we formalized our corporate values as follows:

Integrity:

- Uphold the Highest Ethical Standards in everything we do
- Keep Our Commitments
- Safeguard Company IP

Team

- Treat Everyone with Respect
- Encourage Open and Vibrant Communications
- Promote Creative Solutions
- Move Forward Together

Table of Contents

Growth:	Customers
● Embrace Change and Drive Innovation	● Provide Passionate Dedication to Customer Success
● Pursue Long-term Profitable Growth	● Deliver the Highest Quality Products and Support
● Take Responsibility for Personal Growth	● Fiercely Protect Customer IP

Although we are not a member of the Responsible Business Alliance (or RBA) (formerly, the Electronics Industry Citizenship Coalition or EICC), in 2021 in an effort to further our ESG efforts, we adopted the RBA Code of Conduct to supplement our Code of Ethics, including the specific policies of the RBA Code relating to the five critical areas of corporate social responsibility: labor, health and safety, environment, management systems, and ethics. Guided by our above values and the following initial priorities, we believe we can achieve our business objectives and long-term stockholder value while doing our part in each of these areas. For additional information, see "Human Capital Management" in this Report below.

Care for Our People

- We believe in upholding the principle of human rights, worker safety, and observing fair labor practices within our organization and our supply chain.

- We embrace diverse viewpoints and perspectives, recognizing that greater inclusion fosters innovation and achieves better decision making and financial results. We have and plan to continue to undertake actions around organizational training, formalized company values, and a revitalized recruitment strategy.

- We are committed to ensuring that proper working conditions exist for the safety of our employees, such as developing, implementing, and continuously improving health and safety systems and conditions, and providing appropriate preparation, education, reporting, and controls. For example, we have Illness Prevention and Hazard Communication programs and an Emergency Action Plan for worker safety at our clean room facility.

Environmental Responsibility

- We are committed to protecting the natural environment and our community by complying with all applicable legal and regulatory requirements. For example, in 2020, we began the process of ISO14001 certification of our clean room facility, which specifies the requirements for the formulation and maintenance of an environmental management systems (EMS) and a specific framework for implementing relevant sustainable practices.

- We ask our employees to help us accomplish this by looking for opportunities to conserve energy, reduce consumption of natural resources, preserve air, soil, and water quality, manage waste properly, and reuse and recycle, and reduce the use of toxic substances in our operations where possible, including, in particular, in our clean room and lab facilities. Our clean room facility does not produce any off gas or emissions and the only reportable, hazardous material that we use at that facility is liquid nitrogen, which is in a tank external to our building and monitored using telematics by an independent third party specializing in such activity.

- We look for ways to reduce energy consumption in our facilities around the world, including upgrades and or retrofits to LED and/or motion detector lighting and smart HVAC system.

Ethics & Corporate Responsibility

- We are committed to ensuring ethical organizational governance, promoting business ethics and integrity, and embracing diversity, and inclusion in the board room and throughout the organization.

- We are committed to observing fair, transparent, and accountable operating practices.

- We seek to create and foster a healthy, balanced, and ethical work environment for everyone in our organization. To this end, we promote a positive work-life balance and ethical organizational culture and encourage all employees, regardless of position or level, to raise questions or concerns about actual or potential ethical issues and company policies and to offer suggestions about how we can make our organization better to address concerns.

- We have a Whistleblower Ethics Hotline that includes global telephone and web access together with local language support. The web portal enables online reporting of concerns, where allowed by local law, and a place to ask questions or quickly access ethics and compliance policies.

- We believe these efforts strengthen our ethics and compliance efforts and foster an environment where employees can express concerns and have them resolved.

- In our view, the goals of providing value to stockholders and upholding the principle of human rights and treating people fairly and with dignity are integrally interconnected. We are committed to promoting equality and supporting racial justice in the communities where we do business.

Supply Chain Responsibility

- We request that our suppliers adhere to the RBA Code of Conduct or its equivalent by flowing this requirement through our commercial contracts.

- We also support Rule 13p-1 under the Exchange Act (known as the Conflict Minerals Law) and efforts to avoid sourcing conflict minerals that directly or indirectly finance or benefit armed groups in the Democratic Republic of Congo (or DRC) and in adjoining countries. Consistent with the Conflict Minerals Law and the OECD Due Diligence Guidance concerning conflict minerals, we adopted the Conflict Free Sourcing Initiative Due Diligence reporting process and seek to obtain conflict minerals content declarations from our suppliers each year, all in an effort to promote supply chain transparency. We do not directly source tin, tantalum, tungsten, or gold (collectively referred to as 3TG) from mines, smelters or refiners, and we are in most cases several or more levels removed from these supply chain participants.

- We therefore expect:

  - our suppliers to source 3TG only from smelters and refiners validated as being conflict free and that do not directly or indirectly benefit or finance armed groups in the DRC or other covered country;

  - our suppliers to fully-comply with the Conflict Minerals Law and provide all necessary declarations;

  - our suppliers to pass these requirements through to their supply chain and determine the source and chain of custody of specified minerals, including 3TG; and

  - any suppliers not willing to comply with these requirements to be reviewed by global procurement with regard to future business and sourcing declarations. This conflict minerals policy encourages our suppliers to respect and protect human rights throughout the world.

Human Capital Management

We believe we have a responsibility to foster a healthy, balanced, and ethical work environment for everyone in our organization through sound ethical and organizational governance, by promoting business ethics and integrity, and by embracing equality, diversity, and inclusion throughout our organization and even extending to the board room. For

additional information, see “Environmental, Social & Governance (ESG) Initiatives—Ethics & Corporate Responsibility,” in Part I, Item 1 of this Report.

We established a cross-functional advisory team of company leaders at the onset of the COVID-19 pandemic to ensure that promoting the health and safety of our employees in accordance with the World Health Organization (WHO) and the U.S. Centers for Disease Control and Prevention (CDC) guidelines remains a constant focal point. Work in our offices and travel policies are in compliance with local, state, and national requirements. For employees working remotely, we encouraged them to tell us what home office equipment and IT support they needed to set up a home office for healthy and productive work. For a small number of employees on-site at our clean room facility, we set up strict COVID safety protocols. To stay connected while working remotely, beginning in April 2020, our Chief Executive Officer and other members of the executive team have led virtual meetings twice a month with the various sales, research and development, engineering, and administrative teams to discuss developments and business updates and answer questions. Safety protocols, such as attendance capacity, temperature checking requirements, 6-feet distancing, managed traffic flows, providing and requiring appropriate masks to be worn while in the office, eliminating/spacing out eating in common areas, limiting attendance in conference rooms, accessible hand sanitation stations throughout the office, and visitor prescreening have been put in place in worldwide offices as advised by the CDC and required by local regulations when local regulations have allowed employees to be in the office.

We support employee action to protect the natural environment and the communities in which we operate through pollution prevention, conservation, responsible use, charitable giving, and sustainable practices. For example, we organize and engage employees in an annual charitable giving campaign. We work to ensure that our business practices support diversity and inclusion to build an innovative workforce and to strive toward having our organization reflect the complexion of our customers and suppliers. We are strengthening our diversity and inclusion programs with actions around organizational training, formalized company values, and a revitalized recruitment strategy.

As of December 31, 2021, we had 407 employees worldwide, including 178 field application engineers and consultants, 130 in research and development, 50 in sales and marketing, and 49 in general and administrative functions. Of these employees, 218 are located in the United States and Canada, 157 in Asia, and 32 in Europe.

None of our employees are represented by a labor union. Our employees in France and Italy are subject to collective bargaining agreements in those countries. We believe our relationship with our employees is good. Competition is intense in the recruiting of personnel in our industry. We believe that our future success will depend, in part, on our continued ability to hire and retain qualified management, sales, and technical employees.

Information about our Executive Officers

The following table and notes set forth information about our current executive officers as of the date of this Form 10-K.

Name	Age	Position
John K. Kibarian, Ph.D.	57	President, Chief Executive Officer, and Director
Adnan Raza	49	Executive Vice President, Finance and Chief Financial Officer
Kimon Michaels, Ph.D.	55	Executive Vice President, Products and Solutions
Adrzej Strojwas, Ph.D.	69	Chief Technology Officer

John K. Kibarian, Ph.D., one of our founders, has served as President since November 1991 and has served as our Chief Executive Officer since July 2000. Dr. Kibarian has served as a director since December 1992. Dr. Kibarian received a B.S. in Electrical Engineering, an M.S. E.C.E. and a Ph.D. E.C.E. from Carnegie Mellon University.

Adnan Raza, joined in January 2020 as Executive Vice President, Finance, and was appointed Chief Financial Officer effective in March 2020. Prior to joining the Company, Mr. Raza served as an independent strategy consultant for private and public companies from July 2019 to January 2020. Prior to that, Mr. Raza served in various roles at Synaptics Inc., a developer of human interface technologies, including as Senior Vice President of Corporate Development from

August 2017 to June 2019 and Vice President of Corporate Development from February 2015 to August 2017. Prior roles include technology investment banking at Goldman, Sachs & Co. and UBS Investment Bank, strategic advising at Blackreef Capital, engineering and marketing at Azanda Network Devices, and engineering at Lucent Technologies. Mr. Raza also served as a Board Member at FIDO Alliance, an alliance of leading technology companies to enhance user security and authentication. Mr. Raza holds a M.B.A. from The Wharton School at the University of Pennsylvania, a M. Eng. in Electrical Engineering from Cornell University, and a B.S. in Electrical Engineering from Valparaiso University.

Kimon Michaels, Ph.D., one of our founders, has served as Vice President, Products and Solutions since July 2010 and was designated as an Executive VP in February 2019. Dr. Michaels served as Vice President, Design for Manufacturability from June 2007 through June 2010. Prior to that, Dr. Michaels served as Vice President, Field Operations for Manufacturing Process Solutions from January 2006 through May 2007, and has been a Director since November 1995. From March 1993 through December 2005, he served in various vice presidential capacities. He also served as Chief Financial Officer from November 1995 to July 1998. Dr. Michaels received a B.S. in Electrical Engineering, and M.S. E.C.E. and a Ph.D. E.C.E. from Carnegie Mellon University.

Andrzej Strojwas, Ph.D., served as a technical advisor to the Company since our founding, as chief technologist from 1997 to 2021. He joined the Company as an employee in July 2021 as Vice President and Technical General Manager, and was appointed by the Board of Directors to be our Chief Technology Officer effective December 2021. From October 1982 to July 2021, Dr. Strojwas was the Keithley Professor of Electrical and Computer Engineering at Carnegie Mellon University. In addition, Dr. Strojwas has held senior technical positions at Harris Semiconductor Co., AT&T Bell Labs, Texas Instruments, NEC, Hitachi, SEMATECH, and KLA-Tencor. He holds an M.S. in Electronic Engineering from Warsaw Technical University and a Ph.D. in Electrical Engineering from Carnegie Mellon University.

Available Information

We file or furnish various reports, such as registration statements, periodic and current reports, proxy statements and other materials with the SEC. Our Internet website address is www.pdf.com. You may obtain, free of charge on our website, copies of our annual reports on Form 10-K, quarterly reports on Form 10-Q, current reports on Form 8-K, and amendments to those reports filed or furnished pursuant to Section 13(a) or 15(d) of the Exchange Act, as soon as reasonably practicable after we electronically file such material with, or furnish it to, the SEC. The Company's website address provided is not intended to function as a hyperlink, and the information on the Company's website is not, and should not be considered, part of this Annual Report on Form 10-K and is not incorporated by reference herein.

The SEC maintains a Web site (http://www.sec.gov) that contains reports, proxy and information statements and other information regarding issuers, such as us, that file electronically with the SEC.

Item 1A. Risk Factors

Risks Associated with Our Business

We invest significant resources into research and development to pursue new product and technology initiatives, including our DFI system and Exensio platform, and if we invest more resources than anticipated or fail to successfully carry out these initiatives on the expected timeline or at all, our business, financial condition, or results of operations could be adversely impacted.

As part of the evolution of our business, we have made substantial investments in research and development efforts to develop new products, including our DFI system and Exensio cloud-based platform, as well continued investment to enhance existing products. New competitors, technological advances in the semiconductor industry or by competitors, our entry into new markets, or other competitive factors may require us to invest significantly greater resources than we anticipate. If we are required to invest significantly greater resources than anticipated without a corresponding increase in revenue, our operating results could decline. The technologies or products that we invest in may later not be sought after by semiconductor companies. In this event, we would not recoup our investment and our results would suffer. If we are unable to anticipate technological changes in our industry by introducing new or enhanced products in a timely and cost-effective manner, or if we fail to introduce products that meet market demand, we may lose our competitive position, our products may become obsolete, and our business, financial condition or results of operations could be adversely affected. Additionally, our periodic research and development expenses may be independent of our level of revenue, which could negatively impact our financial results.

Our sales cycle is lengthy and customers may delay entering into contracts or decide not to adopt our products or solutions after we have performed services or supported evaluation by them of our technology, which could result in delays in recognizing revenue and negatively impact our results of operations in a quarter or result in lower revenue than we expected if a contract is not consummated at all.

On-going negotiations and evaluation projects for new products, with new customers or in new markets may not result in significant revenues for us if we are unable to close new engagements on terms favorable to us, in a timely manner, or at all. Unexpected delays in our sales cycle could cause our revenues to fall short of expectations. Further, the timing and length of negotiations required to enter into agreements with our customers and the ultimate enforcement of complex negotiated contractual provisions as we intended is difficult to predict. If we do not successfully negotiate certain key complex contractual provisions, there are disputes regarding such provisions, or they are not enforceable as we intended, our revenues and results of operations would suffer. Further, our customers sometimes delay starting negotiations until they begin developing a new process, need to insert a new product, or experience specific yield issues. This means that on occasion we have, and may continue to provide technology and services under preliminary documentation before executing the final contract. In these cases, we would not recognize revenue and may defer associated costs until execution of the final contract, which, if significant, could negatively impact our results of operations in the periods before we execute the final contract. Further, if we were to incur significant effort and then fail to enter into a final contract, we would have to write-off such deferred costs in the period in which the negotiations ended, which would increase our costs and expenses and could result in significant operating losses.

Our fixed-fee services or product or system installation/configurations may take longer than budgeted, which could slow our revenue recognition and may also result in a loss contract or a claim of breach by our customers, which would negatively affect our operating results.

Our fixed-fee services, including in particular for characterization, require a team of engineers to collaborate with our customers to address complex issues by using our software and other technologies, and the installation and configuration of our software into our customers’ fabrication and test/assembly facilities requires experienced engineers working with our customers on active foundry and test/assembly equipment. We must estimate the amount of resources needed to complete both of these types of services to estimate when the engineers will be able to commence the next engagement. In addition, our accounting for contracts with such services, which generate fixed fees, sometimes requires adjustments to profit (loss) based on revised estimates during the performance of the contract. These adjustments may have a material effect on our results of operations in the period in which they are made. The estimates giving rise to these risks, which are

inherent in fixed-price contracts, include the forecasting of costs and schedules, and contract revenues related to contract performance. If we significantly fail to meet a customer's expectations in either case, the customer could claim that we breached our obligations, which could result in lost revenue and increased expenses.

Our ability to sell our products, systems, and solutions depends in part on the quality of our support and services offerings, and the failure to offer high-quality support and services could negatively affect our sales and results of operations.

Once our products are integrated within our customers' hardware and software systems, our customers may depend on our support organization to resolve any issues relating to our products. Further, in connection with delivering our SaaS, which requires us to maintain adequate server hardware and internet infrastructure, including system redundancies, we are required to meet contractual uptime obligations. A high level of system and support is critical for the successful marketing and sale of our products. If we do not effectively provide subscription access to our SaaS customers, assist our customers in deploying our products, succeed in helping our customers quickly resolve post-deployment issues, and provide effective ongoing support and data security, we may face contractual penalties or customers may not renew subscriptions or services in the future, which would negatively impact our results of operations. In addition, due to our international operations, our system and support organization faces challenges associated with delivering support, hours that support is available, training, and documentation where the user's native language may not be English. If we fail to maintain high-quality support and services and adequately address our customers' support needs, our customers may choose our competitors' products instead of ours in the future, which would negatively affect our revenues and results of operations.

Defects in our proprietary technologies, hardware and software tools, and failure to effectively remedy any such defects could decrease our revenue and our competitive market share.

If the software, hardware, or proprietary technologies we provide to customers contain defects that negatively impact customers' ability to use our systems or software, increase our customers' cost of goods sold and time-to-market, or damage our customers' property, these defects could significantly decrease the market acceptance of our products and services or results in warranty or other claims. We must adequately train our new personnel, especially our customer service and technical support personnel, to effectively and accurately, respond to and support our customers. If we fail to do this, it could lead to dissatisfaction among our customers, which could slow our growth. Further, the cost of support resources required to remedy any defects in our technologies, hardware, or software tools could exceed our expectations. Any actual or perceived defects with our software, hardware, or proprietary technologies may also hinder our ability to attract or retain industry partners or customers, leading to a decrease in our revenue. These defects are frequently found during the period following introduction of new software, hardware, or proprietary technologies or enhancements to existing software, hardware, or proprietary technologies, which means that we may not discover the errors or defects until after customer implementation of the silicon design and manufacturing process recommended by us. If our software, hardware, or proprietary technologies contain errors or defects, it could require us to expend significant resources to remedy these problems or defend/indemnify claims, which could reduce margins and result in the diversion of technical and other resources from our other customer implementations and development efforts.

Inadvertent disclosure of our customers' confidential information or our failure to comply with our customers' security rules, including for cloud-based solutions or on-site access could result in costly litigation, cause us to lose existing and potential customers, or negatively impact on-going business with existing customers.

Our customers consider their product yield information and other confidential information, which we must collect in the course of our engagement with the customer or through our software tools, to be extremely competitively sensitive or subject to strict protection frameworks, including data and personal data about our customers' employees necessary to administer the licenses. Many of our customers have strict security rules for on-site access to, or hosting, to their confidential information. If we suffered an unauthorized intrusion or we inadvertently disclosed or were required to disclose this information, or if we fail to adequately comply with customers' security protocols for accessing or hosting confidential information, we could lose existing and potential customers or be subject to costly penalties or litigation, or our on-going business could be negatively impacted and insurance to cover such situations may not fully cover our exposure. In addition, to avoid potential disclosure of confidential information to competitors, some of our customers may, in the future, ask us not to work with key products or processes, which could limit our revenue opportunities.

We generate a significant portion of our revenues from a limited number of customers, and a large percentage of our revenues from two customers, so decreased business with, or the loss of, any one of these customers, or pricing pressure, or customer consolidation could significantly reduce our revenues or margins and negatively impact results of operations.

Historically, we have had a small number of large customers for our IYR engagements and that contribute significant Gainshare royalties. In the year ended December 31, 2021, two customers accounted for 27% of our revenues. We have in the past and could in the future lose a customer due to its decision not to develop or produce its own future process node. Customers could also choose to not engage us on future process nodes, or reduce the scope of our services or technology under contract (which is permitted in one of our customer contracts if the customer's business materially adversely changes).We could also lose customers as a result of industry factors, including but not limited to reduced manufacturing volume or consolidation. Consolidation among our customers could also lead to increased customer bargaining power, or reduced customer spending on software and services. Further, new business may be delayed if a key customer uses its leverage to push for terms that are worse for us and we delay entering into the contract to negotiate for better terms, in which case revenue in any particular quarter or year may fail to meet expectations. Also, the loss of any of these customers or the failure to secure new contracts with these customers could further increase our reliance on our remaining customers. Further, if any of our key customers default, declare bankruptcy or otherwise delay or fail to pay amounts owed, or we otherwise have a dispute with any of these customers, our results of operations would be negatively affected in the short term and possibly the long term. For example, in 2021 and 2020, we incurred expenses in the amount of $2.0 million and $1.1 million, respectively, related to the arbitration with SMIC New Technology Research & Development (Shanghai) Corporation due to SMIC's failure to pay fees due to us under a series of contracts. If we are not able to resolve this matter amicably prior to trial, we will incur substantial additional expenses related to resolution of this matter through such an arbitration trial. These events could cause significant fluctuations in results of operations because our expenses are fixed in the short term and it takes us a long time to replace customers or reassign resources.

If we do not continuously meet our development milestones of key research and development projects or successfully commercialize our Design-for-Inspection system, our future market opportunity and revenues will suffer and our costs may not be recouped.

We have invested significantly in the design and development of our eProbe tool and related intellectual property. Key customers failing to purchase, renew, or expand the number or use of such systems on our expected timeline or at all will cause our results to miss expectations. Also, if the results of our DFI system, including new applications, are not as we expect, we may not be able to successfully commercialize this system or such applications on schedule, or at all, and we may miss the market opportunity and not recoup our investment. Further, our eProbe tool could cause unexpected damage to wafers or delay processing wafers, which we could be liable for, or which could make customers unwilling to use it. If we are not able to create significant interest and show reliable and useful results without significant damage to wafers, our investment may not be recouped and our future results may suffer.

Decreases in wafer volumes at our customers' manufacturing sites or the volume of ICs that some of our customers are able to sell to their customers would cause our Integrated Yield Ramp revenue to suffer.

Our Integrated Yield Ramp revenue includes amounts largely determined by wafer volumes at manufacturing sites covered by our contracts and, in some cases, the volume of an IC product that our customer is able to sell to its customers. Both of these factors are outside of our control. We have seen a significant reduction in our Integrated Yield Ramp revenue in recent years. Further, some of our manufacturing customers' business is largely dependent on customers that use our manufacturing customer as a second or third source. If those customers consolidate and/or otherwise move the orders to manufacturing facilities not covered by our contracts, or suspend their manufacturing at covered facilities for any reason, including consolidation, our Integrated Yield Ramp revenue will continue to decrease, which could cause us to fail to meet expectations. Further, reduced demand for semiconductor products or protectionist policies has from time to time decreased and may continue to decrease the volume of wafers and, in some cases, products our customers are able to make or sell, which would also decrease our Integrated Yield Ramp revenue. Also, our customers may unilaterally decide to implement changes to their manufacturing processes during the period that volume is covered by royalty contracts, which could negatively affect yield results and, thus, our Integrated Yield Ramp revenue.

Since we currently work on a small number of large projects at specified manufacturing sites and, in some cases, on specific IC products, our results of operations have been and may continue to be adversely affected by negative changes at those sites or in those products, including slowdowns in manufacturing due to external factors, such as U.S. trade restrictions, the impact of the COVID-19 pandemic, or supply chain issues. Also, if wafer orders from sites covered by our contracts are not secured by our customers, if an end product does not achieve commercial viability, if a process line or, in some cases, a specific product, does not achieve significant increases in yield or sustain significant volume manufacturing during the time we receive royalties, revenues associated with such volumes or products would be negatively impacted. This could significantly reduce our Integrated Yield Ramp revenue and results of operations could fail to meet expectations. In addition, if we work with two directly competitive manufacturing facilities or products, volume in one may offset volume, and thus any of our related revenue, in the other facility or product.

Our success depends upon our ability to effectively plan and manage our resources and restructure our business through rapidly fluctuating economic and market conditions, which actions may have an adverse effect on our financial and operating results.

Our ability to successfully offer our products and services in a rapidly evolving market requires an effective planning, forecasting, and management process to enable us to effectively scale and adjust our business and business models in response to fluctuating market opportunities and conditions, which has and could continue to require us to increase headcount, acquire new companies or engage in restructurings from time to time. For example, while we have increased investment in our business by, for example, increasing headcount, acquiring companies, and increasing our investment in R&D, sales and marketing, and other parts of our business from time to time, we have initiated a restructuring plan to reduce expenses and align our operations with evolving business needs. Some of our expenses related to such efforts are fixed costs that cannot be rapidly or easily adjusted in response to fluctuations in our business or numbers of employees. Rapid changes in the size, alignment or organization of our workforce, including sales account coverage, could adversely affect our ability to develop and deliver products and services as planned or impair our ability to realize our current or future business and financial objectives. Our ability to achieve the anticipated cost savings and other benefits from our restructuring initiatives within the expected time frame is subject to many estimates and assumptions, which are subject to significant economic, competitive and other uncertainties, some of which are beyond our control. If these estimates and assumptions are incorrect, if we are unsuccessful at implementing changes, or if other unforeseen events occur, our business and results of operations could be adversely affected.

Our business may be impacted by political events, war, terrorism, business interruptions and other geopolitical events and uncertainties beyond our control.

War, terrorism, geopolitical uncertainties and other business interruptions could cause damage to, disrupt or cancel sales of our products and services on a global or regional basis, which could have a material adverse effect on our business or vendors with which we do business. Such events could also make it difficult or impossible for us to deliver products and services to our customers. In addition, territorial invasions can lead to cybersecurity attacks on technology companies, such as ours, located far outside of the conflict zone. In the event of prolonged business interruptions due to geopolitical events, we could incur significant losses, require substantial recovery time and experience significant expenditures in order to resume our business operations. We have no operations in Russia or the Ukraine, but we do not and cannot know if the current uncertainties in these geopolitical areas, which are unfolding in real-time, may escalate and result in broad economic and security conditions, which could result in material implications for our business. In addition, our insurance policies typically contain a war exclusion of some description and we do not know how our insurers are likely to respond in the event of a loss alleged to have been caused by geopolitical uncertainties.

Global economic conditions or semiconductor market conditions could materially adversely impact demand for our products and services, decrease our sales, or delay our sales cycle.

Our customers are global semiconductor companies, which means that our operations and performance depend significantly on worldwide economic conditions as well as semiconductor market specific changes. Uncertainty about global economic conditions could result in customers postponing purchases of our products and services, including in response to tighter credit, inflationary concerns, unemployment, negative financial news and/or declines in income or asset values and other macroeconomic factors, which could have a material negative effect on demand for our products and

services and, accordingly, on our business, results of operations or financial condition. For example, the timing of the build-out of the semiconductor market in China depends significantly on governmental funding on both local and national levels and a delay in this funding could negatively affect our revenues. For further example, any economic and political uncertainty caused by the United States tariffs imposed on goods from China, among other potential countries, and any corresponding tariffs from China or such other countries in response, may negatively impact demand and/or increase the cost for our products. Similarly, the COVID-19 pandemic in China or in other nations has and may continue to cause a slowdown in the global economy and demand for our products and services. Further, the semiconductor industry historically has been volatile with up cycles and down cycles, due to sudden changes in customers' manufacturing capacity requirements and spending, which depend in part on capacity utilization, demand for customers' IC products by consumers, inventory levels relative to demand, and access to affordable capital. As a result of the various factors that affect this volatility, the timing and length of any cycles can be difficult to predict and could be longer than anticipated. Any of these events could negatively affect our revenues and make it challenging for us to forecast our operating results, make business decisions, and identify the risks that may affect our business, financial condition and results of operations. Customers with liquidity issues may also lead to additional bad debt expense.

Supply-chain disruption could impact our ability to build additional hardware tools or meeting customer deadlines.

Any disruptions to our supply chain, significant increase in component costs resulting from inflationary pressures, or shortages of critical components, could impact our ability to build additional hardware tools, which would decrease our sales, earnings, and liquidity or otherwise adversely affect our business and result in increased costs. Such a disruption could occur as a result of any number of events, including, but not limited to: an extended closure of or any slowdown at our suppliers' plants or shipping delays due to efforts to limit the spread of COVID-19, market shortages due to the surge in demand from other purchasers for critical components, increases in prices, the imposition of regulations, quotas or embargoes or tariffs on components or our products themselves, labor stoppages, transportation delays or failures affecting the supply chain and shipment of materials and finished goods, third-party interference in the integrity of the products sourced through the supply chain, cyberattacks, the unavailability of raw materials, severe weather conditions, adverse effects of climate change, natural disasters, geopolitical developments, war or terrorism and disruptions in utilities and other services. In addition, the development, licensing, or acquisition of new products in the future may increase the complexity of supply chain management. Failure to effectively manage the supply of components and products would adversely affect our business.

Risks Related to Our Technology

If we fail to protect our intellectual property rights, customers or potential competitors may be able to use our technologies to develop their own solutions, which could weaken our competitive position, reduce our revenues, or increase our costs.

Our success depends largely on the proprietary nature of our technologies. Our contractual, patent, copyright, trademark, and trade secret protection may not be effective against any particular threat or in any particular location. Our pending patent applications may not result in issued patents, and even if issued, they may not be sufficiently broad to protect our proprietary technologies. Some foreign countries do not currently provide effective legal protection for intellectual property and our ability to prevent the unauthorized use of our products in those countries is therefore limited. Our trade secrets may also be stolen, otherwise become known, or be independently developed by competitors. Litigation may be necessary from time to time to enforce our IP rights. As a result of any such litigation, we could lose our proprietary rights and incur substantial unexpected operating costs. Litigation could also divert our resources, including our managerial and engineering resources. If we are unable to exclude others from using our proprietary technologies and methods without compensation to us, through litigation or otherwise, it could impede our ability to grow our business and our revenues may suffer.

We are exposed to risks related to information technology infrastructure, information management and protection, cybersecurity threats, and cyber incidents.

We are heavily reliant on our technology and infrastructure, as well as the public cloud to an increasing degree, to provide our products and services to our customers. We have experienced in the past, and may experience in the future,

interruptions in our information systems on which our global operations depend. We may in the future experience unplanned downtime of the infrastructure that delivers our SaaS products. Further, we may face attempts by others to gain unauthorized access through the Internet to our information technology systems whether hosted by us or service providers, to intentionally hack, interfere with, or cause physical or digital damage to or failure of such systems (such as significant viruses or worms), which attempts we or they may be unable to prevent. Our security measures may also be breached due to employee errors, malfeasance, or otherwise. Despite our ongoing efforts to enhance our network security measures, our information systems are susceptible to computer viruses, cyber-related security breaches and similar disruptions from unauthorized intrusions, tampering, misuse, criminal acts, including phishing, or other events or developments that we may be unable to anticipate or fail to mitigate and are subject to the inherent vulnerabilities of network security measures. For example, in the middle of 2020, we became aware that a malicious third-party actor had fraudulently obtained one-time credentials to a limited set of hosts in a small segregated part of our network due to a vulnerability in a third-party VPN device. Third parties may also attempt to influence employees, users, suppliers or customers to disclose sensitive information in order to gain access to our, our customers' or business partners' data. Additionally, third parties with whom we work, such as vendors or developers, may violate applicable laws or our policies and such violations can place personal information of our customers at risk. We or our service providers could be unaware of an incident or its magnitude and effects until after it is too late to prevent it and the damage it may cause. Further, because the techniques used to obtain unauthorized access to the information systems change frequently, and may not be recognized until launched against a target, we may be unable to anticipate these techniques or to implement adequate preventative measures.

The theft, unauthorized use, or a cybersecurity attack that results in the publication of our trade secrets and other confidential business information as a result of such an incident could negatively affect our competitive position, the value of our investment in product or research and development, and third parties might assert against us or our customers claims related to resulting losses of confidential or proprietary information or end-user data and/or system reliability. We carry insurance that provides some protection against the potential losses arising from a cybersecurity incident, but it will not likely cover all such losses, and the losses that it does not cover may be significant. In any such event, our business could be subject to significant disruption, which could impact our revenues or cause customers to cease doing business with us, and we could suffer monetary and other losses, including reputational harm, which costs we may not be able to recover from our service providers. Our operations are dependent upon our ability to protect our technology infrastructure against damage from business continuity events that could have a significant disruptive effect on our operations.

Our technologies could infringe the intellectual property rights of others, causing costly litigation and the loss of significant rights.

Significant litigation regarding intellectual property rights exists in the semiconductor industry. It is possible that a third party may claim that our technologies infringe their intellectual property rights or misappropriate their trade secrets. For example, in late 2020, Ocean Semiconductor LLP ("Ocean") filed complaints against a number of semiconductor companies in the United States, including a number of our customers, alleging that the importation of IC devices made overseas on a process that, in some cases, included our software, infringed U.S. patents owned by Ocean. Any claim, even if without merit, could be time consuming to defend, result in costly litigation, or require us to enter into royalty or licensing agreements, which may not be available to us on acceptable terms, or at all and could adversely affect our sales opportunities, expenses, and revenues.

In addition, we collect, use, store or disclose (collectively, "process") an increasingly large amount of personal information, including from employees and customers, in connection with the operation of our business. The personal information we process is subject to an increasing number of federal, state, local and foreign laws regarding privacy and data security, as well as contractual commitments. Any failure or perceived failure by us to comply with such obligations may result in governmental enforcement actions, fines, litigation, or public statements against us by consumer advocacy groups or others and could cause our customers to lose trust in us, which could have an adverse effect on our reputation and business. Additionally, changes to applicable privacy or data security laws could impact how we process personal information, and therefore limit the effectiveness of our solutions or our ability to develop or deliver new products or services. For example, the European Union General Data Protection Regulation imposes stringent data protection requirements and provides for significant penalties for noncompliance of up to the greater of €20 million or four percent of worldwide annual revenues. Regulation is also increasingly occurring at the U.S. state level to supplement federal

legislative action or inaction, as indicated by the California Consumer Privacy Act (CCPA), which first became enforceable in 2020, and similar statutes that have been adopted in other states.

Additionally, we must frequently expand our internal information system to meet increasing demand in storage, computing and communication, which may result in increased costs. Our internal information system is expensive to expand and must be highly secure due to the sensitive nature of our customers' information that we transmit. Building and managing the support necessary for our growth places significant demands on our management and resources. These demands may divert these resources from the continued growth of our business and implementation of our business strategy.

Competition in the market for data analytics and related systems and services may intensify in the future, which could impede our ability to grow or execute our strategy.

We currently face indirect competition from the internal groups at IC companies and direct competition from providers of (i) yield management and/or prediction systems, such as KLA-Tencor, Siemens AG ("Siemens"), Onto Innovation, Inc. ("Onto"), and Synopsys, Inc. ("Synopsys"); (ii) semiconductor manufacturing software, such as Applied Materials, Inc., Synopsys, Invantest, Inc., NI, Inc., Onto, and Siemens; (iii) inline inspection, metrology and electrical test equipment providers, such as Applied Materials and Keysight Technologies, Inc.; and, (iv) connectivity software or integration products/services supporting factory connectivity or control needs of customers, such as PEER Group, Inc., Kontron AIS, GmbH, Yokogawa Electric Corp., and Kornic Automation Co. Ltd. There may be other providers of competitive commercial solutions of which we are not aware and we may compete with the products or offerings of these named companies or additional companies if we expand our offerings through acquisition or development. For example, since our acquisition of Cimetrix Incorporated in late 2020, we now face competition in the connectivity and integration products/services supporting factory equipment connectivity and control. The demand for solutions that address the need for better integration between the silicon design and manufacturing processes may encourage direct competitors to enter into our market. For example, in 2020, two of our competitors were acquired by larger entities, Synopsys, Inc. acquired Qualtera and NI, Inc. acquired Optimal+, which may enable greater investment or marketing of these competitive applications. This competition in our market may intensify in the future, which could lead to increased pricing pressure, negatively impacting our revenues, and slow our ability to grow or execute our strategy. Also, our current and potential customers may choose to develop their own solutions internally, particularly if we are slow in deploying our solutions or improving them to meet market needs. These and other competitors may be able to operate with a lower cost structure than our engineering organization, which would give any such competitor's products a competitive advantage over our solutions.

Risks Related to Our Operations

Measurement of our variable consideration requires data collection and customers' use of estimates in some cases and is subject to customers' agreement and is later offset if actual data differ from customers' estimates, which can result in uncertainty and cause quarterly results to fluctuate.

We can only recognize volume- or average selling price- based royalties once we have reached agreement with our customers on their level of yield performance improvements or average selling prices (also called "ASP") and quarterly agreements are sometimes based on estimates of volume results or ASP each quarter. Measuring the amount of yield improvement is inherently complicated and dependent on our customers' internal processes and certain non-public information, thus, there may be uncertainty as to some components of measurement or calculation. Also, some variable consideration can be highly susceptible to delays in the customer measurement of key factors such as reporting volumes results and level of yield or ASP. Therefore, we may have to estimate revenue related to contingent variable fees or usage-based or sales-based royalties prior to the receipt of performance reports, such as royalty acknowledgements, or other related information from customers. These estimates are subject to judgment to evaluate whether it is probable that a significant revenue reversal will not occur in future periods, which could result in our recognition of less Integrated Yield Ramp revenue than expected in any particular period and later offset when actual results become available.

We have customers with past due receivable balances and our failure to collect a significant portion of such balances could adversely affect our cash, require us to write-off receivables, or increase expense or our bad debt allowance.

If our customers fail to pay receivable balances when due, our cash will decrease and we may have to incur additional expenses in an attempt to collect it, write-off a portion or all of such receivables, or increase our bad debt allowance. Our accounts receivable balance, net of reserves, was $40.1 million and $34.1 million as of December 31, 2021, and 2020, respectively. Unbilled accounts receivable, included in accounts receivable, totaled $11.8 million and $7.2 million as of December 31, 2021 and 2020, respectively. Unbilled accounts receivable that are not expected to be billed and collected during the succeeding 12-month period are recorded in other non-current assets and totaled $1.3 million and $2.0 million as of December 31, 2021 and 2020, respectively. Two customers accounted for 44% of our gross accounts receivable as of December 31, 2021 and two customers accounted for 27% our gross accounts receivable as of December 31, 2020. The total accounts receivable reserves was $0.9 million and $1.0 million as of December 31, 2021 and 2020, respectively. We generally do not require collateral or other security to support accounts receivable. Despite the financial ability of these customers to pay for on-going services by PDF under valid contracts, customers may delay payments. Our allowances for potential credit losses, if any, could be insufficient, and we may need to adjust our allowance for doubtful accounts from current estimates or write-off receivables depending on such claims in the future. If we are forced to pursue legal remedies to collect receivables, our expenses could rise significantly and our business relationship and future business with these customers could suffer.

We have experienced losses in the past and we may incur losses again in the future.

We have experienced losses in the past, and we may incur losses again in the future if we are not able to adequately control our costs or if total revenues fail to exceed costs. In addition, virtually all of our quarterly operating expenses are fixed, so any shortfall in anticipated quarterly revenues could significantly reduce our operating results below expectations. Our accumulated deficit was $97.7 million as of December 31, 2021. We have in the past and may in the future incur significant expenses in connection with:

- funding for research and development;
- restructuring costs related to our cost control and management efforts;
- expansion of our sales and marketing efforts; and
- additional non-cash charges relating to amortization and stock-based compensation.

We face operational and financial risks associated with international operations that could negatively impact our revenues.

In recent years, we have derived nearly or over half of our revenues from sales outside of the United States, and we expect our international business to continue to grow. We have in the past expanded and reorganized, at different times, our operations, including international operations, and may in the future continue such expansion or reorganization by establishing or restructuring international subsidiaries, offices, or contractor relationships in locations, if and when, deemed appropriate by our management. Thus, the success of our business is subject to risks inherent in doing business internationally, including in particular:

- our potential growth in China is dependent upon continued investments in the semiconductor industry by both private and public entities within China. Should circumstances change such that the level of investments is substantially reduced, our future growth potential may be limited;
- some of our key engineers and other personnel are foreign nationals and they may not be permitted access to certain technical information under U.S. export laws or by certain of our customers and may have difficulty gaining access to the United States and other countries in which our customers or our offices may be located and it may be difficult for us to recruit and retain qualified technical and managerial employees in foreign offices;

- ineffective or inadequate protection or enforcement of our intellectual property in foreign jurisdictions;
- greater difficulty in collecting account receivables resulting in longer collection periods, bad debt, and increased cost to collect;
- language and other cultural differences may inhibit our sales and marketing efforts and create internal communication problems among our U.S. and foreign teams, increasing the difficulty of managing multiple, remote locations and negatively impacting sales and revenue;
- compliance with, inconsistencies among, and unexpected changes in, a wide variety of foreign laws and regulatory environments with which we are not familiar, including, among other issues, with respect to employees, personal data, tax, protection of our IP, and a wide variety of operational regulations and trade and export controls under domestic, foreign, and international law;
- currency risk due to the fact that certain of our payables and for our international offices are denominated in the foreign currency, including the Euro, Yen, and RMB, while virtually all of our revenues is denominated in U.S. dollars, or in the event a larger portion of our revenues becomes denominated in foreign currencies, we would be subject to a potentially significant exchange rate risk;
- inadequate local infrastructure that could result in business disruptions;
- additional taxes, interest, and potential penalties, and uncertainty around changes in tax laws of various countries;
- geopolitical instability or changes in government could disrupt our operations or our customers' purchases or operations or those of related supply chain participants;
- quarantine, private travel limitation, or business disruption in regions affecting our operations, stemming from actual, imminent or perceived outbreak of human pandemic or contagious disease, including the COVID-19; or
- economic or political instability, including but not limited to armed conflict, terrorism, interference with information or communication of networks or systems, as well as strained or worsening relations between the United States and China, and occupation or war involving Russia and Ukraine, and the resulting disruption to economic activity and business operations.

Further, our employees and contractors include professionals located in various international locations, including Shanghai, China, and Ramallah, Palestine, who provide software-related development, quality assurance, maintenance, and other technical support services for certain of our software products. Political changes, including policies regarding export control, that affect these or other international operations could disrupt or limit the work our employees and contractors are able to perform, and thus negatively affect the range of services we are able to provide our customers or our cost for such services.

The COVID-19 pandemic has affected the manufacturing and shipment of goods. From time to time since the start of the pandemic in 2020, our offices around the world have been temporarily shut down and restrictions have limited the ability of our local employees to travel to customer sites or visit our other offices. An extended closure of our customers' plants due to a resurgence of COVID-19 or variants thereof could adversely impact our business.

In addition, our global operations are subject to numerous U.S. and foreign laws and regulations, including those related to anti-corruption, tax, corporate governance, imports and exports, financial and other disclosures, privacy, and labor relations. These laws and regulations are complex and may have differing or conflicting legal standards, making compliance difficult and costly. In addition, there is uncertainty regarding how proposed, contemplated, or future changes to these complex laws and regulations could affect our business. We may incur substantial expense in complying with the new obligations to be imposed by these laws and regulations, and we may be required to make significant changes in our business operations, all of which may adversely affect our revenues and our business overall. Given the high level of

complexity of these laws, there is a risk that some provisions may be inadvertently or intentionally breached, for example through fraudulent or negligent behavior of individual employees, our failure to comply with certain formal documentation requirements or otherwise. If we violate these laws and regulations, we could be subject to fines, penalties, or criminal sanctions, and may be prohibited from conducting business in one or more countries. Additionally, we may be held liable for actions taken by our local dealers and partners. A significant violation could additionally have a significantly negatively impact our sales opportunities, operations, and financial results. Even if our operations and ability to deliver products and services to customers in China and elsewhere are not significantly negatively impacted by such changing regulations, our customers in China and elsewhere may decide to use only local vendors as a precaution. In such case, our expected international business may be slower than expected or not materialize at all, in which case, our sales opportunities, operations, and financial results would suffer.

Further, the U.S. government has most recently imposed a “first tranche” of broad sanctions against Russia relating to its invasion of Ukraine aimed at Russia’s financial, technology, energy and transport sectors, and certain companies and high-wealth individuals, and has additionally continued a bipartisan consensus in the U.S. government favoring increased confrontation of China in trade practices and economic matters, national security, and human rights. The current U.S. Administration views technology as a domain of strategic competition in which the U.S. and allies must stay ahead of China and has reaffirmed the U.S. government consensus identifying semiconductor, artificial intelligence, and 5G technologies, and protection of U.S. supply chains as priority efforts. If the Administration continues to augment ongoing U.S. efforts by enlisting the cooperation of allied countries in both advanced development and protection against P.R.C. and/or Russian use of U.S. and allied advances, or expands or intensifies export controls and sanctions, including by adding more P.R.C. or Russian companies to the U.S. Export Administration Regulations (EAR) Entity List, our ability to sell to these companies or companies supplied by them could be negatively impacted. Our standard operations include development, distribution processes, software download sites, and professional service centers and processes located in various geographies around the world. Some customers have expressed concerns to us that continued action by the U.S. government could potentially interrupt their ability to make use of our products or services. The continuing tension between the U.S. and P.R.C. and Russian governments in trade and security matters or the perception of that tension could lead to disruptions or reductions in international trade, deter or prevent purchasing activity of customers, and negatively impact us in our financial results, including in particular sales in China and Russia.

We must comply with a variety of existing and future laws and regulations that could impose substantial costs on us and may adversely affect our business.

Increasingly regulators, customers, investors, employees and other stakeholders are focusing on Environmental, Social and Governance (ESG) matters. While we have certain ESG initiatives at the Company, there can be no assurance that regulators, customers, investors, and employees will determine that these programs are sufficiently robust. In addition, there can be no assurance that we will be able to attain any announced goals related to our ESG program, as statements regarding our ESG goals reflect our current plans and aspirations and are not guarantees that we will be able to achieve them within the timelines we announce or at all. Actual or perceived shortcomings with respect to our ESG initiatives and reporting can impact our ability to hire and retain employees, increase our customer base, or attract and retain certain types of investors. In addition, these parties are increasing focused on specific disclosures and frameworks related to ESG matters. Collecting, measuring, and reporting ESG information and metrics can be costly, difficult and time consuming, is subject to evolving reporting standards, and can present numerous operational, reputational, financial, legal and other risks, any of which could have a material impact, including on our reputation and stock price. Inadequate processes to collect and review this information prior to disclosure could be subject to potential liability related to such information.

Tax Risks

Changes in effective tax rates could positively affect our earnings, thereby raising investors’ expectations, while the final tax rates that are determined could be significantly higher, thereby lowering our earnings and causing us to miss investors’ expectations, which could cause our stock price to drop.

We conduct our business globally and, as a result, are subject to taxation in the United States and foreign countries. Our future tax rates could be affected by numerous factors, including recent changes in tax laws or the interpretation of such tax laws, insufficient taxable income to realize deferred tax assets, and changes in accounting policies. Our filings

are subject to reviews or audit by the Internal Revenue Service and state, local and foreign taxing authorities. We cannot be sure that any final determination in an audit would not be materially different than the treatment reflected in our historical income tax provisions and accruals. If additional taxes are assessed as a result of an audit, there could be a significant negative effect on our income tax provision and our operating results in the period or periods for which that determination is made. Any changes in our geographical earnings mix in various tax jurisdictions, including those resulting from transfer pricing adjustments, could materially increase our effective tax rate.

Future events may impact our deferred tax asset position, including the utilization of net operating loss and tax credit carryforwards.

Realization of our deferred tax assets is dependent primarily upon future taxable income in the applicable jurisdiction. We previously recorded a full valuation allowance against all of our U.S. federal and state deferred tax assets due to the uncertainty surrounding the future realization of these deferred tax assets. Therefore, no benefit has been recognized for the net operating loss carryforwards, tax credit carryforwards, and other deferred tax assets. The net operating loss and tax credits could expire unused and be unavailable to reduce future income tax liabilities. We intend to continue maintaining a full valuation allowance on these deferred tax assets until there is sufficient evidence to support the reversal of all or some portion of these allowances. We evaluate our deferred tax assets for realizability each reporting period. The impact of releasing some or all of such valuation allowance in a future period could be a material benefit in the period in which such release occurs.

U.S. federal tax reform and changes in other tax laws could increase our tax burden and adversely affect our business and financial condition.

In December 2017, the U.S. government enacted comprehensive tax legislation, the Tax Cuts and Jobs Act of 2017, significantly reforming the Internal Revenue Code of 1986, as amended. These changes include, among others, (i) a permanent reduction to the corporate income tax rate, (ii) a partial limitation on the deductibility of business interest expense, (iii) a shift of the U.S. taxation of multinational corporations from a tax on worldwide income to a territorial system (along with certain rules designed to prevent erosion of the U.S. income tax base) and (iv) a one-time tax on accumulated offshore earnings held in cash and illiquid assets, with the latter taxed at a lower rate.

In addition, beginning in 2022, the recently enacted tax legislation will require research and experimental expenditures to be capitalized and amortized ratably over a five-year period. Any such expenditures attributable to research conducted outside the United States must be capitalized and amortized over a 15-year period.

Notwithstanding the reduction in the corporate income tax rate, the overall impact of this tax reform is uncertain, and our business and financial condition could be adversely affected. Furthermore, it is uncertain if and to what extent various states will conform to the enacted federal tax law or any newly enacted federal legislation. In addition, new legislation or regulation which could affect our tax burden could be enacted by any governmental authority. We cannot predict the timing or extent of such tax related developments which could have a negative impact on our financial results. Additionally, we use our best judgment in attempting to quantify and reserve for these tax obligations. However, a challenge by a taxing authority, our ability to utilize tax benefits such as carryforwards or tax credits, or a deviation from other tax related assumptions could have a material adverse effect on our business, results of operations, or financial condition.

Risks Related to Our Strategic Transactions

We may not realize the benefits of our strategic partnership with Advantest, which could have an adverse effect on our business and results of operations

On July 29, 2020, we entered into a strategic partnership with Advantest Corporation through its wholly-owned subsidiary, Advantest America, Inc. (collectively, “Advantest”), that includes: (i) a significant agreement for our assistance in development of cloud-based applications for Advantest tools that leverage our Exensio software analytics platform; (ii) a commercial agreement providing for the license to third parties of solutions that result from the development work that combine Advantest’s testing applications and our Exensio platform; (iii) a 5-year cloud-based subscription for our Exensio analytics platform and related services; and (iv) the purchase of 3,306,924 shares of our

common stock, for aggregate gross proceeds of $65.2 million. The full extent of the future impact of this strategic partnership on our financial condition and results of operations is currently unknown and the failure to reap the anticipated benefits of Advantest's financial resources, technology, customer relationships, and global footprint and/or develop successful joint solutions could have an adverse effect on our business and results of operations.

Our acquisitions and divestitures create special risks and challenges that could adversely affect our financial results.

We have made, and may continue to make, acquisitions in order to enhance our business. For example, we acquired Cimetrix Incorporated ("Cimetrix") in December 2020 for a gross purchase price of approximately $37.5 million ($31.6 million net of cash acquired) for all of its outstanding equity. Acquisitions involve numerous risks, including, but not limited to, problems combining the purchased operations, technologies or products, unanticipated costs, liabilities, litigation, and diversion of management's attention from our core businesses, adverse effects on existing business relationships with suppliers and customers, risks associated with entering markets in which we have no or limited prior experience, and where competitors in such markets have stronger market positions, initial dependence on unfamiliar supply chains or relatively small supply partners, failure of our due diligence processes to identify significant problems, liabilities or other challenges of an acquired company or technology, and the potential loss of key employees, customers, distributors, vendors, and other business partners of the companies we acquire.

There can be no assurance that we will be able to successfully integrate any businesses, products, technologies, or personnel that we might acquire or that the transaction will advance our business strategy. The integration of businesses that we may acquire is likely to be a complex, time-consuming, and expensive process and we may not realize the anticipated revenues or other benefits associated with our acquisitions. If we fail to successfully manage, operate, or integrate any acquired business or if we are unable to efficiently operate as a combined organization, including through the use of common information and communication systems, operating procedures, financial controls, and human resources practices, we could be required to write-down investments and our business, financial condition, and results of operations may be adversely affected. We may also be unable to protect or enforce the intellectual property rights of any target business that we acquire, or such target businesses may become subject to claims of intellectual property infringement. Further, if we become subject to liabilities as a result of an acquisition, the liabilities we incur may be substantial and the amounts of such liabilities may not be covered by and/or may exceed any liability protections.

In connection with certain acquisitions, we may agree to issue common stock, or assume equity awards, that dilute the ownership of our current stockholders, use a substantial portion of our cash resources, assume liabilities (both known and unknown), record goodwill and amortizable intangible assets that will be subject to impairment testing on a regular basis and potential periodic impairment charges, incur amortization expenses related to certain intangible assets, and incur large and immediate write-offs and restructuring and other related expenses, all of which could harm our financial condition and results of operations.

COVID-19 Risks

The COVID-19 pandemic has significantly affected how we and our customers are operating our business and the duration and extent to which this will impact our future results of operations and overall financial performance remains uncertain.

The COVID-19 pandemic has significantly affected how we and our customers are operating our business. For example, most U.S. states and countries worldwide imposed and may continue to impose from time-to-time for the foreseeable future, restrictions on the physical movement of our employees, partners, and customers to limit the spread of COVID-19. Our US headquarters and R&D facility and offices in Canada, France, Japan and Korea have experienced temporary closures since the first quarter of 2020. In addition, since that time, our personnel worldwide have also been subject to various country to country travel restrictions, which limit our ability to provide services to customers at their facilities. These impacts have disrupted our normal operations. If the COVID-19 pandemic has a substantial impact on our employees' productivity, our results of operations and overall financial performance may be harmed.

Moreover, the conditions caused by the COVID-19 pandemic could adversely affect our customers' ability or willingness to purchase our products or services, delay prospective customers' purchasing decisions, adversely impact our

ability to provide or deliver products and on-site services to our customers, delay the provisioning of our offerings, lengthen payment terms, reduce the value or duration of their subscriptions, or affect attrition rates, all of which could adversely affect our future sales, operating results and overall financial performance. For example, we believe the lack of an ability to meet face-to-face during most of 2020 and 2021 have made it harder for us to sell complex or new technologies to such customers during these periods.

While the future economic impact brought by the COVID-19 pandemic may be difficult to assess or predict, a long-term market downturn resulting from the spread of COVID-19 could materially impact the value of our common stock, impact our access to capital and affect our business in the near and long-term.

The duration and extent of the continuing impact from the COVID-19 pandemic depends on future developments that cannot be accurately predicted at this time, such as the severity and transmission rate of the virus and variants thereof, the extent and effectiveness of containment actions, including the availability and effective distribution of vaccines, and the impact of these and other factors on our employees, customers, partners and vendors. If we are not able to respond to and manage the impact of such events effectively, or if the macroeconomic conditions of the general economy continue to worsen or the industries in which we operate are negatively impacted over the long-term, our business, operating results, financial condition and cash flows could be adversely affected.

General Risk Factors

If we are not able to retain, attract, motivate, and strategically locate talented employees, including some key executives, our business may suffer.

Our success and competitiveness depend on our ability to retain, attract, motivate, and strategically locate in our offices around the globe, talented employees, including some of our key executives. Achieving this objective may be difficult due to many factors, including fluctuations in global economic and industry conditions, changes in our management or leadership, the hiring practices at our competitors or customers, cost reduction activities, and the effectiveness of our compensation programs, including equity-based programs. Further, we have had, and expect to continue to have, difficulty in obtaining visas permitting entry for some of our employees that are foreign nationals into the United States, and delays in obtaining visas permitting entry into other key countries, for several of our key personnel, which disrupts our ability to strategically locate our personnel. In recent years, the United States increased the level of scrutiny in granting H-1(b), L-1 and other business visas. Compliance with United States immigration and labor laws could require us to incur additional unexpected labor costs and expenses or could restrain our ability to retain skilled professionals. If we lose the services of certain of our key executives or a significant number of our engineers, it could disrupt our ability to implement our business strategy. If we do not successfully attract, retain, and motivate key employees, including key executives, we may be unable to realize our business objectives and our operating results may suffer.

Our earnings per share and other operating results may vary quarter to quarter, which could result in not meeting investors' expectations and cause our stock price to drop.

Our stock price has fluctuated widely during the last few years. A factor in the volatility may be that our historical quarterly operating results have fluctuated. Our future quarterly operating results will likely fluctuate from time to time and may not meet the expectations of securities analysts and investors in some future period, which could cause our stock price to decrease again. A significant reduction in our stock price negatively impacts our ability to raise equity capital in the public markets and increases the cost to us, as measured by dilution to our existing shareholders, of equity financing. In addition, the reduced stock price also increases the cost to us, in terms of dilution, of using our equity for employee compensation or for acquisitions of other businesses. A greatly reduced stock price could also have other negative results, including the potential loss of confidence by employees, the loss of institutional investor interest, a hostile take-over bid, and fewer business development opportunities. Also, significant volatility in the stock price could be followed by a securities class action lawsuit, which could result in substantial costs and a diversion of our management's attention and resources.

Our business could be negatively affected as a result of actions of activist shareholders, and such activism could impact the trading value of our securities.

In recent years, shareholder activists have become involved in numerous public companies, including our company. Shareholder activists frequently propose to involve themselves in the governance, strategic direction, and operations of a company. Such proposals may disrupt our business, increase our expenses, and divert the attention of our Board of Directors and our management and employees, and any perceived uncertainties as to our future direction resulting from such a situation could result in the loss of potential business opportunities, interfere with our ability to execute our strategic plan be exploited by our competitors, cause concern to our current or potential customers, and make it more difficult to attract and retain qualified personnel and business partners, all of which could adversely affect our business. A proxy contest for the election of directors at our annual meeting could also require us to incur significant legal fees and proxy solicitation expenses. In addition, actions of activist shareholders may cause significant fluctuations in our stock price based on temporary or speculative market perceptions or other factors that do not necessarily reflect the underlying fundamentals and prospects of our business.

Item 1B. ***Unresolved Staff Comments***

None.

Item 2. ***Properties***

None.

Item 3. ***Legal Proceedings***

From time to time, we are subject to various claims and legal proceedings that arise in the ordinary course of business. We accrue for losses related to litigation when a potential loss is probable and the loss can be reasonably estimated in accordance with Financial Accounting Standards Board (FASB) requirements. As of December 31, 2021, except as disclosed below, we were not party to any material legal proceedings, thus no loss was probable, and no amount was accrued.

On May 6, 2020, the Company initiated an arbitration proceeding with the Hong Kong International Arbitration Center against SMIC New Technology Research & Development (Shanghai) Corporation ("SMIC") due to SMIC's failure to pay fees due to PDF under a series of contracts. We seek to recover the unpaid fees, a declaration requiring SMIC to pay fees under the contracts in the future, and costs associated with bringing the arbitration proceeding. The arbitration is on-going.

Item 4. ***Mine Safety Disclosures***

None.

PART II

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

Our common stock trades on the Nasdaq Global Market under the symbol "PDFS." As of February 25, 2022, we had approximately 29 stockholders of record. The number of stockholders of record does not include individuals whose stock is in nominee or "street name" accounts through brokers.

Dividend Policy

No cash dividends were declared or paid in 2021 and 2020. We currently intend to retain all available funds to finance future growth, product development, and stock repurchases and, therefore, do not anticipate paying any cash dividends on our common stock for the foreseeable future.

Unregistered Sales of Equity Securities

The information required to be disclosed by paragraph (a) of Item 5 to Form 10-K has been included in a current report on Form 8-K and, therefore, is not furnished herein, pursuant to the last sentence in that paragraph.

Purchases of Equity Securities by the Issuer and Affiliated Purchasers

On June 4, 2020, the Company's Board of Directors adopted a stock repurchase program (the "2020 Program") to repurchase up to $25.0 million of the Company's common stock both on the open market and in privately negotiated transactions, including through Rule 10b5-1 plans, over the next two years. During the year ended December 31, 2021, 251,212 shares were repurchased under the 2020 Program at an average price of $18.01 per share for an aggregate total price of $4.5 million.

There were no purchases made by or on behalf of the Company or any "affiliated purchaser" (as the term is defined in Rule 10b-18(a)(3) under the Exchange Act) of our common stock during the fourth quarter ended December 31, 2021.

Item 6. ***Selected Financial Data***

The following selected consolidated financial information has been derived from the audited consolidated financial statements. The information set forth below is not necessarily indicative of results of future operations and should be read in conjunction with Item 7. “Management’s Discussion and Analysis of Financial Condition and Results of Operations” and the consolidated financial statements and notes to those statements included therein and in Part II of this Form 10-K.

	Year Ended December 31,				
	2021 (1)	2020 (1)	2019	2018	2017
	(In thousands, except per share amounts)				
Consolidated Statements of Loss Data:					
Total revenues	$ 111,060	$ 88,046	$ 85,585	$ 85,794	$ 101,871
Costs and Expenses:					
Costs of revenues	44,193	36,765	33,474	42,803	47,521
Research and development	43,780	34,654	32,747	27,998	30,078
Selling, general and administrative	37,649	32,677	26,299	23,934	23,684
Amortization of acquired intangible assets	1,255	741	609	435	398
Restructuring charges	—	—	92	576	—
Write-down in value of property and equipment	3,183	—	—	—	—
Interest and other expense (income), net	(683)	1,269	(276)	(493)	264
Loss before taxes	(18,317)	(18,060)	(7,360)	(9,459)	(74)
Income tax expense (benefit)	3,171	22,303	(1,942)	(1,743)	1,263
Net loss	$ (21,488)	$ (40,363)	$ (5,418)	$ (7,716)	$ (1,337)
Net loss per share:					
Basic and Diluted	$ (0.58)	$ (1.17)	$ (0.17)	$ (0.24)	$ (0.04)
Weighted average common shares used to calculate net loss per share, basic and diluted	37,138	34,458	32,411	32,169	32,038

	December 31,				
	2021 (1)	2020 (1) (2)	2019	2018	2017
	(In thousands)				
Consolidated Balance Sheets Data:					
Cash, cash equivalents and short-term investments	$ 140,226	$ 145,296	$ 97,605	$ 96,089	$ 101,267
Working capital	144,681	151,175	119,580	137,693	144,263
Total assets	273,768	287,580	239,544	225,905	224,176
Long-term obligations	10,357	10,869	15,391	6,582	6,171
Total stockholders’ equity	219,585	234,506	196,157	199,795	198,368

(1) In December 2020, we completed the acquisition of Cimetrix Incorporated (“Cimetrix”). Payments made for this acquisition, net of cash acquired, amounted to $3.1 million and $28.6 million in fiscal 2021 and 2020, respectively, or total payments of $31.6 million, for all of the outstanding equity of Cimetrix. The Consolidated Statements of Comprehensive Loss Data for fiscal 2021 and 2020 also include results of operations of Cimetrix since acquisition date. For further information about this acquisition, see Note 4 of “Notes to Consolidated Financial Statements” (Item 8 of Part II of this Annual Report).

(2) On July 29, 2020, we entered into a strategic partnership with Advantest, which includes, among others, a Securities Purchase Agreement wherein we issued and sold to Advantest America, Inc., an aggregate of 3,306,924 shares of our common stock, at a purchase price of $19.7085 per share, for aggregate gross proceeds of $65.2 million, on July 30, 2020.

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

Overview

We offer products and services designed to empower engineers and data scientists across the semiconductor ecosystem to connect, collect, manage, and analyze data about design, equipment, manufacturing, and test to improve the yield and quality of their products. We derive revenues from two sources: Analytics and Integrated Yield Ramp. Our offerings combine proprietary software, professional services using proven methodologies and third-party cloud-hosting platforms for SaaS, electrical measurement hardware tools, and physical IP for IC designs. We primarily monetize our offerings through license fees and contract fees for professional services and software as a service (or SaaS). In some cases, especially on our historical IYR engagements, we also receive a value-based variable fee or royalty, which we call Gainshare. Our products, services, and solutions have been sold to IDMs, fabless semiconductor companies, foundries, OSATs, capital equipment manufacturers, and system houses.

Industry Trend

The COVID-19 pandemic has significantly affected how we and our customers operate our businesses. For example, most U.S. states and countries worldwide imposed in 2020, and may continue to impose from time-to-time for the foreseeable future, restrictions on the physical movement of people to limit the spread of COVID-19, including travel restrictions and stay-at-home orders. As a result, during portions of 2021, many of our offices were temporarily shut down and our local employees were restricted from traveling to customer sites or visiting our other offices. We continue to closely monitor the COVID-19 situation and will reopen our corporate headquarters in the United States and other offices according to local restrictions, in each case, with a focus on our employees' safety. In addition, our personnel worldwide continue to be subject to various country-to-country travel restrictions, which limits the ability of some employees to travel to other offices or customer sites. We believe the lack of an ability to meet in person during most of 2020 and 2021 made it harder for us to sell complex or new technologies to some customers during these periods. Once we can again begin to meet with these customers in person, we believe we may improve traction with them. To date, we have been able to provide uninterrupted access to our products and services due to our globally distributed workforce, many of whom were working remotely prior to the pandemic, and our pre-existing infrastructure, which supports secure access to our internal systems. The total duration and full extent of the impact from the COVID-19 pandemic depends on future developments that cannot be accurately predicted at this time, such as the ultimate severity and transmission rate of the virus and variants, the extent and effectiveness of containment actions and vaccinations, and the impact of these and other factors on our employees, customers, partners, and suppliers. To date, one effect of the COVID-19 pandemic is a global shortage in semiconductors due primarily to supply chain disruptions and many companies, including automotive industry, have announced shortages in production. Although this shortage has not materially affected our business, this trend may affect our future business opportunities, particularly future Gainshare and Cimetrix run-time licenses, if our customers' production volumes decrease.

Certain other trends may affect our Analytics revenue specifically. In particular, the confluence of Industry 4.0 (i.e. the fourth industrial revolution, or the automation and data exchange in manufacturing technologies and processes) and cloud computing (i.e. the on-demand availability of computing resources and data storage without direct active management by the user) is driving increased innovation in semiconductor and electronics manufacturing and analytics, as well as in the organization of IT networks and computing at semiconductor and electronics companies across the ecosystem. First, the ubiquity of wireless connectivity and sensor technology enables any manufacturing company to augment its factories and visualize its entire production line. In parallel, the cost per terabyte of data storage has continually decreased year to year. The combination of these two trends means that more data is collected and stored than ever before. Further, semiconductor companies are striving to analyze these very large data sets in real-time to make rapid decisions that measurably improve manufacturing efficiency and quality. In parallel, the traditional practice of on-site data storage, even for highly sensitive data, is changing. The ability to cost-effectively and securely store, analyze, and retrieve massive quantities of data from the cloud versus on-premise enables data to be utilized across a much broader population of users, frequently resulting in greater demands on analytics programs. The combination of these latter two trends means that cloud-based, analytic programs that effectively manage identity management, physical security, and data protection are increasingly in demand for insights and efficiencies across the organizations of these companies. We believe that all these trends will continue for the next few years, and the challenges involved in adopting Industry 4.0 and secure cloud

computing will create opportunities for our combination of advanced analytics capabilities, proven and established supporting infrastructure, and professional services to configure our products to meet customers' specialized needs.

Other trends may continue to affect our characterization services business and Integrated Yield Ramp revenue specifically. The logic foundry market at the leading edge nodes, such as 10nm, 7nm, and smaller, underwent significant change over the past few years. The leading foundry continues to dominate market share as other foundries started later than originally forecast in some cases. This trend will likely continue to impact our characterization services business and Integrated Yield Ramp business on these nodes. We expect most logic foundries to invest in derivatives of older process nodes, such as 28nm and 14nm, to extract additional value as many of their customers will not move to advanced nodes due to either technological barriers or restrictive economics. Foundries that participate at leading edge nodes are expected to continue to invest in new technologies such as memory, packaging, and multi-patterned and EUV lithography, as well as new innovations in process control and variability management. We expect China's investment in semiconductors to continue. In order for these trends to provide opportunities for us to increase our business leveraging electrical characterization, Chinese semiconductors manufacturers will need to increase their production volumes on advanced technology nodes and continue to engage foreign suppliers, subject to compliance with changing U.S. export restrictions. As a result of these market developments, we have chosen to focus our resources and investments in products, services, and solutions for analytics.

There are other business trends that may affect our business opportunities generally. For instance, the demand for consumer electronics, communications devices, and high-performance computing continues to drive technological innovation in the semiconductor industry as the need for products with greater performance, lower power consumption, reduced costs, and smaller size continues to grow with each new product generation. In addition, advances in computing systems and mobile devices continue to fuel demand for higher capacity memory chips. To meet these demands, IC manufacturers and designers are constantly challenged to improve the overall performance of their ICs by designing and manufacturing ICs with more embedded applications to create greater functionality while lowering power and cost per transistor. As this trend continues, companies will continually be challenged to improve process capabilities to optimally produce ICs with minimal random and systematic yield loss, which is driven by the lack of compatibility between the design and its respective manufacturing process. We believe that these difficulties will continue to create a need for our products and services that address yield loss across the IC product life cycle.

The U.S. government continues to expand and intensify export controls and sanctions, including the addition of many P.R.C. companies to the U.S. Export Administration Regulations ("EAR") Entity List. These listings restrict supply to designees of items that are subject to the EAR. After an internal evaluation, we determined that a large percentage of our software products are not of U.S. origin and are, thus, not subject to the EAR. Our standard operations include development, distribution processes, software download sites, and professional service centers and processes located in various geographies around the world to better serve our customers. Some customers have nonetheless expressed concerns to us that continued action by the U.S. government could potentially interrupt their ability to make use of our products or services. The continuing tension between the U.S. and P.R.C. governments in trade and security matters or the perception of that tension could lead to disruptions or reductions in international trade, deter or prevent purchasing activity of customers, and negatively impact our China sales and financial results.

Cimetrix Acquisition

On December 1, 2020, we completed the acquisition of Cimetrix for approximately $31.6 million in cash consideration, net of cash on Cimetrix's balance sheet as of closing, and other closing adjustments, for all of the outstanding equity of Cimetrix. The combination of Cimetrix connectivity products with our Exensio platform, which leverages machine learning, is intended to enable IC, assembly, and equipment manufacturer customers to extract more intelligence from their tools, not just data, to build more reliable chips and systems at lower manufacturing costs. We accounted for this acquisition as a business combination in accordance with FASB ASC Topic 805, Business Combinations. For further information about this acquisition, see Note 4 of "Notes to Consolidated Financial Statements" (Item 8 of Part II of this Annual Report).

Financial Highlights

The following are our financial highlights for the year ended December 31, 2021:

- Total revenues were $111.1 million, an increase of $23.0 million, or 26%, compared to the year ended December 31, 2020. Analytics revenue was $93.4 million, an increase of $36.2 million, or 63%, compared to the year ended December 31, 2020. The increase in Analytics revenue was primarily driven by a $30.1 million increase in revenue, of which a substantial amount was from Cimetrix due to full year included results post acquisition and remainder was from Exensio software licenses due to higher demand from customers, and a $6.1 million increase in revenue from CV systems due to higher hours for characterization services worked across multiple contracts and customers. Integrated Yield Ramp revenue decreased $13.2 million, or 43%, compared to the year ended December 31, 2020, primarily due to a decrease in Gainshare royalty from certain customers due to the end of Gainshare periods on certain contracts and lower hours worked on other contracts.

- Costs of revenues increased $7.4 million for the year ended December 31, 2021, compared to the year ended December 31, 2020, primarily due to increased personnel-related costs due to higher headcount resulting from the acquisition of Cimetrix, cloud-delivery costs, software licenses costs, and amortization of acquired intangible assets. These increases were partially offset by decreases in facilities and information technology-related costs and due to the timing of deferral of contract costs.

- Net loss was $21.5 million, compared to $40.4 million for the year ended December 31, 2020. The decrease in net loss was primarily attributable to increases in total revenues and other income, and a $19.1 million decrease in income tax expense, partially offset by increases in costs of revenues and operating expenses. Our income tax expense in fiscal 2020 was higher due primarily to the recognition of a full valuation allowance against our U.S. net deferred tax assets. Increases in operating expenses were related primarily to our research and development, sales and marketing activities, general and administrative expenses primarily due to increase in personnel-related costs due primarily to higher headcount as a result of the Cimetrix acquisition, subcontractor costs, facilities and information technology-related costs, fees for legal services for the arbitration proceeding over a disputed customer contract, amortization expense of acquired intangible assets, and a write-down in value of property and equipment.

- Cash, cash equivalents and short-term investments decreased $5.1 million to $140.2 million at December 31, 2021, from $145.3 million at December 31, 2020, primarily due to repurchases of common stock, cash used to purchase property and equipment, payment for taxes related to net share settlement of equity awards, payment of the holdback amount to Cimetrix shareholders, partially offset by cash provided by operating activities and proceeds from the exercise of stock options and proceeds from purchases under our employee stock purchase plans.

Critical Accounting Policies and Estimates

The preparation of financial statements and related disclosures in conformity with accounting principles generally accepted in the United States requires us to make judgments, assumptions, and estimates that affect the amounts reported in the Consolidated Financial Statements and accompanying notes. Notes 1 and 2 of Notes to Consolidated Financial Statements describe the significant accounting policies and methods used in the preparation of the Consolidated Financial Statements. We consider the accounting policies described below to be our critical accounting policies. These critical accounting policies are impacted significantly by judgments, assumptions, and estimates used in the preparation of the Consolidated Financial Statements and actual results could differ materially from the amounts reported based on these policies.

Revenue Recognition

We derive revenue from two sources: Analytics and Integrated Yield Ramp.

Analytics Revenue

Analytics revenue is derived from the following primary offerings: licenses and services for standalone Software (which consists primarily of Exensio and Cimetrix products), SaaS (which consists primarily of Exensio products), and DFI and CV systems (including Characterization services) that do not include performance incentives based on customers' yield achievement.

Revenue from standalone software is recognized depending on whether the license is perpetual or time-based. Perpetual (one-time charge) license software is recognized at the time of the inception of the arrangement when control transfers to the customers, if the software license is distinct from the services offered by us. Revenue from post-contract support is recognized over the contract term on a straight-line basis, because we are providing (i) support and (ii) unspecified software updates on a when-and-if available basis over the contract term. Revenue from time-based-licensed software is allocated to each performance obligation and is recognized either at a point in time or over time as follows. The license component is recognized at the time when control transfers to customers, with the post-contract support component recognized ratably over the committed term of the contract. For contracts with any combination of licenses, support, and other services, distinct performance obligations are accounted for separately. For contracts with multiple performance obligations, we allocate the transaction price of the contract to each performance obligation on a relative basis using the standalone selling price ("SSP") attributed to each performance obligation.

Revenue from SaaS arrangements, which allow for the use of a cloud-based software product or service over a contractually determined period of time without taking possession of software, is accounted for as subscriptions and is recognized as revenue ratably, on a straight-line basis, over the subscription period beginning on the date the service is first made available to customers.

Revenue from DFI systems and CV systems (including Characterization services) that do not include performance incentives based on customers' yield achievement is recognized primarily as services are performed. Where there are distinct performance obligations, we allocate revenue to all deliverables based on their SSPs. For these contracts with multiple performance obligations, we allocate the transaction price of the contract to each performance obligation on a relative basis using SSP attributed to each performance obligation. Where there are not discrete performance obligations, historically, revenue is primarily recognized as services are performed using a percentage of completion method based on costs or labor-hours inputs, whichever is the most appropriate measure of the progress towards completion of the contract. The estimation of percentage of completion method is complex and subject to many variables that require significant judgment.

Integrated Yield Ramp Revenue

Integrated Yield Ramp revenue is derived from our yield ramp engagements that include Gainshare or other performance incentives based on customers' yield achievement.

Revenue under these project–based contracts, which are delivered over a specific period of time typically for a fixed fee component paid on a set schedule, is recognized as services are performed using a percentage of completion method based on costs or labor-inputs, whichever is the most appropriate measure of the progress towards completion of the contract. Where there are distinct performance obligations, we allocate revenue to all deliverables based on their SSPs and allocate the transaction price of the contract to each performance obligation on a relative basis using SSP. Similar to the services provided in connection with DFI systems and CV systems that are contributing to Analytics revenue, due to the nature of the work performed in these arrangements, the estimation of percentage of completion method is complex and subject to many variables that require significant judgment.

The Gainshare royalty contained in yield ramp contracts is a variable fee related to continued usage of our IP after the fixed-fee service period ends, based on the customers' yield achievement. Revenue derived from Gainshare is contingent

upon our customers reaching certain defined production yield levels. Gainshare royalty periods are generally subsequent to the delivery of all contractual services and performance obligations. We record Gainshare as a usage-based royalty derived from customers' usage of intellectual property and record it in the same period in which the usage occurs.

Income Taxes

We are required to assess whether it is "more-likely-than-not" that we will realize our deferred tax assets. If we believe that they are not likely to be fully realizable before the expiration dates applicable to such assets, then to the extent we believe that recovery is not likely, we must establish a valuation allowance. Based on all available evidence, both positive and negative, we determined a full valuation allowance was still appropriate for our U.S. federal and state net deferred tax assets ("DTAs"), primarily driven by a cumulative loss incurred over the 12-quarter period ended December 31, 2021, and the likelihood that we may not utilize tax attributes before they expire. The valuation allowance was approximately $51.6 million and $41.9 million as of December 31, 2021 and 2020, respectively. We will continue to evaluate the need for a valuation allowance and may change our conclusion in a future period based on changes in facts (e.g., 12-quarter cumulative profit, significant new revenue, etc.). If we conclude that we are more likely than not to utilize some or all of our U.S. DTAs, we will release some or all of our valuation allowance and our tax provision will decrease in the period in which we make such determination.

We evaluate our DTAs for realizability considering both positive and negative evidence, including our historical financial performance, projections of future taxable income, future reversals of existing taxable temporary differences, tax planning strategies and any carryback availability. In evaluating the need for a valuation allowance, we estimate future taxable income based on management approved business plans. This process involves significant management judgment about assumptions that are subject to change from period to period based on changes in tax laws or variances between future projected operating performance and actual results. Changes in the net DTAs, less offsetting valuation allowance, in a period are recorded through the income tax provision and could have a material impact on the Consolidated Statements of Comprehensive Loss.

Our income tax calculations are based on application of applicable U.S. federal, state, or foreign tax law. Our tax filings, however, are subject to audit by the respective tax authorities. Accordingly, we recognize tax liabilities based upon our estimate of whether, and the extent to which, additional taxes will be due when such estimates are more-likely-than-not to be sustained. An uncertain income tax position will not be recognized if it has less than a 50% likelihood of being sustained. To the extent the final tax liabilities are different than the amounts originally accrued, the increases or decreases are recorded as income tax expense or benefit in the Consolidated Statements of Comprehensive Loss. At December 31, 2021, no deferred taxes have been provided on undistributed earnings from our international subsidiaries. We intend to reinvest the earnings of our non-U.S. subsidiaries in those operations indefinitely. As such, we have not provided for any foreign withholding taxes on the earnings of foreign subsidiaries as of December 31, 2021. The earnings of our foreign subsidiaries are taxable in the U.S. in the year earned under the Global Intangible Low-Taxed Income rules implemented under 2017 Tax Cuts and Jobs Act.

On March 11, 2021, the American Rescue Plan Act of 2021 ("American Rescue Plan") was signed into law to provide additional relief in connection with the ongoing COVID-19 pandemic. The American Rescue Plan includes, among other things, provisions relating to Paycheck Protection Program (PPP) loan expansion, defined pension contributions, excessive employee remuneration, and the repeal of the election to allocate interest expense on a worldwide basis. Under ASC 740 the effects of new legislation are recognized upon enactment. Accordingly, the American Rescue Plan became effective beginning in the quarter ended March 31, 2021. Such provisions did not have a material impact on the Company's consolidated financial statements.

Software Development Costs

Internally developed software is software developed to meet our internal needs to provide certain services to our customers. Our capitalized software development costs consist of internal compensation related costs and external direct costs incurred during the application development stage and are amortized over their useful lives, which is generally five to six years. The costs to develop software that is marketed externally have not been capitalized as we believe our current software development process is essentially completed concurrent with the establishment of technological feasibility. As

such, all related software development costs are expensed as incurred and included in research and development expense in our Consolidated Statements of Comprehensive Loss.

Stock-Based Compensation

We account for stock-based compensation using the fair value method, which requires us to measure stock-based compensation based on the grant-date fair value of the awards and recognize the compensation expense over the requisite service period. As stock-based compensation expense recognized is based on awards ultimately expected to vest, it has been reduced for estimated forfeitures. Forfeitures are estimated at the time of grant and revised, if necessary, in subsequent periods if actual forfeitures differ from those estimates.

The fair value of our restricted stock units is equal to the market value of our common stock on the date of the grant. These awards are subject to time-based vesting which generally occurs over a period of four years.

The fair value of our stock options is estimated using the Black-Scholes-Merton option-pricing model, which incorporates various assumptions including volatility, expected life and interest rates. The expected volatility is based on the historical volatility of our common stock over the most recent period commensurate with the estimated expected life of our stock options. The expected life is based on historical experience and on the terms and conditions of the stock options granted. The interest rate assumption is based upon observed Treasury yield curve rates appropriate for the expected life of our stock options.

Business Combinations

We allocate the fair value of purchase consideration to the tangible assets acquired, liabilities assumed and intangible assets acquired based on their estimated fair values at the date of the business combination. The excess of the fair value of purchase consideration over the fair values of these identifiable assets and liabilities is recorded as goodwill. Such valuations require us to make significant estimates and assumptions, especially with respect to intangible assets. Significant estimates in valuing certain intangible assets include, but are not limited to, estimated replacement costs and future expected cash flows from acquired customers, acquired technology, acquired patents, and trade names from a market participant perspective, useful lives and discount rates. The estimates of fair value are based upon assumptions believed to be reasonable, but which are inherently uncertain and unpredictable and, as a result, actual results may differ from estimates. Allocation of purchase consideration to identifiable assets and liabilities affects our amortization expense, as acquired finite-lived intangible assets are amortized over the useful life, whereas any indefinite lived intangible assets, including IPR&D and goodwill, are not amortized. During the measurement period, which is not to exceed one year from the acquisition date, we record adjustments to the assets acquired and liabilities assumed, with the corresponding offset to goodwill. Upon the conclusion of the measurement period, any subsequent adjustments are recorded to earnings in the Consolidated Statements of Comprehensive Loss.

As part of a prior acquisition, we recorded at the time of the acquisition acquired IPR&D for a project in progress that had not yet reached technological feasibility. Acquired IPR&D is initially accounted for as an indefinite-lived intangible asset and tested annually for impairment. Once the acquired IP R&D asset becomes available for use, it will be amortized over the estimated useful life or will be written off upon abandonment.

Valuation of Long-lived Assets including Goodwill and Intangible Assets

We record goodwill when the purchase consideration of an acquisition exceeds the fair value of the net tangible and identified intangible assets as of the date of acquisition. We have one operating segment and one operating unit. We perform an annual impairment assessment of goodwill during the fourth quarter of each calendar year or more frequently, if required to determine if any events or circumstances exist, such as an adverse change in business climate or a decline in the overall industry demand, that would indicate that it would more likely than not reduce the fair value of a reporting unit below its carrying amount, including goodwill. If events or circumstances do not indicate that the fair value of a reporting unit is below its carrying amount, then goodwill is not considered to be impaired and no further testing is required. If the carrying amount exceeds its fair value, an impairment loss would be recognized equal to the amount of excess, limited to the amount of total goodwill. There was no impairment of goodwill for the year ended December 31, 2021 and 2020.

Our long-lived assets, excluding goodwill, consist of property, equipment, and intangible assets. We periodically review our long-lived assets for impairment. For assets to be held and used, we initiate our review whenever events or changes in circumstances indicate that the carrying amount of a long-lived asset group may not be recoverable. Recoverability of an asset group is measured by comparison of its carrying amount to the expected future undiscounted cash flows that the asset group is expected to generate. If it is determined that an asset group is not recoverable, an impairment loss is recorded in the amount by which the carrying amount of the asset group exceeds its fair value. There was no impairment of intangible assets for the year ended December 31, 2021 and 2020. In fiscal 2021, we wrote down the value of property and equipment aggregating $3.2 million pertaining to our first-generation of e-beam tools for DFI™ systems where carrying values may not be fully recoverable due to lack of market demand and future needs of our customers for these tools.

Leases

We have operating leases for our administrative and sales offices, research and development laboratory and clean room. We recognize our long-term operating lease rights and commitments as operating lease right-of-use assets, operating lease liabilities and operating lease liabilities, non-current, respectively, on our Consolidated Balance Sheets.

We determine if an arrangement is, or contains, a lease at inception. Operating lease right-of-use assets, and operating lease liabilities are initially recorded based on the present value of lease payments over the lease term. Lease terms include the minimum unconditional term of the lease, and may include options to extend or terminate the lease when it is reasonably certain at the commencement date that such options will be exercised. The decision to include these options involves consideration of our overall future business plans and other relevant business economic factors that may affect our business. Since the determination of the lease term requires an application of judgment, lease terms that differ in reality from our initial judgment may potentially have a material impact on our Consolidated Balance Sheets. In addition, our leases do not provide an implicit rate. In determining the present value of our expected lease payments, the discount rate is calculated using our incremental borrowing rate determined based on the information available, which requires additional judgment.

Recent Accounting Pronouncements and Accounting Changes

See our Note 1, “Description of Business and Summary of Significant Accounting Policies” of “Notes to Consolidated Financial Statements” included under Part II, Item 8 of this Form 10-K for a description of recent accounting pronouncements and accounting changes, including the expected dates of adoption and estimated effects, if any, on our consolidated financial statements.

Results of Operations

Discussion of Financial Data for the years ended December 31, 2021 and 2020

Revenues, Costs of Revenues, and Gross Margin

	Year Ended December 31,		$ Change	% Change
(Dollars in thousands)	**2021**	**2020**	**2020 to 2021**	
Revenues:				
Analytics	$ 93,415	$ 57,232	$ 36,183	63 %
Integrated Yield Ramp	17,645	30,814	(13,169)	(43)%
Total revenues	$ 111,060	$ 88,046	$ 23,014	26 %
Costs of revenues	44,193	36,765	7,428	20 %
Gross profit	$ 66,867	$ 51,281	$ 15,586	30 %
Gross margin	60 %	58 %		
Analytics revenue as a percentage of total revenues	84 %	65 %		
Integrated Yield Ramp revenue as a percentage of total revenues	16 %	35 %		

Analytics Revenue

Analytics revenue was $93.4 million, an increase of $36.2 million, or 63%, compared to the year ended December 31, 2020. The increase in Analytics revenue was primarily driven by a $30.1 million increase in revenue, of which a substantial amount was from Cimetrix due to full year included results post acquisition and remainder was from Exensio software licenses due to higher demand from customers, and a $6.1 million increase in revenue from CV systems due to higher hours worked across multiple contracts and customers.

Integrated Yield Ramp Revenue

Integrated Yield Ramp revenue was $17.6 million for the year ended December 31, 2021, a decrease of $13.2 million, compared to the year ended December 31, 2020, primarily due to a decrease in Gainshare royalty due to the end of Gainshare periods from certain contracts and lower hours worked on other contracts. Our Integrated Yield Ramp revenue may continue to fluctuate from period to period primarily due to the contribution of Gainshare royalty, which is dependent on many factors that are outside our control, including among others, continued production of ICs by our customers at facilities at which we generate Gainshare, sustained yield improvements by our customers, and whether we enter into new contracts containing Gainshare.

Our revenues may also fluctuate in the future due to other factors, including the semiconductor industry’s continued acceptance of our products, services and solutions, the timing of purchases by existing and new customers, cancellations by existing customers, our ability to attract new customers and penetrate new markets, supply chain challenges and further penetration of our current customer base. Fluctuations in future results may also occur if any of our significant customers renegotiate pre-existing contractual commitments, including due to adverse changes in their own business.

Costs of Revenues

Costs of revenues consist primarily of costs incurred to provide and support our services, costs recognized in connection with licensing our software, and amortization of acquired technology. Services costs include material, employee compensation and related benefits including stock-based compensation expense, subcontractor costs, overhead costs, travel, and allocated facilities-related costs. Software license costs consist of costs associated with cloud-delivery related expenses and licensing third-party software used by us in providing services to our customers in solution engagements or sold in conjunction with our software products.

The increase in costs of revenues of $7.4 million for the year ended December 31, 2021, compared to the year ended December 31, 2020, was primarily due to (i) a $5.6 million increase in personnel-related costs due to higher headcount as a result of the Cimetrix acquisition, higher benefit costs, and merit increases, partially offset by a decrease in stock-based compensation expense, (ii) a $2.2 million increase in third-party cloud-delivery costs, software licenses costs, and hardware costs, and (iii) a $1.4 million increase in amortization of acquired intangible assets. These were partially offset by (i) a $1.0 million decrease in facilities and information technology-related costs including depreciation expense, (ii) a $0.4 million decrease due to the timing of deferral of contract costs, and (iii) a $0.3 million decrease in other expenses.

Gross Margin

Gross margin for the year ended December 31, 2021, was 60% compared to 58% for the year-ago period, or an increase of 2%. The higher gross margin during year ended December 31, 2021, was primarily due to higher total revenue growth and decreases in certain costs of revenues, as discussed above, which decreased the costs of revenues as a percentage of total revenues, when compared to the year-ago period.

Operating Expenses:

Research and Development

(Dollars in thousands)	Year Ended December 31, 2021	2020	$ Change 2020 to 2021	% Change 2020 to 2021
Research and development	$ 43,780	$ 34,654	$ 9,126	26 %
As a percentage of total revenues	*39 %*	*39 %*		

Research and development expenses consist primarily of personnel-related costs including compensation, benefits and stock-based compensation expense, outside development services, travel, third-party cloud-services related costs, and facilities cost allocations to support product development activities.

Research and development expenses increased 26% for the year ended December 31, 2021, compared to the year-ago period, primarily due to (i) a $6.6 million increase in personnel-related costs due to higher headcount as a result of the Cimetrix acquisition, higher benefit costs, merit increases and higher stock-based compensation expense, (ii) a $2.6 million increase in subcontractor expenses primarily related to our characterization services and Exensio and Cimetrix software, (iii) a $0.4 million increase in third-party cloud-services related costs, and (iv) a $0.3 million increase in facilities and information technology-related costs. These were partially offset by (i) a $0.4 million decrease in software maintenance expense and (ii) a $0.4 million decrease in various other expenses.

We anticipate our expenses in research and development will fluctuate in absolute dollars from period to period as a result of the size and the timing of product development projects.

Selling, General and Administrative

(Dollars in thousands)	Year Ended December 31, 2021	2020	$ Change 2020 to 2021	% Change 2020 to 2021
Selling, general and administrative	$ 37,649	$ 32,677	$ 4,972	15 %
As a percentage of total revenues	*34 %*	*37 %*		

Selling, general and administrative expenses consist primarily of compensation, benefits and stock-based compensation expense for sales, marketing and general and administrative personnel, legal and accounting services, marketing communications expenses, third-party cloud-services related costs, travel and facilities cost allocations.

Selling, general, and administrative expenses increased 15% for the year ended December 31, 2021, compared to the year-ago period, primarily due to (i) a $4.1 million increase in personnel-related costs due to higher headcount as a result of the Cimetrix acquisition, higher benefit costs, merit increases and higher stock-based compensation expense, (ii) a $1.5 million increase in facilities and information technology-related costs including rent and depreciation expense, (iii) a $0.9 million increase in legal fees related to the arbitration proceeding over a disputed customer contract, and (iv) a $0.5 million increase in third-party cloud-services related costs. These were partially offset by (i) a $1.5 million decrease in acquisition related costs, and (ii) a $0.6 million decrease in general legal expenses.

We anticipate our selling, general and administrative expenses will fluctuate in absolute dollars from period to period as a result of cost control initiatives and to support increased selling efforts in the future.

Amortization of acquired intangible assets

(Dollars in thousands)	Year Ended December 31, 2021	Year Ended December 31, 2020	$ Change 2020 to 2021	% Change 2020 to 2021
Amortization of acquired intangible assets	$ 1,255	$ 741	$ 514	69 %

Amortization of acquired intangible assets consists of amortization of intangibles acquired as a result of certain business combinations. The increase in amortization of acquired intangible assets for the year ended December 31, 2021, compared to the year ended December 31, 2020, was primarily related to amortization of acquired intangible assets in the acquisition of Cimetrix.

Write-down in value of property and equipment

(Dollars in thousands)	Year Ended December 31, 2021	Year Ended December 31, 2020	$ Change 2020 to 2021	% Change 2020 to 2021
Write-down in value of property and equipment	$ 3,183	$ —	$ 3,183	100 %

In fiscal 2021, we wrote down the value of property and equipment aggregating $3.2 million pertaining to our first-generation of e-beam tools for DFI™ systems where carrying values may not be fully recoverable due to lack of market demand and future needs of our customers for these tools.

Interest and Other Expense (Income), Net

(Dollars in thousands)	Year Ended December 31, 2021	Year Ended December 31, 2020	$ Change 2020 to 2021	% Change 2020 to 2021
Interest and other expense (income), net	$ (683)	$ 1,269	$ (1,952)	(154)%

Interest and other expense (income), net primarily consists of interest income, gains, and losses from foreign currency forward contracts, and foreign currency transaction exchange gains and losses.

Interest and other expense (income), net resulted in income for the year ended December 31, 2021, compared to a loss in the year-ago period, primarily due to higher net favorable fluctuations in foreign exchange rates, and a decrease in loss related to foreign currency forward contracts, partially offset by a decrease in interest income due to lower interest rates and a decrease in other income.

Income Tax Expense

(Dollars in thousands)	Year Ended December 31, 2021	Year Ended December 31, 2020	$ Change 2020 to 2021	% Change 2020 to 2021
Income tax expense	$ 3,171	$ 22,303	$ (19,132)	(86)%

Income tax expense decreased for the year ended December 31, 2021, compared to the year-ago period. Our income tax expense in fiscal 2020 was significantly higher due primarily to the recognition of a full valuation allowance against our U.S. net deferred tax assets due to the uncertainty of the ultimate realization of the future benefits of such deferred tax assets.

Any significant change in our future effective tax rates could adversely impact our consolidated financial position, results of operations and cash flows. Our future tax rates may be adversely affected by a number of factors including increase in expenses not deductible for tax purposes, tax legislations in the United States and in foreign countries where we are subject to tax jurisdictions, the geographic composition of our pre-tax income, the amount of our pre-tax income as business activities fluctuate, our ability to use tax attributes such as research and development tax credits and net operation losses, the tax effects of employee stock activity, audit examinations with adverse outcomes, changes in general accepted accounting principles and the effectiveness of our tax planning strategies.

Discussion of Financial Data for the years ended December 31, 2020 and 2019

For a discussion of our results of operations for the years ended December 31, 2020 and 2019, please see our Annual Report on Form 10-K for the year ended December 31, 2020, filed with the SEC on March 11, 2021.

Liquidity and Capital Resources

As of December 31, 2021, our working capital, defined as total current assets less total current liabilities, was $144.7 million, compared to $151.2 million as of December 31, 2020. Cash, cash equivalents and short-term investments, on a consolidated basis, were $140.2 million as of December 31, 2021, compared to $145.3 million as of December 31, 2020. As of December 31, 2021 and 2020, cash and cash equivalents held by our foreign subsidiaries were $5.3 million and $4.0 million, respectively. We believe that our existing cash resources and anticipated funds from operations will satisfy our cash requirements to fund our operating activities, capital expenditures, and other obligations, for at least the next twelve months.

There has been no significant impact to our liquidity and capital resources from the global COVID-19 pandemic. For risk discussion about the continuing impact of global COVID-19 pandemic on our operations or demand for our products, refer to Item 1A, Risk Factors on Part I of this Annual Report.

Cimetrix Acquisition

On December 1, 2020, the Company completed the acquisition of Cimetrix with total payments made in fiscal 2021 and 2020 of $31.6 million, net of cash acquired. The net cash payment for this acquisition which also include the settlement of adjusted Holdback Amount, as discussed below, was funded from the available cash of the Company.

In 2020, the Company held back $3.5 million of the purchase price (the “Holdback Amount”) to satisfy adjustments and claims for indemnity arising out of breaches of certain representations, warranties and covenants, and certain other enumerated items in the merger agreement. The Holdback Amount was recorded under accrued and other current liabilities account and the corresponding restricted cash was included in the “Prepaid expenses and other current assets” account in the 2020 Consolidated Balance Sheet. During 2021, the Company recorded a measurement period adjustment that reduced the Holdback Amount to $3.1 million. The measurement period adjustment did not have an impact on the Company’s Consolidated Statement of Comprehensive Loss during the year ended December 31, 2021. The Holdback Amount, as adjusted, was paid to the participating equity holders in December 2021. See Note 4 of “Notes to Consolidated Financial Statements” (Item 8 of Part II of this Annual Report) for further discussion.

Repurchase of Company’s Common Stock

On June 4, 2020, the Company’s Board of Directors adopted a stock repurchase program (the “2020 Program”) to repurchase up to $25.0 million of the Company’s common stock both on the open market and in privately negotiated transactions, including through Rule 10b5-1 plans, over the next two years. During the year ended December 31, 2021, 251,212 shares were repurchased under the 2020 Program at an average price of $18.01 per share, for a total price of $4.5 million under the 2020 Program.

Consolidated Statements of Cash Flows Data

	Year Ended December 31,		$ Change
	2021	**2020**	**2020 to 2021**
(In thousands)			
Net cash flows provided by (used in):			
Operating activities	$ 4,243	$ 21,783	$ (17,540)
Investing activities	(4,667)	(150,502)	145,835
Financing activities	(5,525)	64,798	(70,323)
Effect of exchange rate changes on cash and cash equivalents	(182)	131	(313)
Net decrease in cash, cash equivalents, and restricted cash	$ (6,131)	$ (63,790)	$ 57,659

Net Cash Provided by Operating Activities

Cash flow from operating activities during 2021 mostly consisted of net loss from operations, adjusted for certain non-cash items, which primarily consisted of depreciation and amortization, share-based compensation expense, write-down in value of property and equipment, changes in deferred tax assets, and changes in operating assets and liabilities.

Cash generated from operating activities decreased by $17.5 million for the year ended December 31, 2021, compared to the year ended December 31, 2020, driven primarily by (i) a $21.6 million increase in net change in operating assets and liabilities, (ii) a $14.8 million decrease in non-cash adjustments to net loss, primarily due to a decrease in changes of deferred taxes of $19.6 million, an increase in write-down in value of property and equipment of $2.7 million, and an increase in amortization of acquired intangible assets of $1.9 million. These increases were partially offset by an $18.9 million decrease in net loss.

The major contributors to the net change in operating assets and liabilities for the year ended December 31, 2021, were as follows:

- Accounts receivable increased by $6.0 million, primarily due to an increase in sales and higher contractual invoicing activity during the fourth quarter of 2021;

- Prepaid expense and other current assets decreased by $1.1 million, primarily due to the timing of billing of contract assets related to fixed-price service contracts, and a decrease in income tax receivables, partially offset by an increase in prepaid expenses related to third party software licenses and cloud-subscription related costs;

- Other non-current assets increased by $1.3 million, primarily due to an increase in capitalized direct sales commission costs and prepaid expenses related to third party software licenses and cloud-subscription related costs;

- Accrued compensation and related benefits increased by $1.3 million, primarily due to the timing of payments of accrued bonuses, accrued sales commissions and accrued payroll taxes, and an increase in contributions to employee stock purchase plans, partially offset by a decreased in accrued vacation;

- Deferred revenues increased by $5.0 million primarily due to timing of billing and revenue recognition, and

- Billings in excess of recognized revenues decreased by $1.3 million, primarily due to the timing of billing and revenue recognition.

Net Cash Used in Investing Activities

Net cash used in investing activities in the year ended December 31, 2021, decreased by $145.8 million compared to the year ended December 31, 2020.

For the year ended December 31, 2021, cash used in investing activities primarily related to (i) purchases of $168.6 million short-term investments, (ii) a $3.1 million payment of the Holdback Amount related to the acquisition of Cimetrix, (refer to above discussion on Cimetrix Acquisition for further details), and (iii) a $4.1 million equipment purchased and prepayment property and equipment, primarily related to our DFI systems, including construction of additional second-generation eProbe tools, partially offset by $171.0 million proceeds from maturities of short-term investments.

For the year ended December 31, 2020, cash used in investing activities primarily related to (i) purchases of $131.5 million short-term investments, (ii) a $28.6 million payment for the acquisition of Cimetrix, and (iii) a $7.0 million for equipment purchased and prepayment property and equipment, primarily related to our DFI systems, including construction of additional second-generation eProbe tools, partially offset by $16.5 million proceeds from maturities of short-term investments.

Net Cash Provided by (Used in) Financing Activities

Net cash used in financing activities was $5.5 million for the year ended December 31, 2021, compared to net cash provided by financing activities of $64.8 million for the year ended December 31, 2020.

For the year ended December 31, 2021, net cash used in financing activities primarily consisted of $4.5 million for the repurchase of shares of our common stock and $4.0 million in cash payments for taxes related to net share settlement of equity awards, partially offset by $3.0 million of proceeds from purchases under our employee stock purchase plans and the exercise of stock options.

For the year ended December 31, 2020, net cash provided by financing activities primarily consisted of $65.1 million net proceeds from the issuance of common stock in connection with the Securities Purchase Agreement with Advantest, and $4.2 million of proceeds from purchases under our employee stock purchase plan and the exercise of stock options, partially offset by $4.5 million in cash payments for taxes related to net share settlement of equity awards.

Related Party Transactions

Refer to Note 3, Strategic Partnership Agreement with Advantest and Related Party Transactions of the Notes to Consolidated Financial Statements (Item 8 of Part II of this Annual Report) for a discussion on related party transactions between the Company and Advantest.

Off-Balance Sheet Arrangements

We do not have any off-balance sheet arrangements, investments in special purpose entities or undisclosed borrowings or debt.

Contractual Obligations

The following table summarizes our known contractual obligations as of December 31, 2021 (in thousands):

	Payments Due by Period						
Contractual Obligations	**2022**	**2023**	**2024**	**2025**	**2026**	**2027 and thereafter**	**Total**
Operating lease obligations (1)	$ 1,825	$ 1,217	$ 807	$ 823	$ 789	$ 1,365	$ 6,826
Purchase obligations (2)	7,448	824	320	321	—	—	8,913
Total (3)	$ 9,273	$ 2,041	$ 1,127	$ 1,144	$ 789	$ 1,365	$ 15,739

(1) Refer to Note 7 of "Notes to Consolidated Financial Statements" (Item 8 of Part II of this Annual Report) for further discussion.

(2) Purchase obligations consist of agreements to purchase goods and services entered in the ordinary course of business.

(3) The contractual obligation table above excludes liabilities for uncertain tax positions of $2.6 million, which are not practicable to assign to any particular years due to the inherent uncertainty of the tax positions. See Note 11 of "Notes to Consolidated Financial Statements" (Item 8 of Part II of this Annual Report) for further discussion.

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

The following discusses our exposure to market risk related to changes in interest rates and foreign currency exchange rates. We do not currently own any equity investments, nor do we expect to own any in the foreseeable future. This discussion contains forward-looking statements that are subject to risks and uncertainties. Actual results could vary materially as a result of a number of factors.

Interest Rate Risk. As of December 31, 2021, we had cash and cash equivalents and short-term investments of $140.2 million. Cash and cash equivalents consisted of cash and highly liquid money market instruments and short-term investments consisted of U.S. Government securities. We would not expect our operating results or cash flows to be affected to any significant degree by the effect of a sudden change in market interest on our portfolio. A hypothetical increase in market interest rates of 100 basis points from the market rates in effect at December 31, 2021, would cause the fair value of these investments to decrease by an immaterial amount which would not have significantly impacted our financial position or results of operations.

At December 31, 2021 and periodically throughout the year, we have maintained cash balances in various operating accounts in excess of federally insured limits. We limit the amount of credit exposure to any financial institution by evaluating the creditworthiness of the financial institutions with which we invest and investing through more than one financial institution.

Foreign Currency and Exchange Risk. Certain of our receivables and payables for our international offices are denominated in the local currency, including the Euro, Yen and RMB. Therefore, a portion of our revenues and operating expenditures are subject to foreign currency risks. From time to time, we enter into foreign currency forward contracts to reduce the exposure to foreign currency exchange rate fluctuations on certain foreign currency denominated monetary assets and liabilities. We do not use foreign currency forward contracts for speculative or trading purposes. We record these forward contracts at fair value. The counterparty to these foreign currency forward contracts is a financial institution that we believe is creditworthy, and therefore, we believe the credit risk of counterparty non-performance is not significant. The change in fair value of these contracts is recorded into earnings as a component of other income (expense), net and offsets the change in fair value of foreign currency denominated monetary assets and liabilities, which is also recorded in other income (expense), net. As of December 31, 2021, we had no outstanding forward contracts.

Item 8. ***Financial Statements and Supplementary Data***

REPORT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

To the Board of Directors and Stockholders of
PDF Solutions, Inc.

Opinion on the Consolidated Financial Statements

We have audited the accompanying consolidated balance sheets of PDF Solutions, Inc. (a Delaware corporation) and its subsidiaries (the "Company") as of December 31, 2021 and 2020, and the related consolidated statements of comprehensive loss, stockholders' equity, and cash flows for each of the years in the two-year period ended December 31, 2021, and the related notes (collectively referred to as the "consolidated financial statements"). In our opinion, the consolidated financial statements present fairly, in all material respects, the financial position of the Company as of December 31, 2021 and 2020, and the results of its operations and its cash flows for each of the two years in the period ended December 31, 2021, in conformity with accounting principles generally accepted in the United States of America.

We also have audited, in accordance with the standards of the Public Company Accounting Oversight Board (United States) ("PCAOB"), the Company's internal control over financial reporting as of December 31, 2021, based on criteria established in *Internal Control—Integrated Framework (2013)* issued by the Committee of Sponsoring Organizations of the Treadway Commission ("COSO"), and our report dated March 1, 2022, expressed an unqualified opinion.

Basis for Opinion

These consolidated financial statements are the responsibility of the Company's management. Our responsibility is to express an opinion on the Company's consolidated financial statements based on our audits. We are a public accounting firm registered with the PCAOB and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audits in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the consolidated financial statements are free of material misstatement, whether due to error or fraud. Our audits included performing procedures to assess the risks of material misstatement of the consolidated financial statements, whether due to error or fraud, and performing procedures that respond to those risks. Such procedures included examining, on a test basis, evidence regarding the amounts and disclosures in the consolidated financial statements. Our audits also included evaluating the accounting principles used and significant estimates made by management, as well as evaluating the overall presentation of the consolidated financial statements. We believe that our audits provide a reasonable basis for our opinion.

Critical Audit Matter

The critical audit matter communicated below is a matter arising from the current period audit of the consolidated financial statements that was communicated or required to be communicated to the audit committee and that: (1) relates to accounts or disclosures that are material to the consolidated financial statements and (2) involved our especially challenging, subjective, or complex judgments. The communication of critical audit matters does not alter in any way our opinion on the consolidated financial statements, taken as a whole, and we are not, by communicating the critical audit matter below, providing a separate opinion on the critical audit matter or on the accounts or disclosures to which it relates.

Revenue Recognition

As described in Note 2 to the consolidated financial statements, the Company derives revenue from Analytics and Integrated Yield Ramp Revenue. Contracts with customers can include various combinations of licenses, subscriptions, products and services, some of which are distinct and are accounted for as separate performance obligations. Significant judgment is exercised by the Company in determining revenue recognition for customer agreements, including determining whether licenses, subscriptions, and services are distinct performance obligations, determining the standalone selling price (or SSP) attributed to each performance obligation, establishing the pattern of delivery for each distinct performance

obligation, and estimating variable consideration when determining the amount of revenue to recognize. In addition, for revenue under project-based contracts for fixed-price services, revenue is recognized as services are performed using a percentage-of-completion (or POC) method based on costs or labor-hours input method. Estimated costs to complete each contract are based on i) future labor and product costs and ii) expected productivity efficiencies. Changes in these estimates can have a material effect on revenue recognized and/or related cost. Finally, the Company recognized Gainshare royalty revenue in the same period in which the usage occurs. The Company accrues the related revenue based on estimates of customers' underlying sales achievements. These estimates are based on historical data, trends, seasonality, changes in contract rate, knowledge of changes in the industry and changes in the customer's manufacturing environment learned through discussions with customers and sales personnel.

The principal audit considerations for our determination that performing procedures related to the Company's revenue recognition for customer agreements is a critical audit matter are the significant amount of judgment required by management in this process. Significant judgment is required in determining SSP as the Company rarely licenses software on a standalone basis, so the Company is required to estimate the range of SSPs for each performance obligation, which in turn led to significant auditor judgment, subjectivity and effort in performing audit procedures in assessing the allocation of SSPs to performance obligations. In addition, significant judgment is required in determining the total estimated contract costs for fixed-price contracts, which in turn led to significant auditor judgment, subjectivity, and effort in performing audit procedures and in evaluating audit evidence relating the total estimated contract costs. Significant judgment is also required in recording Gainshare royalty revenue in the same period in which the usage occurs. The Company generally does not receive the acknowledgment reports from customers during a given quarter, so the Company is required to accrue the related revenue based on estimates of customers underlying sales achievement, which in turn led to significant auditor judgment, subjectivity, and effort in evaluating the reasonableness of these estimates based on historical data, trends, seasonality and other factors.

Addressing the matter involved performing procedures and evaluating audit evidence in connection with forming our overall opinion on the consolidated financial statements. These procedures included testing the effectiveness of internal controls relating to the revenue recognition process, including internal controls related to (1) the identification of distinct performance obligations and data used to establish SSP for licenses, subscriptions, products and services, (2) project estimates to completion for fixed fee arrangements accounted for under POC and (3) estimates of Gainshare royalty revenue accrual and subsequent true-ups. These procedures also included, among others, evaluating management's significant accounting policies related to these customer agreements for reasonableness. In addition, for a sample of customer agreements, we obtained and read contract source documents, including master agreements and other documents that were part of the agreement, tested management's identification of significant terms for completeness, including the identification of distinct performance obligations and variable consideration, assessed the terms in the customer agreements and evaluated the appropriateness of management's application of their accounting policies, along with their use of estimates, in the determination of revenue recognition conclusions, and tested the mathematical accuracy of management's calculations of revenue and the associated timing of revenue recognized in the consolidated financial statements. In addition, we evaluated the reasonableness of management's estimates of SSP for projects and services that are not sold separately, where applicable, costs to complete for project-based contracts for fixed-price services and customers' underlying achievements for royalty revenue.

/s/ BPM LLP

We have served as the Company's auditor since 2018.

San Jose, CA
March 1, 2022

REPORT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

To the Board of Directors and Stockholders of
PDF Solutions, Inc.

Opinion on Internal Control over Financial Reporting

We have audited the internal control over financial reporting of PDF Solutions, Inc. (a Delaware corporation) and its subsidiaries (the "Company") as of December 31, 2021, based on criteria established in *Internal Control—Integrated Framework (2013)* issued by the Committee of Sponsoring Organizations of the Treadway Commission ("COSO"). In our opinion, the Company maintained, in all material respects, effective internal control over financial reporting as of December 31, 2021, based on criteria established in *Internal Control—Integrated Framework (2013)* issued by COSO.

We also have audited, in accordance with the standards of the Public Company Accounting Oversight Board (United States) ("PCAOB"), the consolidated balance sheets as of December 31, 2021 and 2020 and the related consolidated statements of comprehensive loss, stockholders' equity, and cash flows for each of the two years in the period ended December 31, 2021 and the related notes (collectively referred to as the "consolidated financial statements") of the Company, and our report dated March 1, 2022, expressed an unqualified opinion on those consolidated financial statements.

Basis for Opinion

The Company's management is responsible for maintaining effective internal control over financial reporting, and for its assessment of the effectiveness of internal control over financial reporting, included in the accompanying Management's Report on Assessment of Internal Controls Over Financial Reporting. Our responsibility is to express an opinion on the Company's internal control over financial reporting based on our audit. We are a public accounting firm registered with the PCAOB and are required to be independent with respect to the Company in accordance with the U.S. federal securities laws and the applicable rules and regulations of the Securities and Exchange Commission and the PCAOB.

We conducted our audit in accordance with the standards of the PCAOB. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether effective internal control over financial reporting was maintained in all material respects. Our audit of internal control over financial reporting included obtaining an understanding of internal control over financial reporting, assessing the risk that a material weakness exists, and testing and evaluating the design and operating effectiveness of internal control based on the assessed risk. Our audit also included performing such other procedures as we considered necessary in the circumstances. We believe that our audit provides a reasonable basis for our opinion.

Definition and Limitations of Internal Control over Financial Reporting

A company's internal control over financial reporting is a process designed to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles. A company's internal control over financial reporting includes those policies and procedures that (1) pertain to the maintenance of records that, in reasonable detail, accurately and fairly reflect the transactions and dispositions of the assets of the company; (2) provide reasonable assurance that transactions are recorded as necessary to permit preparation of financial statements in accordance with generally accepted accounting principles, and that receipts and expenditures of the company are being made only in accordance with authorizations of management and directors of the company; and (3) provide reasonable assurance regarding prevention or timely detection of unauthorized acquisition, use, or disposition of the company's assets that could have a material effect on the financial statements.

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

/s/ BPM LLP

San Jose, California
March 1, 2022

PDF SOLUTIONS, INC.
CONSOLIDATED BALANCE SHEETS
(in thousands, except par values)

	December 31,	
	2021	**2020**
ASSETS		
Current assets:		
Cash and cash equivalents	$ 27,684	$ 30,315
Short-term investments	112,542	114,981
Accounts receivable, net of allowance for doubtful accounts of $890 and $963 in 2021 and 2020, respectively	40,087	34,140
Prepaid expenses and other current assets	8,194	13,944
Total current assets	188,507	193,380
Property and equipment, net	35,295	39,242
Operating lease right-of-use assets, net	5,408	6,672
Goodwill	14,123	15,774
Intangible assets, net	21,239	24,573
Deferred tax assets, net	75	249
Other non-current assets	9,121	7,690
Total assets	$ 273,768	$ 287,580
LIABILITIES AND STOCKHOLDERS' EQUITY		
Current liabilities:		
Accounts payable	$ 5,554	$ 4,399
Accrued compensation and related benefits	9,495	8,339
Accrued and other current liabilities	3,328	6,309
Operating lease liabilities – current portion	1,758	1,926
Deferred revenues – current portion	23,691	19,895
Billings in excess of recognized revenues	—	1,337
Total current liabilities	43,826	42,205
Long-term income taxes payable	2,656	2,956
Non-current operating lease liabilities	5,258	6,516
Other non-current liabilities	2,443	1,397
Total liabilities	54,183	53,074
Commitments and contingencies (Note 8)		
Stockholders' equity:		
Preferred stock, $0.00015 par value, 5,000 shares authorized, no shares issued and outstanding	—	—
Common stock, $0.00015 par value, 70,000 shares authorized; shares issued 47,414 and 46,400, respectively; shares outstanding 37,411 and 36,850, respectively	6	6
Additional paid-in-capital	423,069	407,173
Treasury stock at cost, 10,003 and 9,550 shares, respectively	(104,705)	(96,215)
Accumulated deficit	(97,721)	(76,233)
Accumulated other comprehensive loss	(1,064)	(225)
Total stockholders' equity	219,585	234,506
Total liabilities and stockholders' equity	$ 273,768	$ 287,580

See accompanying notes to consolidated financial statements.

PDF SOLUTIONS, INC.
CONSOLIDATED STATEMENTS OF COMPREHENSIVE LOSS
(in thousands, except per share amounts)

	Year Ended December 31,	
	2021	**2020**
Revenues:		
Analytics	$ 93,415	$ 57,232
Integrated Yield Ramp	17,645	30,814
Total revenues	111,060	88,046
Costs and Expenses:		
Costs of revenues	44,193	36,765
Research and development	43,780	34,654
Selling, general and administrative	37,649	32,677
Amortization of acquired intangible assets	1,255	741
Write-down in value of property and equipment	3,183	—
Interest and other expense (income), net	(683)	1,269
Loss before income taxes	(18,317)	(18,060)
Income tax expense	3,171	22,303
Net loss	$ (21,488)	$ (40,363)
Other comprehensive income (loss):		
Foreign currency translation adjustments, net of tax	(825)	1,253
Change in unrealized losses related to available-for-sale debt securities, net of tax	(14)	2
Total other comprehensive income (loss)	(839)	1,255
Comprehensive loss	$ (22,327)	$ (39,108)
Net loss per share, basic and diluted	$ (0.58)	$ (1.17)
Weighted average common shares used to calculate net loss per share, basic and diluted	37,138	34,458

See accompanying notes to consolidated financial statements.

PDF SOLUTIONS, INC.
CONSOLIDATED STATEMENTS OF STOCKHOLDERS' EQUITY
(in thousands)

	Common Stock		Additional Paid-In Capital	Treasury Stock		Accumulated Deficit	Accumulated Other Comprehensive Loss	Total Stockholders' Equity
	Shares	Amount		Shares	Amount			
Balances, January 1, 2020	32,503	$ 5	$ 325,197	9,294	$ (91,695)	$ (35,870)	$ (1,480)	$ 196,157
Issuance of common stock, net of issuance of $0.1 million	3,307	1	65,077	—	—	—	—	65,078
Issuance of common stock in connection with employee stock purchase plan	183	—	1,670	—	—	—	—	1,670
Issuance of common stock in connection with exercise of options	246	—	2,570	—	—	—	—	2,570
Vesting of restricted stock units	611	—	—	—	—	—	—	—
Purchases of treasury stock in connection with tax withholdings on restricted stock grants	—	—	—	256	(4,520)	—	—	(4,520)
Stock-based compensation expense	—	—	12,659	—	—	—	—	12,659
Comprehensive income (loss)	—	—	—	—	—	(40,363)	1,255	(39,108)
Balances, December 31, 2020	36,850	6	407,173	9,550	(96,215)	(76,233)	(225)	234,506
Repurchase of common stock	(251)	—	—	251	(4,523)	—	—	(4,523)
Issuance of common stock in connection with employee stock purchase plan	109	—	1,035	—	—	—	—	1,035
Issuance of common stock in connection with exercise of options	216	—	1,930	—	—	—	—	1,930
Vesting of restricted stock units	487	—	—	—	—	—	—	—
Purchases of treasury stock in connection with tax withholdings on restricted stock grants	—	—	—	202	(3,967)	—	—	(3,967)
Stock-based compensation expense	—	—	12,931	—	—	—	—	12,931
Comprehensive loss	—	—	—	—	—	(21,488)	(839)	(22,327)
Balances, December 31, 2021	37,411	$ 6	$ 423,069	10,003	$ (104,705)	$ (97,721)	$ (1,064)	$ 219,585

See accompanying notes to consolidated financial statements.

PDF SOLUTIONS, INC.
CONSOLIDATED STATEMENTS OF CASH FLOWS
(in thousands)

	Year Ended December 31,	
	2021	**2020**
Cash flows from operating activities:		
Net loss	$ (21,488)	$ (40,363)
Adjustments to reconcile net loss to net cash provided by operating activities:		
Depreciation and amortization	6,218	6,725
Stock-based compensation expense	12,931	12,463
Amortization of acquired intangible assets	3,334	1,446
Amortization of costs capitalized to obtain revenue contracts	674	549
Loss on disposal and write-down in value of property and equipment	3,183	500
Deferred taxes	1,373	21,007
Other	147	(25)
Changes in operating assets and liabilities:		
Accounts receivable	(5,980)	8,101
Prepaid expenses and other current assets	1,136	(433)
Operating lease right-of-use assets	1,414	1,193
Other non-current assets	(1,336)	2,069
Accounts payable	(86)	(918)
Accrued compensation and related benefits	1,264	1,926
Accrued and other liabilities	(648)	928
Deferred revenues	5,028	7,755
Billings in excess of recognized revenues	(1,337)	220
Operating lease liabilities	(1,584)	(1,360)
Net cash provided by operating activities	4,243	21,783
Cash flows from investing activities:		
Proceeds from maturities of short-term investments	171,000	16,500
Purchases of short-term investments	(168,560)	(131,454)
Purchases of property and equipment	(3,672)	(6,005)
Prepayment for the purchase of property and equipment	(381)	(963)
Payment for business acquisition, net of cash acquired	(3,054)	(28,580)
Net cash used in investing activities	(4,667)	(150,502)
Cash flows from financing activities:		
Proceeds from exercise of stock options	1,930	2,570
Proceeds from employee stock purchase plan	1,035	1,670
Payments for taxes related to net share settlement of equity awards	(3,967)	(4,520)
Repurchases of common stock	(4,523)	—
Proceeds from issuance of common stock, net of issuance costs paid	—	65,078
Net cash provided by (used in) financing activities	(5,525)	64,798
Effect of exchange rate changes on cash and cash equivalents	(182)	131
Net decrease in cash, cash equivalents, and restricted cash	(6,131)	(63,790)
Cash, cash equivalents, and restricted cash at beginning of year	33,815	97,605
Cash, cash equivalents, and restricted cash at end of year	$ 27,684	$ 33,815
Reconciliation of cash, cash equivalents, and restricted cash to the balance sheets:		
Cash and cash equivalents	$ 27,684	$ 30,315
Restricted cash	—	3,500
Total cash, cash equivalents, and restricted cash	$ 27,684	$ 33,815

Continued on next page.

PDF SOLUTIONS, INC.
CONSOLIDATED STATEMENTS OF CASH FLOWS — CONTINUED
(in thousands)

	Year Ended December 31,	
	2021	**2020**
Supplemental disclosure of cash flow information:		
Cash paid during the period for taxes	$ 1,873	$ 2,707
Cash paid for amounts included in the measurement of operating lease liabilities	$ 1,947	$ 2,022
Supplemental disclosure of noncash information:		
Property and equipment received and accrued in accounts payable and accrued and other liabilities	$ 1,359	$ 133
Advances for purchase of fixed assets transferred from prepaid assets to property and equipment	$ 963	$ —
Operating lease liabilities arising from obtaining right-of-use assets	$ 161	$ 286
Stock-based compensation capitalized as software development costs	$ —	$ 190

See accompanying notes to consolidated financial statements.

PDF SOLUTIONS, INC.
NOTES TO CONSOLIDATED FINANCIAL STATEMENTS

1. DESCRIPTION OF BUSINESS AND SUMMARY OF SIGNIFICANT ACCOUNTING POLICIES

Description of Business

PDF Solutions, Inc. (the “Company” or “PDF”), provides products and services designed to empower engineers and data scientists across the semiconductor ecosystem to connect, collect, manage, and analyze data about design, equipment, manufacturing, and test to improve the yield and quality of their products and operational efficiency. The Company’s products, services, and solutions include proprietary software, physical intellectual property (or IP) for integrated circuit (or IC) designs, electrical measurement hardware tools, proven methodologies, and professional services.

Basis of Presentation

The consolidated financial statements include the accounts of the Company and its wholly-owned subsidiaries after the elimination of all significant intercompany balances and transactions.

Use of Estimates

The preparation of financial statements in conformity with generally accepted accounting principles in the United States (“U.S. GAAP”) requires management to make estimates and assumptions that affect the reported amounts of assets and liabilities, the disclosure of contingent assets and liabilities at the date of the financial statements and the reported amounts of revenues and expenses during the reporting period. Significant estimates in these financial statements include revenue recognition, the estimated useful lives of property and equipment and intangible assets, assumptions made in analysis of allowance for doubtful accounts, fair values of assets acquired and liabilities assumed in business combinations, impairment of goodwill and long-lived assets, valuation for deferred tax assets, and accounting for lease obligations, stock-based compensation expense, and income tax uncertainties and contingencies. Actual results could differ from those estimates and may result in material effects on the Company’s operating results and financial position.

The global COVID-19 pandemic has impacted the operations and purchasing decisions of companies worldwide. As of the date of issuance of the consolidated financial statements, the Company is not aware of any specific event or circumstance relating to COVID-19 that would require updates to the Company’s estimates and judgments or revisions to the carrying value of its assets or liabilities. These estimates may change, as new events occur and additional information is obtained, and are recognized in the consolidated financial statements as soon as they become known. Actual results could differ from those estimates and any such differences may be material to the financial statements.

Concentration of Credit Risk

Financial instruments that potentially expose the Company to concentrations of credit risk consist primarily of cash and cash equivalents, short -term investments, and accounts receivable. The Company maintains its cash and cash equivalents and short-term investments with what it considers high credit quality financial institutions.

The Company primarily sells its products and services to companies in Asia, Europe and North America within the semiconductor industry. As of December 31, 2021, two customers accounted for 44% of the Company’s gross accounts receivable and two customers accounted for 27% of the Company’s total revenues for 2021. As of December 31, 2020, two customers accounted for 27% of the Company’s gross accounts receivable and one customer accounted for 23% of the Company’s revenues for 2020. See Note 13 for further details. The Company does not require collateral or other security to support accounts receivable. To reduce credit risk, management performs ongoing credit evaluations of its customers’ financial condition. The Company maintains allowances for potential credit losses.

The allowance for doubtful accounts, which was based on management’s best estimates, could be adjusted in the near term from current estimates depending on actual experience. Such adjustments could be material to the consolidated financial statements.

Cash and Cash Equivalents, Short-term Investments, and Restricted Cash

The Company considers all highly liquid investments with an original maturity of 90 days or less or investments with a remaining maturity of 90 days or less at the purchase to be cash equivalents and investments with original maturities greater than 90 days but less than one year to be short-term investments. The Company classifies securities with readily determinable market values as available-for-sale. Short-term investments include available-for-sale securities and are carried at estimated fair value, with the unrealized gains and losses deemed temporary in nature, net of tax, reported as a component of accumulated other comprehensive loss in stockholders' equity. Realized gains and losses and declines in value determined to be other than temporary are based on the specific identification method and are included as a component of other expense, net in the Consolidated Statements of Comprehensive Loss.

The Company periodically reviews short-term investments for impairment. In the event a decline in value is determined to be other-than-temporary, an impairment loss is recognized. When determining if a decline in value is other-than-temporary, the Company takes into consideration the current market conditions, the duration and severity of and the reason for the decline, and the likelihood that it would need to sell the security prior to a recovery of par value.

As of December 31, 2021 and 2020, short-term investments consisted solely of U.S. Treasury bills. The cost of these securities approximated fair value and there was no material gross realized or unrealized gains or losses as of December 31, 2021. There were also no impairments in the investments' value in the year ended December 31, 2021. Refer to Note 14 "Fair Value Measurements" for further discussion on the Company's investments.

Restricted cash of $3.5 million included in the "Prepaid expenses and other current assets" in the Company's Consolidated Balance Sheet as of December 31, 2020 pertains to the amount, subject to adjustments, specifically designated to pay for the Holdback amount related to the Company's acquisition of Cimetrix Incorporated ("Cimetrix"). Refer to Note 4, "Business Combination" for further discussion about the payment of Holdback Amount in fiscal 2021.

Accounts Receivable

Accounts receivable include amounts that are unbilled at the end of the period that are expected to be billed and collected within a 12-month period. Unbilled accounts receivable is determined on an individual contract basis. Unbilled accounts receivable, included in accounts receivable, totaled $11.8 million and $7.2 million as of December 31, 2021 and 2020, respectively. Unbilled accounts receivable that are not expected to be billed and collected during the succeeding 12-month period are recorded in other non-current assets and totaled $1.3 million and $2.0 million as of December 31, 2021 and 2020, respectively. The Company performs ongoing credit evaluations of its customers' financial condition. An allowance for doubtful accounts is maintained for probable credit losses based upon the Company's assessment of the expected collectability of the accounts receivable. The allowance for doubtful accounts is reviewed on a quarterly basis to assess the adequacy of the allowance.

Accounts receivable reserves are summarized below (in thousands):

	Balance at Beginning of Period	Charged to Expense (1)	Charged Against Revenue (1)	Deductions/ Write-offs of Accounts Receivable (1)	Balance at End of Period
2021	$ 963	$ —	$ —	$ (73)	$ 890
2020	$ 213	$ —	$ 800	$ (50)	$ 963

(1) Additions to the accounts receivable reserve for doubtful accounts are charged to bad debt expense. Additions to the receivable reserve for billing adjustments are charged against revenue.

Property and Equipment

Property and equipment are stated at cost and are depreciated using the straight-line method over the estimated useful lives (in years) of the related asset as follows:

Computer equipment	3
Software	3
Furniture, fixtures, and equipment	3-10
Laboratory and test equipment	3-10
Leasehold improvements	Shorter of estimated useful life or term of lease

Intangible Assets

Intangible assets consist of acquired technology, certain contract rights, customer relationships, trademarks and trade names, and in-process research and development (IPR&D). These intangible assets may be acquired through business combinations or direct purchases. Intangible assets are amortized on a straight-line basis over their estimated useful lives which range from one to ten years, except for IPR&D projects. Acquired IPR&D is initially accounted for as indefinite-lived intangible asset and tested annually for impairment. Once the IPR&D asset becomes available for use, it will be amortized over the estimated useful life or will be written off upon abandonment. The Company continually monitors events and changes in circumstances that could indicate carrying amounts of long-lived assets, including property and equipment and intangible assets, may not be recoverable. When such events or changes in circumstances occur, the Company assesses the recoverability of long-lived assets. Recoverability of an asset group is measured by comparison of its carrying amount to the expected future undiscounted cash flows that the asset group is expected to generate. If it is determined that an asset group is not recoverable, an impairment loss is recorded in the amount by which the carrying amount of the asset group exceeds its fair value.

Goodwill

The Company records goodwill when the purchase consideration of an acquisition exceeds the fair value of the net tangible and identified intangible assets as of the date of acquisition. The Company has one operating segment and one operating unit. The Company performs a qualitative analysis when testing a reporting unit's goodwill for impairment. The Company performs an annual impairment assessment of goodwill during the fourth quarter of each calendar year or more frequently, if required to determine if any events or circumstances exist, such as an adverse change in business climate or a decline in the overall industry demand, that would indicate that it would more likely than not reduce the fair value of a reporting unit below its carrying amount, including goodwill. If events or circumstances do not indicate that the fair value of a reporting unit is below its carrying amount, then goodwill is not considered to be impaired and no further testing is required. If the carrying amount exceeds its fair value, an impairment loss would be recognized equal to the amount of excess, limited to the amount of total goodwill.

Leases

The Company has operating leases for administrative and sales offices, research and development laboratory and clean room. The Company recognizes long-term operating lease rights and commitments as operating lease right-of-use assets (ROU), operating lease liabilities and operating lease liabilities, non-current, respectively, in the Consolidated Balance Sheets. The Company also elected the transition package of three practical expedients which allow companies not to reassess (i) whether agreements contain leases, (ii) the classification of leases, and (iii) the capitalization of initial direct costs. Further, the Company elected to not separate lease and non-lease components for all of its leases.

The Company determines if an arrangement is, or contains, a lease at inception. Operating lease right-of-use assets, and operating lease liabilities are initially recorded based on the present value of lease payments over the lease term. Lease terms include the minimum unconditional term of the lease, and may include options to extend or terminate the lease when it is reasonably certain at the commencement date that such options will be exercised. The decision to include these options

involves consideration of our overall future business plans and other relevant business economic factors that may affect our business. Since the determination of the lease term requires an application of judgment, lease terms that differ in reality from our initial judgment may potentially have a material impact on the Company's Consolidated Balance Sheets. In addition, the Company's leases do not provide an implicit rate. In determining the present value of the Company's expected lease payments, the discount rate is calculated using the Company's incremental borrowing rate determined based on the information available, which requires additional judgment.

Software Development Costs

Internally developed software is software developed to meet our internal needs to provide certain services to the customers. The Company's capitalized software development costs consist of internal compensation related costs and external direct costs incurred during the application development stage and are amortized over their useful lives, generally five to six years. The costs to develop software that is marketed externally have not been capitalized as we believe our current software development process is essentially completed concurrent with the establishment of technological feasibility. As such, all related software development costs are expensed as incurred and included in research and development expense in our Consolidated Statements of Comprehensive Loss.

Cost of Revenues

Costs of revenues consist primarily of costs incurred to provide and support our services, costs recognized in connection with licensing our software, and amortization of acquired technology. Services costs include material, employee compensation and related benefits, subcontractor costs, overhead costs, travel, and allocated facilities-related costs. Software license costs consist of costs associated with cloud-delivery related expenses and licensing third-party software used by us in providing services to the Company's customers in solution engagements or sold in conjunction with the Company's software products.

Research and Development Expenses

Research and development expenses consist primarily of personnel-related costs to support product development activities, including compensation and benefits, outside development services, travel, facilities cost allocations, and stock-based compensation charges. Research and development expenses are charged to operations as incurred.

Selling, General and Administrative Expenses

Selling, general and administrative expenses consist primarily of compensation and benefits for sales, marketing and general and administrative personnel, legal and accounting services, marketing communications, travel and facilities cost allocations, and stock-based compensation charges.

Stock-Based Compensation

The Company accounts for stock-based compensation using the fair value method, which requires the Company to measure stock-based compensation based on the grant-date fair value of the awards and recognize the compensation expense over the requisite service period. As stock-based compensation expense recognized is based on awards ultimately expected to vest, it has been reduced for estimated forfeitures. Forfeitures are estimated at the time of grant and revised, if necessary, in subsequent periods if actual forfeitures differ from those estimates.

The fair value of the Company's restricted stock units ("RSUs") is equal to the market value of the Company's common stock on the date of the grant. These awards are subject to time-based vesting which generally occurs over a period of four years.

The fair value of the Company's stock options is estimated using the Black-Scholes-Merton option-pricing model, which incorporates various assumptions including volatility, expected life and interest rates. The expected volatility is based on the historical volatility of the Company's common stock over the most recent period commensurate with the estimated expected life of the Company's stock options. The expected life is based on historical experience and on the

terms and conditions of the stock options granted. The interest rate assumption is based upon observed Treasury yield curve rates appropriate for the expected life of the Company's stock options.

Income Taxes

The Company's provision for income tax comprises its current tax liability and change in deferred tax assets and liabilities. Deferred tax assets and liabilities are recognized for the expected tax consequences of temporary differences between the tax bases of assets and liabilities. The measurement of current and deferred tax assets and liabilities is based on provisions of enacted tax laws; the effect of future changes in tax laws or rates are not anticipated. Valuation allowances are provided to reduce deferred tax assets to an amount that in management's judgment is more likely than not to be recoverable against future taxable income. No U.S. taxes are provided on earnings of non-U.S. subsidiaries, to the extent such earnings are deemed to be permanently invested. The Company's income tax calculations are based on application of applicable U.S. federal and state or foreign tax laws. The Company's tax filings, however, are subject to audit by the respective tax authorities. Accordingly, the Company recognizes tax liabilities based upon its estimate of whether, and the extent to which, additional taxes will be due when such estimates are more-likely-than-not to be sustained. An uncertain income tax position will not be recognized if it has less than a 50% likelihood of being sustained. To the extent the final tax liabilities are different from the amounts originally accrued, the increases or decreases are recorded as income tax expense or benefit in the Consolidated Statements of Comprehensive Loss.

Net Income (Loss) Per Share

Basic net income (loss) per share is computed by dividing net income by weighted average number of common shares outstanding for the period (excluding outstanding stock options and shares subject to repurchase). Diluted net income (loss) per share is computed using the weighted-average number of common shares outstanding for the period plus the potential effect of dilutive securities which are convertible into common shares (using the treasury stock method), except in cases in which the effect would be anti-dilutive. Dilutive potential common shares consist of incremental common shares issuable upon exercise of stock options, upon vesting of RSUs, contingently issuable shares for all periods and assumed issuance of shares under the Company's employee stock purchase plan. No dilutive potential common shares are included in the computation of any diluted per share amount when a loss from continuing operations was reported by the Company.

Foreign Currency Translation

The functional currency of the Company's foreign subsidiaries is the local currency for the respective subsidiary. The assets and liabilities are translated at the period-end exchange rate, and statements of comprehensive loss are translated at the average exchange rate during the year. Gains and losses resulting from foreign currency translations are included as a component of other comprehensive loss. Gains and losses resulting from foreign currency transactions are included in the Consolidated Statements of Comprehensive Loss.

Derivative Financial Instruments

The Company operates internationally and is exposed to potentially adverse movements in foreign currency exchange rates. From time to time, the Company enters into foreign currency forward contracts to reduce the exposure to foreign currency exchange rate fluctuations on certain foreign currency denominated monetary assets and liabilities. The Company does not use foreign currency contracts for speculative or trading purposes. The Company records these forward contracts at fair value. The counterparty to these foreign currency forward contracts is a financial institution that the Company believes is creditworthy, and therefore, we believe the credit risk of counterparty non-performance is not significant. These foreign currency forward contracts are not designated for hedge accounting treatment. Therefore, the change in fair value of these derivatives is recorded into earnings as a component of interest and other income (expense), net and offsets the change in fair value of the foreign currency denominated monetary assets and liabilities, which are also recorded in interest and other income (expense), net. The duration of these forward contracts is usually three months.

Business Combinations

The Company allocates the fair value of purchase consideration to the tangible assets acquired, liabilities assumed and intangible assets acquired based on their estimated fair values at the date of the business combination. The excess of the fair value of purchase consideration over the fair values of these identifiable assets and liabilities is recorded as goodwill. Such valuations require management to make significant estimates and assumptions, especially with respect to intangible assets. Significant estimates in valuing certain intangible assets include, but are not limited to, estimated replacement costs and future expected cash flows from acquired customers, acquired technology, acquired patents, and trade names from a market participant perspective, useful lives and discount rates. Management's estimates of fair value are based upon assumptions believed to be reasonable, but which are inherently uncertain and unpredictable and, as a result, actual results may differ from estimates. Allocation of purchase consideration to identifiable assets and liabilities affects the Company's amortization expense, as acquired finite-lived intangible assets are amortized over the useful life, whereas any indefinite lived intangible assets, including IPR&D and goodwill, are not amortized but tested annually for impairment. During the measurement period, which is not to exceed one year from the acquisition date, the Company records adjustments to the assets acquired and liabilities assumed, with the corresponding offset to goodwill. Upon the conclusion of the measurement period, any subsequent adjustments are recorded to earnings.

Litigation

From time to time, the Company is subject to various claims and legal proceedings that arise in the ordinary course of business. The Company accrues for losses related to litigation when a potential loss is probable and the loss can be reasonably estimated in accordance with Financial Accounting Standards Board (FASB) requirements. See Note 8, Commitments and Contingencies.

Recently Adopted Accounting Standards

In December 2019, the Financial Accounting Standards Board ("FASB") issued Accounting Standard Update ("ASU") No. 2019-12, Income Taxes (Topic 740), Simplifying the Accounting for Income Taxes, related to simplifying the accounting for income taxes. The guidance eliminates certain exceptions from Accounting Standards Codification ("ASC") 740 related to the approach for intraperiod tax allocation, the methodology for calculating income taxes in an interim period and the recognition of deferred tax liabilities for outside basis differences. The guidance also clarifies and simplifies other aspects of the accounting for income taxes. The guidance became effective for the Company beginning in the first quarter of 2021 on a prospective basis. The Company adopted this standard on January 1, 2021, and it did not have a material impact on the Company's consolidated financial statements or the related disclosures

In January 2020, the FASB issued ASU No. 2020-01, Investments-Equity Securities (Topic 321), Investments-Equity Method and Joint Ventures (Topic 323), and Derivatives and Hedging (Topic 815)-Clarifying the Interactions between Topic 321, Topic 323, and Topic 815. This ASU clarifies the interaction between accounting standards related to equity securities (ASC 321), equity method investments (ASC 323), and certain derivatives (ASC 815). The amendments in this ASU are effective for fiscal years beginning after December 15, 2020. The Company adopted this standard on January 1, 2021, and it did not have a material impact on the Company's consolidated financial statements or the related disclosures.

Management has reviewed other recently issued accounting pronouncements and has determined there are not any that would have a material impact on the consolidated financial statements.

Accounting Standards Not Yet Effective

In June 2016, the FASB issued ASU No. 2016-13, Financial Instruments – Credit Losses (Topic 326): Measurement of Credit Losses on Financial Instruments (ASU 2016-13), which requires measurement and recognition of expected credit losses for financial assets held at the reporting date based on internal information, external information, or a combination of both relating to past events, current conditions, and reasonable and supportable forecasts. ASU No. 2016-13 replaces the existing incurred loss impairment model with a forward-looking expected credit loss model, which will result in earlier recognition of credit losses. Subsequent to the issuance of ASU No. 2016-13, the FASB issued ASU No. 2018-19, Codification Improvements to Topic 326, Financial Instruments – Credit Losses, ASU No. 2019-04,

Codification Improvements to Topic 326, Financial Instruments – Credit Losses, Topic 815, Derivatives and Hedging, and Topic 825, Financial Instrument, ASU No. 2019-05, Financial Instruments – Credit Losses (Topic 326) Targeted Transition Relief, ASU No. 2016-13, ASU No. 2019-10 Financial Instruments-Credit Losses (Topic 326), Derivatives and Hedging (Topic 815), and Leases (Topic 842), and ASU No. 2019-11 Codification Improvements to Topic 326, Financial Instruments-Credit Losses. The subsequent ASUs do not change the core principle of the guidance in ASU No. 2016-13. Instead, these amendments are intended to clarify and improve operability of certain topics included within ASU No. 2016-13.

Additionally, ASU No. 2019-10 defers the effective date for the adoption of the new standard on credit losses for public filers that are considered small reporting companies ("SRC") as defined by the SEC to fiscal years beginning after December 15, 2022, including interim periods within those fiscal years, which will be fiscal 2023 for the Company if it continues to be classified as an SRC. In February 2020, the FASB issued ASU 2020-02, which provides guidance regarding methodologies, documentation, and internal controls related to expected credit losses. The subsequent amendments will have the same effective date and transition requirements as ASU No. 2016-13. Early adoption is permitted. Topic 326 requires a modified retrospective approach by recording a cumulative-effect adjustment to retained earnings as of the beginning of the period of adoption. While the Company is currently evaluating the impact of Topic 326, the Company does not expect the adoption of this ASU to have a material impact on its consolidated financial statements or the related disclosure.

Management has reviewed other recently issued accounting pronouncements issued or proposed by the FASB, and does not believe any of these accounting pronouncements has had or will have a material impact on the consolidated financial statements.

2. REVENUE

The Company derives revenue from two sources: Analytics revenue and Integrated Yield Ramp revenue.

The Company recognizes revenue in accordance with FASB ASC Topic 606, *Revenue from Contracts with Customers*, and its related amendments (collectively known as "ASC 606"). ASC 606 outlines a single comprehensive model to use in accounting for revenue arising from contracts with customers. Revenue is recognized when control of products or services is transferred to customers, in an amount that reflects the consideration the Company expects to be entitled to in exchange for those promised products or services.

The Company determines revenue recognition through the following five steps:

- Identification of the contract, or contracts, with a customer
- Identification of the performance obligations in the contract
- Determination of the transaction price
- Allocation of the transaction price to the performance obligations in the contract
- Recognition of revenue when, or as, performance obligations are satisfied

The Company accounts for a contract when it has approval and commitment from both parties, the rights of the parties are identified, payment terms are identified, the contract has commercial substance, and collectability of consideration is probable.

Contracts with multiple performance obligations

The Company enters into contracts that can include various combinations of licenses, products and services, some of which are distinct and are accounted for as separate performance obligations. For contracts with multiple performance obligations, the Company allocates the transaction price of the contract to each performance obligation on a relative basis using the standalone selling price ("SSP").

Analytics Revenue

Analytics revenue is derived from the following primary offerings: licenses and services for standalone software (which is primarily Exensio® and Cimetrix® products), SaaS (which is primarily Exensio products), and DFI™ systems and CV® systems (including Characterization services) that do not include performance incentives based on customers' yield achievement.

Revenue from standalone software is recognized depending on whether the license is perpetual or time-based. Perpetual (one-time charge) license software is recognized at the time of the inception of the arrangement when control transfers to the customers, if the software license is considered as a separate performance obligation from the services offered by the Company. Revenue from post-contract support is recognized over the contract term on a straight-line basis, because we are providing (i) support and (ii) unspecified software updates on a when-and-if available basis over the contract term. Revenue from time-based-licensed software is allocated to each performance obligation and is recognized either at a point in time or over time as follows. The license component is recognized at the time when control transfers to customers, with the post-contract support component recognized ratably over the committed term of the contract. For contracts with any combination of licenses, support, and other services, distinct performance obligations are accounted for separately. For contracts with multiple performance obligations, we allocate the transaction price of the contract to each performance obligation on a relative basis using the SSP attributed to each performance obligation.

Revenue from SaaS arrangements, which allow for the use of a cloud-based software product or service over a contractually determined period of time without the customer having to take possession of software, is accounted for as a subscription and is recognized as revenue ratably, on a straight-line basis, over the subscription period beginning on the date the service is first made available to customers. For contracts with any combination of SaaS and related services, distinct performance obligations are accounted for separately. For contracts with multiple performance obligations, we allocate the transaction price of the contract to each performance obligation on a relative basis using SSP attributed to each performance obligation.

Revenue from DFI systems and CV systems (including Characterization services) that do not include performance incentives based on customers' yield achievement is recognized primarily as services are performed. Where there are distinct performance obligations, the Company allocates revenue to all deliverables based on their SSPs. For those contracts with multiple performance obligations, the Company allocates the transaction price of the contract to each performance obligation on a relative basis using SSP attributed to each performance obligation. Where there are not discrete performance obligations, historically, revenue is primarily recognized as services are performed using a percentage of completion method based on costs or labor-hours inputs, whichever is the most appropriate measure of the progress towards completion of the contract. The estimation of percentage of completion method is complex and subject to many variables that require significant judgement. Please refer to "Significant Judgments" section of this Note for further discussion.

Integrated Yield Ramp Revenue

Integrated Yield Ramp revenue is derived from the Company's fixed-fee engagements that include performance incentives based on customers' yield achievement (which consists primarily of Gainshare royalties) typically based on customer's wafer shipments, pertaining to these fixed-price contracts, which royalties are variable.

Revenue under these project–based contracts, which are delivered over a specific period of time, typically for a fixed fee component paid on a set schedule, is recognized as services are performed using a percentage of completion method based on costs or labor-inputs, whichever is the most appropriate measure of the progress towards completion of the contract. Where there are distinct performance obligations, the Company allocates revenue to all deliverables based on their SSPs and allocates the transaction price of the contract to each performance obligation on a relative basis using SSP. Similar to the services provided in connection with DFI systems and CV systems that are contributing to Analytics revenue, due to the nature of the work performed in these arrangements, the estimation of percentage of completion method is complex and subject to many variables that require significant judgement. Please refer to "Significant Judgments" section of this Note for further discussion.

The Gainshare royalty contained in IYR contracts is a variable fee related to continued usage of the Company's intellectual property after the fixed-fee service period ends, based on a customer's yield achievement. Revenue derived from Gainshare is contingent upon the Company's customers reaching certain defined production yield levels. Gainshare royalty periods are generally subsequent to the delivery of all contractual services and performance obligations. The Company records Gainshare as a usage-based royalty derived from customers' usage of intellectual property and records it in the same period in which the usage occurs.

Disaggregation of Revenue

The Company disaggregates revenue from contracts with customers into the timing of the transfer of goods and services and the geographical regions. The Company determined that disaggregating revenue into these categories achieves the disclosure objective to depict how the nature, amount, timing, and uncertainty of revenue and cash flows are affected by economic factors.

The Company's performance obligations are satisfied either over time or at a point-in-time. The following table represents a disaggregation of revenue by timing of revenue:

	Year Ended December 31,	
	2021	**2020**
Over time	65	63 %
Point-in-time	35	37 %
Total	100 %	100 %

International revenues accounted for approximately 55% and 58% of total revenues for the year ended December 31, 2021 and 2020, respectively. See Note 13, Customer and Geographic Information.

Significant Judgments

Judgments and estimates are required under ASC 606. Due to the complexity of certain contracts, the actual revenue recognition treatment required under ASC 606 for the Company's arrangements may be dependent on contract-specific terms and may vary in some instances.

For revenue under project-based contracts for fixed-price implementation services, revenue is recognized as services are performed using a percentage-of-completion method based on costs or labor-hours input method, whichever is the most appropriate measure of the progress towards completion of the contract. Due to the nature of the work performed in these arrangements, the estimation of percentage of completion method is complex, subject to many variables and requires significant judgment. Key factors reviewed by the Company to estimate costs to complete each contract are future labor and product costs and expected productivity efficiencies. If circumstances arise that change the original estimates of revenues, costs, or extent of progress toward completion, revisions to the estimates are made. These revisions may result in increases or decreases in estimated revenues or costs, and such revisions are reflected in revenue on a cumulative catch-up basis in the period in which the circumstances that gave rise to the revision become known.

The Company's contracts with customers often include promises to transfer products, licenses software and provide services, including professional services, technical support services, and rights to unspecified updates to a customer. Determining whether licenses and services are distinct performance obligations that should be accounted for separately, or not distinct and thus accounted for together, requires significant judgment. The Company rarely licenses software on a standalone basis, so the Company is required to estimate the range of SSPs for each performance obligation. In instances where SSP is not directly observable because the Company does not license the software or sell the service separately, the Company determines the SSP using information that may include market conditions and other observable inputs.

The Company is required to record Gainshare royalty revenue in the same period in which the usage occurs. Because the Company generally does not receive the acknowledgment reports from its customers during a given quarter within the time frame necessary to adequately review the reports and include the actual amounts in quarterly results for such quarter, the Company accrues the related revenue based on estimates of customers underlying sales achievement. The Company's

estimation process can be based on historical data, trends, seasonality, changes in the contract rate, knowledge of the changes in the industry and changes in the customer's manufacturing environment learned through discussions with customers and sales personnel. As a result of accruing revenue for the quarter based on such estimates, adjustments will be required in the following quarter to true-up revenue to the actual amounts reported.

Contract Balances

The Company performs its obligations under a contract with a customer by licensing software or providing services in exchange for consideration from the customer. The timing of the Company's performance often differs from the timing of the customer's payment, which results in the recognition of a receivable, a contract asset or a contract liability.

The Company classifies the right to consideration in exchange for software or services transferred to a customer as either a receivable or a contract asset. A receivable is a right to consideration that is unconditional, as compared to a contract asset, which is a right to consideration that is conditional upon factors other than the passage of time. The majority of the Company's contract assets represent unbilled amounts related to fixed-price service contracts when the revenue recognized exceeds the amount billed to the customer. The contract assets are generally classified as current and are recorded on a net basis with deferred revenue (i.e. contract liabilities) at the contract level. At December 31, 2021 and 2020, contract assets of $0.4 million and $3.7 million, respectively, are included in prepaid expenses and other current assets in the Consolidated Balance Sheets. The Company did not record any asset impairment charges related to contract assets during fiscal year 2021 and 2020.

Deferred revenues consist substantially of amounts invoiced in advance of revenue recognition and are recognized as the revenue recognition criteria are met. Deferred revenues that will be recognized during the succeeding twelve-month period are recorded as current deferred revenues and the remaining portion is recorded as non-current deferred revenues. The non-current portion of deferred revenue included in other non-current liabilities as of December 31, 2021 and 2020 was $2.4 million and $1.2 million, respectively. Revenue recognized for the years ended December 31, 2021 and 2020, that was included in the deferred revenues and billings in excess of recognized revenues balances at the beginning of each reporting period was $16.9 million and $10.7 million, respectively.

At December 31, 2021, the aggregate amount of the transaction price allocated to the remaining performance obligations related to customer contracts that were unsatisfied or partially unsatisfied was approximately $179.5 million. Given the applicable contract terms with customers, the majority of this amount is expected to be recognized as revenue over the next two years, with the remainder in the following three years. This amount does not include significant contracts to which the customer is not committed, future sales-based or usage-based royalty payments in exchange for a license of intellectual property, and future payments for performance obligations from on-demand arrangements. This amount is subject to change due to future revaluations of variable consideration, terminations, other contract modifications, or currency adjustments. The estimated timing of the recognition of remaining unsatisfied performance obligations is subject to change and is affected by changes to the scope, change in timing of delivery of products and services, or contract modifications.

The adjustment to revenue recognized in the years ended December 31, 2021 and 2020 from performance obligations satisfied (or partially satisfied) in previous periods was a decrease of $0.4 million and an increase $0.1 million, respectively. These amounts primarily represent changes in estimated percentage-of-completion based contracts and changes in actual versus estimated Gainshare royalty.

Costs to obtain or fulfill a contract

The Company capitalizes the incremental costs to obtain or fulfill a contract with a customer, including direct sales commissions and related fees, when it expects to recover those costs. Amortization expense related to these capitalized costs is recognized over the period associated with the revenue from which the cost was incurred. Total capitalized direct sales commission costs included in prepaid expenses and other current assets in the accompanying Consolidated Balance Sheets as of December 31, 2021 and 2020 was $0.6 million and $0.8 million, respectively. Total capitalized direct sales commission costs included in other non-current assets in the accompanying Consolidated Balance Sheets as of December 31, 2021 and 2020 was $2.1 million and $0.9 million, respectively. Amortization of these assets for each of

the years ended December 31, 2021 and 2020 was $0.7 million and $0.5 million, respectively. There was no impairment loss in relation to the costs capitalized for the periods presented.

Certain eligible initial project costs are capitalized when the costs relate directly to the contract, the costs generate or enhance resources of the Company that will be used in satisfying the performance obligation in the future, and the costs are expected to be recovered. These costs primarily consist of transition and set-up costs related to the installation of systems and processes and other deferred fulfillment costs eligible for capitalization. Capitalized costs are amortized consistent with the transfer to the customer of the services to which the asset relates and recorded as a component of cost of revenues. The Company also incurs certain direct costs to provide services in relation to the specific anticipated contracts. The Company recognizes such costs as a component of cost of revenues, the timing of which is dependent upon identification of a contract arrangement. At the end of the reporting period, the Company evaluates its deferred costs for their probable recoverability. Deferred costs balance included in prepaid expenses and other current assets and other non-current assets in the accompanying Consolidated Balance Sheets was immaterial as of December 31, 2021 and 2020. The Company recognizes impairment deferred costs when it is determined that the costs no longer have future benefits and are no longer recoverable. There was no impairment loss in relation to the costs capitalized for the periods presented.

Practical Expedients

The Company does not adjust transaction price for the effects of a significant financing component when the period between the transfers of the promised good or service to the customer and payment for that good or service by the customer is expected to be one year or less. The Company assessed each of its revenue generating arrangements in order to determine whether a significant financing component exists, and determined its contracts did not include a significant financing component for the years ended December 31, 2021 and 2020.

3. STRATEGIC PARTNERSHIP AGREEMENT WITH ADVANTEST AND RELATED PARTY TRANSACTIONS

On July 29, 2020, the Company entered into a long-term strategic partnership with Advantest Corporation through its wholly-owned subsidiary, Advantest America, Inc. (collectively referred to herein as “Advantest”) that included the following agreements.

- A Securities Purchase Agreement for the purchase by Advantest of an aggregate of 3,306,924 shares of its common stock for aggregate gross proceeds of $65.2 million and a related Stockholder Agreement.

- An Amendment #1 to that certain Software License and Related Services Agreement, dated as of March 25, 2020, for an exclusive commercial arrangement in which the Company and Advantest will collaborate on, and the Company will initially host, develop and maintain, an Advantest-specific cloud layer on the Exensio platform.

- An Amended and Restated Master Development Agreement with Advantest, pursuant to which the Company and Advantest agreed to collaborate on extensions to or combinations of both of their existing technology and new technology to address mutual customers’ needs through one or more development phases subject to certain conditions as set forth therein. Costs and expenses incurred related to this agreement have not been significant for the year ended December 31, 2021 and 2020.

- A Master Commercial Terms and Support Services Agreement for the commercialization and support of integrated products of the Company and Advantest that are the outcome of the above development agreement. No material costs and expenses incurred related to the Commercial Agreement with Advantest have not been significant for the year ended December 31, 2021 and 2020.

Analytics revenue recognized from Advantest during the year ended December 31, 2021 and 2020 was $10.6 million and $3.4 million, respectively. There was no outstanding accounts receivable from Advantest at December 31, 2021. Accounts receivable from Advantest amounted to $0.3 million at December 31, 2020. Deferred revenue amounted to $6.8 million and $5.9 million as of December 31, 2021 and 2020, respectively. There was no occurrence of any termination events under these agreements as of the issuance of these consolidated financial statements.

The Company carries out transactions with Advantest on arm's length commercial customary terms.

4. BUSINESS COMBINATION

On December 1, 2020 (the "Acquisition Date"), the Company acquired all the stock of Cimetrix Incorporated ("Cimetrix"). Cimetrix a global provider of equipment connectivity products for smart manufacturing and Industry 4.0 that enable factory equipment to communicate to increase productivity, reduce costs, and improve quality. The combination of Cimetrix connectivity products and platforms with the Company's Exensio analytics platform powered by machine learning, is intended to enable IC, assembly, and electronics manufacturer customers to extract more intelligence from their tools, not just data, to build more reliable chips and systems at lower manufacturing costs. The gross purchase price was approximately $37.5 million ($31.6 million net of cash acquired) for all of the outstanding equity of Cimetrix. The net cash payment for this acquisition which also include the payment of adjusted Holdback Amount, as discussed below, was funded from the available cash of the Company.

At the Acquisition Date, the Company held back $3.5 million of the purchase price (the "Holdback Amount") to satisfy adjustments and claims for indemnity arising out of breaches of certain representations, warranties and covenants, and certain other enumerated items in the merger agreement. The Holdback Amount was recorded under accrued and other current liabilities account and the corresponding restricted cash was included in the "Prepaid expenses and other current assets" account in the 2020 Consolidated Balance Sheet. In fiscal 2021, the Company recorded a measurement period adjustment which reduced the Holdback Amount to $3.1 million. The measurement period adjustment did not have an impact on the Company's Consolidated Statement of Comprehensive Loss during the year ended December 31, 2021. The adjusted Holdback Amount of $3.1 million was paid to the participating equity holders in December 2021.

The Company accounted for this acquisition as a business combination in accordance with FASB ASC Topic 805, Business Combinations. This method requires that assets acquired and liabilities assumed in a business combination be recognized at their respective estimated fair values as of the Acquisition Date. The excess of purchase consideration over the fair value of net tangible and identifiable intangible assets acquired was recorded as goodwill. The goodwill recorded from this acquisition represents business benefits the Company anticipates from the acquired workforce and expectation for expanded sales opportunities to foster further business growth. Due to the nature of the transaction, the goodwill associated with the acquisition is not deductible for tax purposes.

The final purchase price allocation, completed in the fourth quarter of 2021, resulted in adjustments to certain assets and liabilities primarily related to Holdback amount, as discussed above, and a reduction to net deferred tax liabilities of approximately $1.3 million. The corresponding offset of measurement period acquisition adjustments to goodwill aggregated $1.7 million.

The following summarizes the final allocation of the purchase price for this acquisition, as of the date of the acquisition, is as follows (in thousands, except amortization period):

	Amount	Amortization Period (Years)
Allocation of Purchase Price:		
Assets		
Fair value of tangible assets (including cash of $5,900)	$ 8,298	
Fair value of intangible assets:		
Developed technology	12,541	8
In-process R&D	3,635	N/A
Customer relationships	1,967	10
Noncompetition agreements	848	3
Tradenames and trademarks	808	10
Goodwill	11,830	N/A
Total assets acquired	$ 39,927	
Liabilities		
Accounts payable and accrued expenses	$ 1,447	
Deferred revenue	375	
Operating lease liabilities	132	
Deferred tax liabilities	439	
Total liabilities assumed	$ 2,393	
Total purchase price allocation	$ 37,534	

The estimated fair value of accounts receivable acquired approximates the contractual value of $1.6 million.

Pursuant to the merger agreement, the Company will also make payments to certain employees, subject to their continued employment with Cimetrix, through the second quarter of 2024. The estimated total cash payout is about $1.4 million at Acquisition Date and will be paid at various scheduled payout dates. This amount will be recognized as compensation expense over the period as services are rendered. As of December 31, 2021 and 2020, such accrued compensation recorded under “Accrued compensation and related benefits” in the Consolidated Balance Sheets amounted to $0.5 million and $0.3 million, respectively.

Acquisition-Related Transaction Costs – Transaction expenses related to the acquisition of Cimetrix aggregated $1.6 million for the year ended December 31, 2020. These costs consist of professional fees and administrative costs and were expensed as incurred in the Company’s Consolidated Statement of Comprehensive Loss for the year ended December 31, 2020.

5. PROPERTY AND EQUIPMENT

Property and equipment consist of (in thousands):

	December 31,	
	2021	2020
Computer equipment	$ 11,924	$ 11,585
Software	5,419	5,451
Furniture, fixtures and equipment	2,506	2,507
Leasehold improvements	6,272	6,255
Laboratory and other equipment	3,981	3,451
Test equipment	24,452	26,010
Construction-in-progress	22,158	20,278
	76,712	75,537
Less: accumulated depreciation and amortization	(41,417)	(36,295)
Total	$ 35,295	$ 39,242

Test equipment includes DFI™ assets at customer sites that are contributing to Analytics revenue from DFI systems. The construction-in-progress balance related to construction of DFI™ assets totaled $20.0 million and $18.9 million as of December 31, 2021 and 2020, respectively. Depreciation and amortization expense for years ended December 31, 2021 and 2020 was $6.2 million and $6.7 million, respectively.

In 2021, the Company wrote down the value of its property and equipment by $3.2 million related to its first-generation of e-beam tools for DFI™ systems wherein carrying values may not be fully recoverable due to lack of market demand and future needs of our customers for these tools.

6. GOODWILL AND INTANGIBLE ASSETS

The Company completed the acquisition of Cimetrix in the year ended December 31, 2020. Refer to Note 4 for additional information related to the goodwill and intangible assets added from this acquisition.

As of December 31, 2021 and 2020, the carrying amounts of goodwill were $14.1 million and $15.8 million, respectively. The following table summarizes goodwill transaction for the year ended December 31, 2021 and 2020 (in thousands):

	December 31,	
	2021	2020
Balance at beginning of year	$ 15,774	$ 2,293
Addition	—	13,481
Measurement period acquisition adjustment (1)	1,651	—
Balance at end of year	$ 14,123	$ 15,774

(1) Goodwill adjustment was recorded within the measurement period with a corresponding reduction in the Holdback Amount and reduction to net deferred tax liabilities. See Note 4, *Business Combination*.

Intangible assets balance was $21.2 million and $24.6 million as of December 31, 2021 and 2020, respectively. Intangible assets as of December 31, 2021 and 2020, consist of the following (in thousands):

	Amortization Period (Years)	December 31, 2021			December 31, 2020		
		Gross Carrying Amount	Accumulated Amortization	Net Carrying Amount	Gross Carrying Amount	Accumulated Amortization	Net Carrying Amount
Acquired identifiable intangibles:							
Customer relationships	1-10	$ 9,407	$ (6,041)	$ 3,366	$ 9,407	$ (5,398)	$ 4,009
Developed technology	4-9	33,635	(17,250)	16,385	30,000	(14,987)	15,013
Tradename and trademarks	2-10	1,598	(812)	786	1,598	(706)	892
Patent	7-10	1,800	(1,640)	160	1,800	(1,600)	200
Noncompetition agreements	3	848	(306)	542	848	(24)	824
In-process R&D	*	—	—	—	3,635	N/A	3,635
Total		$ 47,288	$ (26,049)	$ 21,239	$ 47,288	$ (22,715)	$ 24,573

* Non-amortizing intangible asset

Developed technology includes reclassified In-process R&D asset related to Cimetrix's Smart Manufacturing Solutions acquired in fiscal 2020 and reclassified in fiscal 2021 upon it becoming available for us.

The weighted average amortization period for acquired identifiable intangible assets was 6.8 years as of December 31, 2021. The following table summarizes intangible assets amortization expense in the Consolidated Statements of Comprehensive Loss (in thousands):

	Year ended December 31,	
	2021	2020
Amortization of acquired technology included under Costs of Revenues	$ 2,079	$ 705
Amortization of acquired intangible assets presented separately under Costs and Expenses	1,255	741
Balance at end of year	$ 3,334	$ 1,446

The Company expects annual amortization of acquired identifiable intangible assets to be as follows (in thousands):

Year Ending December 31,	Amount
2022	$ 3,468
2023	3,444
2024	3,046
2025	2,882
2026	2,712
2027 and thereafter	5,687
Total future amortization expense	$ 21,239

There were no impairment charges for goodwill and intangible assets for the year ended December 31, 2021 and 2020.

7. LEASES

Lease expense was comprised of the following (in thousands):

	Year Ended December 31,	
	2021	2020
Operating lease expense	$ 1,860	$ 1,828
Short-term lease and variable lease expense (1)	822	545
Total lease expense	$ 2,682	$ 2,373

(1) Leases with an initial term of 12 months or less are not recorded on the Consolidated Balance Sheets, and the Company recognizes lease expense for these leases on a straight-line basis over the lease term. Variable lease expense for the periods presented primarily included common area maintenance charges.

Supplemental balance sheets information related to leases was as follows:

	December 31,	
	2021	2020
Weighted average remaining lease term under operating ROU leases (in years)	5.7	6.4
Weighted average discount rate for operating lease liabilities	5.25 %	5.24 %

Maturity of operating lease liabilities as of December 31, 2021, are as follows (in thousands):

Year Ending December 31,	Amount (1)
2022	$ 1,825
2023	1,459
2024	1,071
2025	1,087
2026	1,053
2027 and thereafter	1,649
Total future minimum lease payments	$ 8,144
Less: Interest (2)	(1,128)
Present value of future minimum lease payments under operating lease liabilities (3)	$ 7,016

(1) As of December 31, 2021, the total operating lease liability includes $1.1 million related to an option to extend a lease term that is reasonably certain to be exercised.
(2) Calculated using incremental borrowing interest rate for each lease.
(3) Includes the current portion of operating lease liabilities of $1.8 million as of December 31, 2021.

8. COMMITMENTS AND CONTINGENCIES

Strategic Partnership with Advantest

See Note 3 for the discussion about the Company’s commitments under the strategic partnership with Advantest.

Operating Leases

Refer to Note 7, Leases, for the discussion about the Company’s lease commitments.

Indemnifications

The Company generally provides a warranty to its customers that its software will perform substantially in accordance with documented specifications typically for a period of 90 days following delivery of its products. The Company also indemnifies certain customers from third-party claims of intellectual property infringement relating to the use of its products. Historically, costs related to these guarantees have not been significant. The Company is unable to estimate the maximum potential impact of these guarantees on its future results of operations.

Purchase obligations

The Company has purchase obligations with certain suppliers for the purchase of goods and services entered in the ordinary course of business. As of December 31, 2021, total outstanding purchase obligations were $8.9 million, the majority of which due within the next 12 months.

Indemnification of Officers and Directors

As permitted by the Delaware general corporation law, the Company has included a provision in its certificate of incorporation to eliminate the personal liability of its officers and directors for monetary damages for breach or alleged breach of their fiduciary duties as officers or directors, other than in cases of fraud or other willful misconduct.

In addition, the Bylaws of the Company provide that the Company is required to indemnify its officers and directors even when indemnification would otherwise be discretionary, and the Company is required to advance expenses to its officers and directors as incurred in connection with proceedings against them for which they may be indemnified. The Company has entered into indemnification agreements with its officers and directors containing provisions that are in some respects broader than the specific indemnification provisions contained in the Delaware general corporation law. The indemnification agreements require the Company to indemnify its officers and directors against liabilities that may arise by reason of their status or service as officers and directors other than for liabilities arising from willful misconduct of a culpable nature, to advance their expenses incurred as a result of any proceeding against them as to which they could be indemnified, and to obtain directors’ and officers’ insurance if available on reasonable terms. The Company has obtained directors’ and officers’ liability insurance in amounts comparable to other companies of the Company’s size and in the Company’s industry. Since a maximum obligation of the Company is not explicitly stated in the Company’s Bylaws or in its indemnification agreements and will depend on the facts and circumstances that arise out of any future claims, the overall maximum amount of the obligations cannot be reasonably estimated.

Litigation

From time to time, the Company is subject to various claims and legal proceedings that arise in the ordinary course of business. The Company accrues for losses related to litigation when a potential loss is probable, and the loss can be reasonably estimated in accordance with FASB requirements. As of December 31, 2021, except as disclosed below, the Company was not party to any material legal proceedings, thus no loss was probable and no amount was accrued.

On May 6, 2020, the Company initiated an arbitration proceeding with the Hong Kong International Arbitration Center against SMIC New Technology Research & Development (Shanghai) Corporation (“SMIC”) due to SMIC’s failure to pay fees due to PDF under a series of contracts. The Company seeks to recover the unpaid fees, a declaration requiring SMIC to pay fees under the contracts in the future, and costs associated with bringing the arbitration proceeding. The arbitration is on-going.

9. STOCKHOLDERS’ EQUITY

Issuance of Common Stock

On July 30, 2020, the Company issued 3,306,924 shares of common stock, at a purchase price of $19.7085 per share, for aggregate gross proceeds of $65.2 million pursuant to a Securities Purchase Agreement with Advantest dated July 29,

2020. Issuance costs related to this private placement aggregated $0.1 million. See Note 3, Securities Purchase Agreement with Advantest, for further details.

Stock Repurchase Program

On May 28, 2020, the Company's 2018 stock repurchase program (the "2018 Program") that was originally adopted on May 29, 2018, expired. As of May 28, 2020, approximately 786,000 shares had been repurchased at an average price of $12.43 per share, for a total price of $9.8 million under the 2018 Program.

On June 4, 2020, the Company's Board of Directors adopted a new stock repurchase program (the "2020 Program") to repurchase up to $25.0 million of the Company's common stock both on the open market and in privately negotiated transactions, including through Rule 10b5-1 plans, over the next two years. During the year ended December 31, 2021, 251,212 shares were repurchased under the 2020 at average price of $18.01 per share for an aggregate total price of $4.5 million under the 2020 Program.

10. EMPLOYEE BENEFIT PLANS

On December 31, 2021, the Company had the following stock-based compensation plans:

Employee Stock Purchase Plans

In July 2001, the Company's stockholders initially approved the 2001 Employee Stock Purchase Plan, which was subsequently amended and restated in 2010 (as amended, the "2010 Purchase Plan") to extend the term of the plan through May 17, 2020. Under the 2010 Purchase Plan, eligible employees can contribute up to 10% of their compensation, as defined in the Purchase Plan, towards the purchase of shares of PDF common stock at a price of 85% of the lower of the fair market value at the beginning of the offering period or the end of the purchase period. The 2010 Purchase Plan provided for twenty-four-month offering periods with four six-month purchase periods in each offering period. The 2010 Purchase Plan expired on May 17, 2020. Existing offering periods under the 2010 Plan continued through the applicable expiration date and the final offering period expired on January 31, 2022. On June 15, 2021, the Company's stockholders approved the 2021 Employee Stock Purchase Plan, which has a ten-year term (the "2021 Purchase Plan"). The terms of 2021 Purchase Plan are substantially similar to those of the 2010 Purchase Plan. A twenty-four-month offering period under the 2021 Purchase Plan commenced on August 1, 2021.

The Company estimated the fair value of purchase rights granted under the 2021 and 2010 Purchase Plans (collectively, the "Stock Purchase Plans") during the period using the Black-Scholes-Merton option-pricing model with the following weighted average assumptions, resulting in the following weighted average fair values:

	2021 Purchase Plan	2010 Purchase Plan	
	Year Ended December 31,	Year Ended December 31,	
	2021	2021	2020
Expected life (in years)	1.25	1.25	1.25
Volatility	48.00 %	34.25 %	34.25 %
Risk-free interest rate	0.11 %	1.43 %	1.43 %
Expected dividend	—	—	—
Weighted average fair value of purchase rights granted during the period	$ 6.71	$ 4.83	$ 4.83

During the year ended December 31, 2021 and 2020, a total of approximately 109,000 and 183,000 shares, respectively, were issued at a weighted-average purchase price of $9.53 and $9.12 per share, respectively. As of December 31, 2021, the estimated unrecognized compensation cost related to the 2021 Purchase Plan was $1.9 million and there was a negligible amount of unrecognized compensation cost related to the 2010 Purchase Plan. These estimated unrecognized compensation costs are expected to be recognized over a weighted average period of 1.6 years. As of December 31, 2021, 1.0 million shares were available for future issuance under the 2021 Purchase Plan, and shares

available for future issuance under the 2010 Purchase Plan was 5.6 million but shares to be issued will be limited only to the final offering period on January 31, 2022.

Stock Incentive Plans

On November 16, 2011, the Company's stockholders initially approved the 2011 Stock Incentive Plan, which has been amended and restated and approved by the Company's stockholders a number of times since then (as amended, the "2011 Plan"). Under the 2011 Plan, the Company may award stock options, stock appreciation rights ("SARs"), stock grants or stock units covering shares of the Company's common stock to employees, directors, non-employee directors and contractors. The aggregate number of shares reserved for awards under this plan is 11,550,000 shares, plus up to 3,500,000 shares previously issued under the 2001 Stock Plan adopted by the Company in 2001, which expired in 2011 (the "2001 Plan") that are either (i) forfeited or (ii) repurchased by the Company or are shares subject to awards previously issued under the 2001 Plan that expire or that terminate without having been exercised or settled in full on or after November 16, 2011. In case of awards other than options or SARs, the aggregate number of shares reserved under the 2011 Plan will be decreased at a rate of 1.33 shares issued pursuant to such awards. The exercise price for stock options must generally be at prices no less than the fair market value at the date of grant. Stock options generally expire ten years from the date of grant and become vested and exercisable over a four-year period.

Stock options granted under the 2001 Plan generally expire ten years from the date of grant and become vested and exercisable over a four-year period. Although no new awards may be granted under the 2001 Plan, awards made under the 2001 Plan that are currently outstanding remain subject to the terms of each such plan.

As of December 31, 2021, 12.1 million shares of common stock were reserved to cover stock-based awards under the 2011 Plan, of which 3.4 million shares were available for future grant. The number of shares reserved and available under the 2011 Plan includes 0.5 million shares that were subject to awards previously made under the 2001 Plan and were forfeited, expired or repurchased by the Company after the adoption of the 2011 Plan through December 31, 2021. As of December 31, 2021, there were no outstanding awards that had been granted outside of the 2011 or 2001 Plans (collectively, the "Stock Plans")

The Company has elected to use the Black-Scholes-Merton option-pricing model, which incorporates various assumptions including volatility, expected life, interest rate and expected dividend. The expected volatility is based on the historical volatility of the Company's common stock over the most recent period commensurate with the estimated expected life of the Company's stock options. The expected life of an award is based on historical experience and on the terms and conditions of the stock awards granted to employees. The interest rate assumption is based upon observed Treasury yield curve rates appropriate for the expected life of the Company's stock options.

	Year Ended December 31,	
	2021	**2020**
Expected life (in years)	—	4.45
Volatility	— %	40.90 %
Risk-free interest rate	— %	0.60 %
Expected dividend	—	—
Weighted average fair value per share of options granted during the period	$ —	$ 5.75

No stock options were granted during the year ended December 31, 2021.

Stock-based compensation is estimated at the grant date based on the award's fair value and is recognized on a straight-line basis over the vesting periods, generally four years. As stock-based compensation expense recognized is based on awards ultimately expected to vest, it has been reduced for estimated forfeitures. Forfeitures are estimated at the time of grant and revised, if necessary, in subsequent periods if actual forfeitures differ from those estimates.

Stock-based compensation expenses related to the Company's stock plans and employee stock purchase plans were allocated as follows (in thousands):

	Year Ended December 31,	
	2021	2020
Costs of revenues	$ 2,563	$ 3,454
Research and development	5,515	4,800
Selling, general and administrative	4,853	4,209
Stock-based compensation expenses	$ 12,931	$ 12,463

The stock-based compensation expense in the table above includes immaterial expense or credit adjustments related to cash-settled SARs granted to certain employees. The Company accounted for these awards as liability awards and the amount was included in accrued compensation and related benefits. SARs were fully exercised in the third quarter of 2020. Stock-based compensation capitalized in the capitalized software development costs included in property and equipment, net, was nil and approximately $0.2 million for the years ended December 31, 2021 and 2020, respectively.

Additional information with respect to options under the Plans is as follows:

	Outstanding Options			
	Number of Options (in thousands)	Weighted Average Exercise Price per Share	Weighted Average Remaining Contractual Term (Years)	Aggregate Intrinsic Value (in thousands)
Outstanding, January 1, 2020	745	$ 10.64		
Granted (weighted average fair value of $5.75 per share)	24	$ 16.72		
Exercised	(246)	$ 10.46		
Canceled	(57)	$ 11.65		
Expired	(10)	$ 10.06		
Outstanding, January 1, 2021	456	$ 10.95		
Granted	—	—		
Exercised	(216)	8.90		
Canceled	(10)	15.56		
Expired	(4)	6.90		
Outstanding, December 31, 2021	226	$ 12.78	3.20	$ 4,288
Vested and expected to vest, December 31, 2021	223	$ 12.75	3.15	$ 4,250
Exercisable, December 31, 2021	190	$ 12.40	2.36	$ 3,684

The aggregate intrinsic value in the table above represents the total intrinsic value based on the Company's closing stock price of $31.79 as of December 31, 2021, which would have been received by the option holders had all option holders exercised their options as of that date. The total intrinsic value of options exercised during the years ended December 31, 2021 and 2020 was $3.0 million and $2.2 million, respectively.

As of December 31, 2021, there was $0.2 million of total unrecognized compensation cost, net of forfeitures, related to unvested stock options. That cost is expected to be recognized over a weighted average period of 1.7 years. The total fair value of options vested during the year ended December 31, 2021, was $0.2 million.

Nonvested shares (restricted stock units) were as follows:

	Shares (in thousands)	Weighted Average Grant Date Fair Value Per Share
Nonvested, January 1, 2020	1,887	$ 12.30
Granted	890	$ 21.31
Vested	(867)	$ 13.25
Forfeited	(163)	$ 13.23
Nonvested, December 31, 2021	1,747	$ 16.33
Granted	977	$ 19.43
Vested	(689)	$ 15.23
Forfeited	(163)	$ 17.63
Non-vested, December 31, 2021	1,872	$ 16.33

As of December 31, 2021, there was $25.4 million of total unrecognized compensation cost related to restricted stock units. That cost is expected to be recognized over a weighted average period of 2.6 years. Restricted stock units do not have rights to dividends prior to vesting.

401(k) Savings Plan

In 1999, the Company established a 401(k) tax-deferred savings plan, whereby eligible employees may elect to defer up to 60% of their eligible compensation but not to exceed the statutorily prescribed limit to the 401(k) plan. The 401(k) plan also has a catch-up contribution feature for employees aged 50 or older who can defer up to 100% of their eligible compensation but not to exceed the statutorily prescribed limit to the 401(k) plan. Company contributions to this plan are discretionary; no such Company contributions have been made since the inception of this plan.

11. INCOME TAXES

During the years ended December 31, 2021 and 2020, loss before taxes from U.S. operations was ($19.7) million and ($18.4) million, respectively, and income before taxes from foreign operations was $1.4 million and $0.3 million, respectively.

	Year Ended December 31, 2021	Year Ended December 31, 2020
	(In thousands)	
U.S.		
Current	$ (67)	$ (1,325)
Deferred	1,318	21,056
Foreign		
Current	237	238
Withholding	1,591	2,392
Deferred	92	(58)
Total income tax expense	$ 3,171	$ 22,303

The income tax expense differs from the amount estimated by applying the statutory federal income tax rate (21% for 2021 and 2020) for the following reasons (in thousands):

	Year Ended December 31,	
	2021	2020
Federal statutory tax expense	$ (3,847)	$ (3,793)
State tax provision	239	703
Stock compensation expense	(499)	(602)
Tax credits	(2,676)	(3,488)
Foreign tax, net	1,653	2,443
Change in valuation allowance	8,099	29,034
Unrealized tax benefit reserve changes	(151)	—
Business combination costs	—	356
Tax law changes	—	(2,237)
Other	353	(113)
Total income tax expense	$ 3,171	$ 22,303

As of December 31, 2021, the Company had Federal and California net operating loss carry-forwards (“NOLs”) of approximately $51.6 million and $13.1 million, respectively. Some of the Federal NOLs, acquired as part of a past acquisition, have expirations at the end of 2021 and onwards, and the California NOLs begin expiring in 2028 onwards.

As of December 31, 2021, the Company had federal and state research and experimental and other tax credit (“R&D credits”) carry-forwards of approximately $21.0 million and $21.6 million, respectively. The federal credits begin to expire after 2022, while the California credits have no expiration. The extent to which the federal and state credit carry forwards can be used to offset future tax liabilities, respectively, may be limited, depending on the extent of ownership changes within any three-year period as provided in the Tax Reform Act of 1986 and the California Conformity Act of 1987.

The Company assesses its deferred tax assets for recoverability on a regular basis, and where applicable, a valuation allowance is recorded to reduce the total deferred tax asset to an amount that will, more likely than not, be realized in the future. Based on all available evidence, both positive and negative, the Company determined a full valuation allowance was still appropriate for its federal and state net deferred tax assets (DTAs) at December 31, 2021, primarily driven by a cumulative loss incurred over the 12-quarter period ended December 31, 2021 and the likelihood that the Company will not utilize tax attributes before they begin to expire at the end of 2022. The valuation allowance was approximately $51.6 million and $41.9 million as of December 31, 2021 and 2020, respectively. The increase in the valuation allowance from December 31, 2020 to December 31, 2021 was primarily driven by net operating losses (NOLs) and credits generated in the current year which require a valuation allowance. Management will continue to evaluate the need for a valuation allowance and may change its conclusion in a future period based on any change in facts (e.g. 12-quarter cumulative profit, significant new revenue, and other relevant factors). If the Company concludes that it is more likely than not to utilize some or all of its US DTAs, it will release some or all of its valuation allowance and our tax provision will decrease in the period in which we make such determination. Net deferred tax assets, after the US valuation allowance, was immaterial as of December 31, 2021 and $0.2 million as of December 31, 2020.

The components of the net deferred tax assets are comprised of (in thousands):

	December 31,	
	2021	2020
Deferred tax assets		
Net operating loss carry forward	$ 13,149	$ 8,085
Research and development and other credit carry forward	26,591	24,723
Foreign tax credit carry forward	11,010	9,435
Accruals deductible in different periods	3,362	3,471
Leases	1,472	1,669
Stock-based compensation	1,442	1,220
Total deferred tax assets	57,026	48,603
Less: valuation allowance	(51,586)	(41,859)
Deferred tax assets, net of valuation allowance	$ 5,440	$ 6,744
Deferred tax liabilities		
Property and equipment, net	178	(629)
Operating lease right-of-use assets	(1,472)	(1,669)
Intangible assets	(4,129)	(4,218)
Deferred tax liabilities	$ (5,423)	$ (6,516)
Net deferred tax assets	$ 17	$ 228

In accordance with the accounting standard relating to accounting for uncertain tax positions, the Company classifies its liabilities for income tax exposures as long-term. The Company includes interest and penalties related to unrecognized tax benefits within the Company's income tax provision. As of December 31, 2021 and 2020, the Company had accrued interest and penalties related to unrecognized tax benefits of $0.7 million and of $0.8 million, respectively. In the years ended December 31, 2021 and 2020, the Company recognized (reversal of) charges for interest and penalties related to unrecognized tax benefits of ($89,000) and $33,000 respectively, in the Consolidated Statements of Comprehensive Loss.

The Company's total amount of unrecognized tax benefits, excluding interest and penalties, as of December 31, 2021 was $14.7 million, of which $2.0 million, if recognized, would impact the Company's effective tax rate. As of December 31, 2021, the Company has recorded unrecognized tax benefits of $2.6 million, including interest and penalties of $0.7 million, as long-term income taxes payable in its Consolidated Balance Sheet. The remaining $12.9 million has been recorded within our deferred tax assets, which is subject to a full valuation allowance. The Company does not expect the change in unrecognized tax benefits over the next twelve months to materially impact its results of operations and financial position.

A reconciliation of the beginning and ending amount of unrecognized tax benefits is as follows (in thousands):

	Amount
Gross unrecognized tax benefits, January 1, 2020	13,615
Increases in tax positions for current year	1,024
Increases in tax positions for prior years	71
Lapse in statute of limitations	(410)
Gross unrecognized tax benefits, December 31, 2020	14,300
Increases in tax positions for current year	853
Increases in tax positions for prior years	1
Lapse in statute of limitations	(411)
Gross unrecognized tax benefits, December 31, 2021	$ 14,743

The Company does not provide deferred taxes on undistributed earnings of its foreign subsidiaries as it intends to indefinitely reinvest those earnings.

The Company conducts business globally and, as a result, files numerous consolidated and separate income tax returns in the U.S. federal, various state and foreign jurisdictions. For U.S. federal and California income tax purposes, the statute of limitations currently remains open for the years ended 2018 to present and 2017 to present, respectively. In addition, due to NOL carryback claims, the tax years 2013 through 2015 may be subject to federal examination and all of the net operating loss and research and development credit carryforwards that may be utilized in future years may be subject to federal and state examination. The Company is not currently under income tax examinations in the US or in any other of its major foreign subsidiaries' jurisdictions.

Valuation allowance for deferred tax assets is summarized (in thousands):

	Balance at Beginning of Period	Charged to Costs and Expenses	Deductions/ Write-offs of Accounts	Balance at End of Period
Valuation allowance for deferred tax assets				
2021	$ 41,859	$ 9,727	$ —	$ 51,586
2020	$ 10,486	$ 31,373	$ —	$ 41,859

12. NET LOSS PER SHARE

Basic net loss per share is computed by dividing net loss by weighted average number of common shares outstanding for the period (excluding outstanding stock options and shares subject to repurchase). Diluted net loss per share is computed using the weighted-average number of common shares outstanding for the period plus the potential effect of dilutive securities which are convertible into common shares (using the treasury stock method), except in cases in which the effect would be anti-dilutive. The following is a reconciliation of the numerators and denominators used in computing basic and diluted net loss per share (in thousands except per share amount):

	Year Ended December 31,	
	2021	2020
Numerator:		
Net loss	$ (21,488)	$ (40,363)
Denominator:		
Basic weighted-average shares outstanding	37,138	34,458
Effect of dilutive options and restricted stock units	—	—
Diluted weighted-average shares outstanding	37,138	34,458
Net loss per share, basic and diluted	$ (0.58)	$ (1.17)

For the years ended December 31, 2021 and 2020, because the Company was in a loss position, basic net loss per share is the same as diluted net loss per share as the inclusion of the potential common shares would have been anti-dilutive.

The following table sets forth potential shares of common stock that are not included in the diluted net loss per share calculation above because to do so would be anti-dilutive for the periods indicated (in thousands):

	Year Ended December 31,	
	2021	2020
Outstanding options	170	332
Non-vested restricted stock units	968	921
Employee Stock Purchase Plans	33	160
Total	1,171	1,413

13. CUSTOMER AND GEOGRAPHIC INFORMATION

Operating segments are defined as components of an enterprise about which separate financial information is available that is evaluated regularly by the chief operating decision maker, or group, in deciding how to allocate resources and in assessing performance.

The Company’s chief operating decision maker, the chief executive officer, reviews discrete financial information presented on a consolidated basis for purposes of regularly making operating decisions, allocation of resources, and assessing financial performance. Accordingly, the Company considers itself to be in one operating and reporting segment, specifically the provision of services for differentiated data and analytics solutions to the semiconductor and electronics industries.

Revenues from individual customers that are approximately 10% or more of the Company’s consolidated total revenues are as follows:

	Year Ended December 31,	
Customer	**2021**	**2020**
A	* %	23 %
D	17 %	* %
E	10 %	* %

Gross accounts receivable balances (including amounts that are unbilled) from individual customers that are approximately 10% or more of the Company’s gross accounts receivable balance are as follows:

	December 31,	
Customer	**2021**	**2020**
A	* %	16 %
B	15 %	* %
C	* %	11 %
D	29 %	* %

* represents less than 10%

Revenues from customers by geographic area based on the location of the customers’ work sites are as follows (in thousands):

	Year Ended December 31,			
	2021		2020	
	Revenues	**Percentage of Revenues**	**Revenues**	**Percentage of Revenues**
United States	$ 50,374	45 %	$ 36,723	42 %
China	14,267	13	13,776	16
Japan	11,097	10	4,762	5
Taiwan	6,387	6	8,038	9
Rest of the world	28,935	26	24,747	28
Total revenue	$ 111,060	100 %	$ 88,046	100 %

Long-lived assets, net by geographic area is as follows (in thousands):

	December 31, 2021	December 31, 2020
United States (1)	$ 39,158	$ 43,663
Rest of the world	1,545	2,251
Total long-lived assets, net	$ 40,703	$ 45,914

(1) Includes assets deployed at customer sites which could be outside the U.S.

14. FAIR VALUE MEASUREMENTS

Fair value is the exit price, or the amount that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants as of the measurement date. The multiple assumptions used to value financial instruments are referred to as inputs, and a hierarchy for inputs used in measuring fair value is established, that maximizes the use of observable inputs and minimizes the use of unobservable inputs by requiring that the most observable inputs be used when available. Observable inputs reflect assumptions market participants would use in pricing an asset or liability based on market data obtained from independent sources while unobservable inputs reflect a reporting entity's pricing based upon its own market assumptions. These inputs are ranked according to a fair value hierarchy that prioritizes the inputs to valuation techniques used to measure fair value into three broad levels.

Level 1 - Inputs are quoted prices in active markets for identical assets or liabilities.

Level 2 - Inputs are quoted prices for similar assets or liabilities in an active market, quoted prices for identical or similar assets or liabilities in markets that are not active, inputs other than quoted prices that are observable and market-corroborated inputs which are derived principally from or corroborated by observable market data.

Level 3 - Inputs are derived from valuation techniques in which one or more significant inputs or value drivers are unobservable.

The following table represents the Company's assets measured at fair value on a recurring basis as of December 31, 2021 and the basis for that measurement (in thousands):

		Fair Value Measurements Using		
Assets	December 31, 2021	Quoted Prices in Active Markets for Identical Assets (Level 1)	Significant Other Observable Inputs (Level 2)	Significant Unobservable Inputs (Level 3)
Cash equivalents				
Money market mutual funds	$ 12,474	$ 12,474	$ —	$ —
Short-term investments (available-for-sale debt securities)				
U.S. Government securities	112,542	112,542	—	—
Total	$ 125,016	$ 125,016	$ —	$ —

The following table represents the Company's assets measured at fair value on a recurring basis as of December 31, 2020 and the basis for that measurement (in thousands):

Assets	December 31, 2020	Fair Value Measurements Using Quoted Prices in Active Markets for Identical Assets (Level 1)	Significant Other Observable Inputs (Level 2)	Significant Unobservable Inputs (Level 3)
Cash equivalents				
Money market mutual funds	$ 18,012	$ 18,012	$ —	$ —
Short-term investments (available-for-sale debt securities)				
U.S. Treasury bills	114,981	114,981	—	—
Total	$ 132,993	$ 132,993	$ —	$ —

(1) The carrying amount of the Company's investments in U.S. Treasury bills approximate fair value due to their short-term maturities, and there have been no events or changes in circumstances that would have had a significant effect on the fair value of these securities at December 31, 2021 and 2020.

From time to time, the Company enters into foreign currency forward contracts to reduce the exposure to foreign currency exchange rate fluctuations on certain foreign currency denominated monetary assets and liabilities, primarily on third-party accounts payables and intercompany balances. The primary objective of the Company's hedging program is to reduce volatility of earnings related to foreign currency exchange rate fluctuations. The counterparty to these foreign currency forward contracts is a financial institution that the Company believes is creditworthy, and therefore, the Company believes the credit risk of counterparty nonperformance is not significant. These foreign currency forward contracts are not designated for hedge accounting treatment. Therefore, the change in fair value of these contracts is recorded into earnings as a component of other expense (income), net, and offsets the change in fair value of the foreign currency denominated assets and liabilities, which is also recorded in other expense (income), net in the Company's Consolidated Statements of Comprehensive Loss. There was no realized gain or loss from foreign currency forward contracts during the year ended December 31, 2021. For the year ended December 31, 2020, the Company recognized a realized loss of $0.2 million on the contracts, which is recorded in interest and other expense (income), net in the Company's Consolidated Statement of Comprehensive Loss. As of December 31, 2021 and 2020, the Company had no outstanding forward contracts.

15. SELECTED QUARTERLY FINANCIAL DATA (UNAUDITED)

The following is a summary of the Company's quarterly consolidated results of operations (unaudited) for the fiscal years ended December 31, 2021 and 2020.

	Year Ended December 31, 2021			
	Q1	Q2	Q3	Q4
	(In thousands, except for per share amounts)			
Total revenues	$ 24,200	$ 27,419	$ 29,555	$ 29,886
Costs of revenues	$ 10,663	$ 10,785	$ 11,070	$ 11,675
Net loss	$ (7,597)	$ (4,484)	$ (2,407)	$ (7,000)
Net loss per share:				
Basic and diluted	$ (0.21)	$ (0.12)	$ (0.06)	$ (0.19)

	Year Ended December 31, 2020			
	Q1	Q2	Q3	Q4
	(In thousands, except for per share amounts)			
Total revenues	$ 21,158	$ 21,409	$ 23,112	$ 22,367
Costs of revenues	$ 8,487	$ 8,946	$ 9,493	$ 9,839
Net loss	$ (528)	$ (3,652)	$ (2,734)	$ (33,449)
Net loss per share:				
Basic and diluted	$ (0.02)	$ (0.11)	$ (0.08)	$ (0.91)

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

None.

Item 9A. *Controls and Procedures*

Evaluation of Disclosure Controls and Procedures

Our management, with the participation of our principal executive officer and principal financial and accounting officer, evaluated the effectiveness of our "disclosure controls and procedures" as defined in Exchange Act Rules 13a-15(e) and 15d-15(e) as of December 31, 2021, in connection with the filing of this Annual Report on Form 10-K. Based on that evaluation, as of December 31, 2021, our principal executive officer and principal financial and accounting officer concluded that our disclosure controls and procedures were effective to ensure that information we are required to disclose in reports that we file or submit under the Exchange Act is recorded, processed, summarized and reported within the time periods specified in the rules and forms of the SEC and is accumulated and communicated to our management as appropriate to allow timely decisions regarding required disclosure.

Management's Report on Internal Control over Financial Reporting

Our management is responsible for establishing and maintaining adequate internal control over financial reporting, as defined in Rules 13a-15(f) and 15d-15(f) under the Exchange Act, for the Company. Our management, with the participation of our principal executive officer and principal financial and accounting officer, assessed the effectiveness of our internal control over financial reporting (ICFR) as of December 31, 2021. This evaluation was based on the framework established in *Internal Control—Integrated Framework (2013)* issued by the Committee of Sponsoring Organizations of the Treadway Commission ("COSO"). Based on our assessment under the COSO framework, our management concluded that our internal control over financial reporting was effective as of December 31, 2021.

The effectiveness of the Company's internal control over financial reporting as of December 31, 2021, has been audited by BPM LLP, the Company's independent registered public accounting firm, as stated in their report which appears in this Annual Report on Form 10-K.

Changes in Internal Control over Financial Reporting

There were no changes in internal control over financial reporting during the fourth quarter ended December 31, 2021, which has materially affected, or is reasonably likely to materially affect, our internal control over financial reporting. We have not experienced any significant impact to our internal controls over financial reporting despite the fact that most of our employees are working remotely due to the COVID-19 pandemic. The design of our processes and controls allow for remote execution with accessibility to secure data. We are continually monitoring and assessing the COVID-19 situation to minimize the impact, if any, on the design and operating effectiveness on our internal controls.

Item 9B. *Other Information.*

None.

Item 9C. *Disclosure Regarding Foreign Jurisdictions that Prevent Inspections.*

None.

PART III

Pursuant to Paragraph (3) of the General Instructions to Form 10-K, certain of the information required by Part III of this Form 10-K is incorporated by reference from our Proxy Statement as set forth below. The Proxy Statement is expected to be filed within 120 days of December 31, 2021.

Item 10. *Directors, Executive Officers and Corporate Governance.*

Information with respect to our directors and our Audit Committee appears in our Proxy Statement under "Proposal No. 1 — Election of Directors — Nominees for the Board of Directors" and is incorporated herein by reference. Information with respect to our executive officers appears in Part I, Item 1 — "Information about our Executive Officers" of this Form 10-K.

With regard to the information required by this item regarding compliance with Section 16(a) of the Exchange Act, we will provide disclosure of delinquent Section 16(a) reports, if any, in our Proxy Statement, and such disclosure, if any, is incorporated herein by reference.

Our Board of Directors has adopted a Code of Ethics ("Code of Ethics"), which is applicable to all employees of the Company, including our principal executive officer and our principal financial and accounting officer. Our Code of Ethics is available on our website at www.pdf.com, on the investor relations page. The Company's website address provided is not intended to function as a hyperlink, and the information on the Company's website is not, and should not be considered, part of this Annual Report on Form 10-K and is not incorporated by reference herein. You may also request a copy of our Code of Ethics in writing by sending your request to PDF Solutions, Inc., Attention: Investor Relations, 2858 De La Cruz Blvd., Santa Clara, California 95050. If we make any substantive amendments to our Code of Ethics or grant any waiver, including any implicit waiver, from a provision of the Code of Ethics to our Chief Executive Officer or Chief Financial Officer, we will disclose the nature of such amendment or waiver on our website or in a current report on Form 8-K.

Item 11. *Executive Compensation.*

The information required by this item is incorporated herein by reference to the section entitled "Compensation of Executive Officers and Other Matters — Executive Compensation" in our Proxy Statement.

Item 12. *Security Ownership of Certain Beneficial Owners and Management and Related Stockholder Matters.*

The information required by this item is incorporated herein by reference to the section entitled "Security Ownership of Certain Beneficial Owners and Management" in our Proxy Statement. Also incorporated by reference is the information in the table under the heading "Equity Compensation Plan Information" in our Proxy Statement.

Item 13. *Certain Relationships and Related Transactions, and Director Independence.*

The information required by this item is incorporated herein by reference to the section entitled "Certain Relationships and Related Transactions and Directors Independence" in our Proxy Statement.

Item 14. *Principal Accountant Fees and Services.*

Information with respect to Principal Accountant Fees and Services is incorporated by reference to "Proposal No. 2: Ratification of Appointment of Independent Registered Public Accounting Firm" in our Proxy Statement.

PART IV

Item 15. ***Exhibits and Financial Statement Schedules***

(a) The following documents are filed as part of this report:

(1) Consolidated Financial Statements and Reports of Independent Registered Public Accounting Firms

The following documents are included as Part II, Item 8 of this Form 10-K:

	Page
Reports of BPM LLP, Independent Registered Public Accounting Firm (PCAOB ID: 207)	47
Consolidated Balance Sheets as of December 31, 2021 and 2020	50
Consolidated Statements of Comprehensive Loss for the Years Ended December 31, 2021 and 2020	51
Consolidated Statements of Stockholders' Equity for the Years Ended December 31, 2021 and 2020	52
Consolidated Statements of Cash Flows for the Years Ended December 31, 2021 and 2020	53
Notes to Consolidated Financial Statements	55

(2) Financial Statement Schedules

All financial statement schedules have been omitted, since the required information is not applicable or is not present in amounts sufficient to require submission of the schedule, or because the information required is included in the consolidated financial statements and notes thereto included in this Form 10-K.

(3) Exhibits required by Item 601 of Regulation S-K

See Item 15(b) below.

(b) Exhibits

INDEX TO EXHIBITS

Exhibit Number	Description
1.01	Board of Directors Acceleration Agreement (incorporated herein by reference to the registrant's Current Report on Form 8-K filed November 23, 2005)*
3.01	Third Amended and Restated Certificate of Incorporation of PDF Solutions, Inc. (incorporated herein by reference to registrant's Registration Statement on Form S-1/A filed July 9, 2001)
3.02	Amended and Restated Bylaws of PDF Solutions, Inc. (incorporated herein by reference to registrant's Quarterly Report on Form 8-K filed May 1, 2019)
4.01	Specimen Stock Certificate (incorporated herein by reference to registrant's Quarterly Report on Form 10-Q filed September 6, 2001)
4.02	Stockholder Agreement by and between PDF Solutions, Inc. and Advantest America, Inc. dated July 29, 2020 (incorporated herein by reference to registrant's Quarterly Report on Form 10-Q filed November 6, 2020)
4.03	Description of the Registrant's Securities Registered Pursuant to Section 12 of the Securities Exchange Act of 1934†
10.01	Form of Indemnification Agreement between PDF Solutions, Inc. and certain of its executive officers and directors (incorporated herein by reference to registrant's Registration Statement on Form S-1 filed August 7, 2000)
10.02	Form of Indemnification Agreement between PDF Solutions, Inc. and certain of its senior executive officers and directors (incorporated herein by reference to the registrant's Annual Report on Form 10-K filed March 16, 2009)*
10.03	PDF Solutions, Inc. 2021 Employee Stock Purchase Plan (incorporated herein by reference to Annex A to the registrant's proxy statement filed on April 28, 2021)*
10.04	PDF Solutions Inc. Sixth Amended and Restated 2011 Stock Incentive Plan (incorporated herein by reference to Appendix A to the registrant's proxy statement dated May 8, 2020)*
10.05	Form of Stock Option Agreement (Non-statutory) under PDF Solutions, Inc. 2011 Stock Incentive Plan (incorporated herein by reference to registrant's Annual Report on Form 10-K filed March 15, 2012)*
10.06	Form of Stock Unit Agreement under PDF Solutions, Inc. 2011 Stock Incentive Plan (incorporated herein by reference to registrant's Annual Report on Form 10-K filed March 15, 2012)*
10.07	Form of Stock Appreciation Right Agreement under PDF Solutions, Inc. 2011 Stock Incentive Plan (incorporated herein by reference to registrant's filing on Form 10-Q filed November 9, 2012)*
10.08	Employment confirmation to John Kibarian from PDF Solutions, Inc. dated October 13, 2009 (incorporated herein by reference to registrant's Annual Report on Form 10-K filed March 15, 2012)*
10.09	Employment confirmation to Kimon Michaels from PDF Solutions, Inc. dated October 13, 2009 (incorporated herein by reference to registrant's Annual Report on Form 10-K filed March 15, 2012)*
10.10	Employment offer to Adnan Raza, dated January 23, 2020 (incorporated herein by reference to registrant's filing on Form 10-K filed on March 10, 2020)*
10.11	Software License and Related Services Agreement by and between PDF Solutions, Inc. and Advantest America, Inc. dated March 25, 2020 and Amendment No.1 thereto dated July 29, 2020 (incorporated herein by reference to registrant's Quarterly Report on Form 10-Q filed November 6, 2020)+
10.12	Amended and Restated Master Development Agreement by and between PDF Solutions, Inc. and Advantest America, Inc. dated July 29, 2020 (incorporated herein by reference to registrant's Quarterly Report on Form 10-Q filed November 6, 2020)+
10.13	Master Commercial Terms and Support Services Agreement by and between PDF Solutions, Inc. and Advantest America, Inc. dated July 29, 2020 (incorporated herein by reference to registrant's Quarterly Report on Form 10-Q filed November 6, 2020)+
10.14	Securities Purchase Agreement by and between PDF Solutions, Inc. and Advantest America, Inc. dated July 29, 2020 (incorporated herein by reference to registrant's Quarterly Report on Form 10-Q filed November 6, 2020)+.

Exhibit Number	Description
21.01	Subsidiaries of Registrant †
23.01	Consent of BPM LLP, Independent Registered Public Accounting Firm†
31.01	Certifications of the principal executive officer and principal financial and accounting officer pursuant to Exchange Act Rules 13a-14(a) and 15d-14(a), as adopted pursuant to Section 302 of the Sarbanes-Oxley Act of 2002†
31.02	Certifications of the principal executive officer and principal financial and accounting officer pursuant to Exchange Act Rules 13a-14(a) and 15d-14(a), as adopted pursuant to Section 302 of the Sarbanes-Oxley Act of 2002†
32.01	Certification pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002**
32.02	Certification pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002**
101	The following financial statements from the Company's Annual Report on Form 10-K for the year ended December 31, 2021, formatted in Inline XBRL: (i) Consolidated Balance Sheets as of December 31, 2021 and 2020, (ii) Consolidated Statements of Comprehensive Loss for the Years Ended December 31, 2021 and 2020, (iii) Consolidated Statements of Changes in Stockholders' Equity for the Years Ended December 31, 2021 and 2020, (iv) Consolidated Statements of Cash Flows for the Years Ended December 31, 2021 and 2020, and (v) Notes to Consolidated Financial Statements, tagged as blocks of text and including detailed tags.
104	Cover Page Interactive Data File (formatted as Inline XBRL and contained in Exhibit 101)

* Indicates management contract or compensatory plan or arrangement.
† Filed herewith.
** Furnished, and not filed.
\+ Certain portions of this document that constitute confidential information have been redacted in accordance with Regulation S-K, Item 601(b)(10).

Item 16. ***Form 10-K Summary***

Not applicable.

SIGNATURES

Pursuant to the requirements of Section 13 or 15(d) of the Securities Exchange Act of 1934, the Registrant has duly caused this report to be signed on its behalf by the undersigned, thereunto duly authorized.

PDF SOLUTIONS, INC.

By:/s/ John K. Kibarian
John K. Kibarian
President and Chief Executive Officer
(Principal executive officer)

By:/s/ Adnan Raza
Adnan Raza
Executive Vice President, Finance and Chief Financial Officer
(Principal financial and accounting officer)

Date March 1, 2022

Pursuant to the requirements of the Securities Exchange Act of 1934, this report has been signed below by the following persons on behalf of the registrant and in the capacities and on the dates indicated.

Date	Signature	Title
March 1, 2022	/s/ JOHN K. KIBARIAN John K. Kibarian	Director, President and Chief Executive Officer (Principal executive officer)
March 1, 2022	/s/ ADNAN RAZA Adnan Raza	Executive Vice President, Finance and Chief Financial Officer (Principal financial and accounting officer)
March 1, 2022	/s/ JOSEPH R. BRONSON Joseph R. Bronson	Lead Independent Director
March 1, 2022	/s/ NANCY ERBA Nancy Erba	Director
March 1, 2022	/s/ MICHAEL B. GUSTAFSON Michael Gustafson	Director
March 1, 2022	s/ MARCO IANSITI Marco Iansiti	Director
March 1, 2022	s/ YE JANE LI Ye Jane Li	Director
March 1, 2022	s/ KIMON MICHAELS Kimon Michaels	Director
March 1, 2022	s/ SHUO ZHANG Shuo Zhang	Director

Exhibit 4.03

DESCRIPTION OF THE REGISTRANT’S SECURITIES REGISTERED PURSUANT TO SECTION 12 OF THE SECURITIES EXCHANGE ACT OF 1934

PDF Solutions, Inc. (“we,” “our,” “us,” or the “Company”) has one class of securities registered under Section 12 of the Securities Exchange Act of 1934, as amended: our common stock. The following summary of the terms of our common stock is based upon our Third Amended and Restated Certificate of Incorporation (“Restated Certificate”) and our Amended and Restated Bylaws (“Bylaws”). This summary does not purport to be complete and is subject to, and is qualified in its entirety by express reference to, the applicable provisions of our Restated Certificate of Incorporation and our Bylaws, which are filed as exhibits to our Annual Report on Form 10-K and are incorporated by reference herein. We encourage you to read our Restated Certificate, our Bylaws and the applicable provisions of the Delaware General Corporation Law (the “DGCL”) for more information.

DESCRIPTION OF COMMON STOCK

General

Our authorized capital stock consists of 70,000,000 shares of common stock with a par value of $0.00015 per share, and 5,000,000 shares of preferred stock with a par value of $0.00015 per share, all of which shares of preferred stock are undesignated. Our board of directors may establish the rights and preferences of the preferred stock from time to time.

Common Stock

The holders of common stock are entitled to one vote for each share held of record on all matters submitted to a vote of the stockholders. Subject to preferences that may be applicable to any outstanding preferred stock, holders of common stock are entitled to receive ratably such dividends as may be declared by the board of directors out of funds legally available for that purpose. See "Dividend Policy." In the event of our liquidation, dissolution or winding, the holders of common stock are entitled to share ratably in all assets remaining after payment of liabilities, subject to the prior distribution rights of any outstanding preferred stock. The common stock has no preemptive or conversion rights or other subscription rights. The outstanding shares of common stock are fully paid and non-assessable.

Delaware Anti-Takeover Law and Charter and Bylaw Provisions

Provisions of Delaware law and our charter documents could make our acquisition and the removal of incumbent officers and directors more difficult. These provisions are expected to discourage certain types of coercive takeover practices and inadequate takeover bids and to encourage persons seeking to acquire control of us to negotiate with us first. We believe that the benefits of increased protection of our potential ability to negotiate with the proponent of an unfriendly or unsolicited proposal to acquire or restructure us outweighs the disadvantages of discouraging such proposals because, among other things, negotiation of such proposals could result in an improvement of their terms.

We are subject to the provisions of Section 203 of the Delaware law. In general, the statute prohibits a publicly-held Delaware corporation from engaging in a "business combination" with an "interested stockholder" for a period of three years after the date that the person became an interested stockholder unless, subject to exceptions, the business combination or the transaction in which the person became an interested stockholder is approved in a prescribed manner. Generally, a "business combination" includes a merger, asset or stock sale, or other transaction resulting in a financial benefit to the stockholder. Generally, an "interested stockholder" is a person who, together with affiliates and associates, owns, or within three years prior, did own, 15% or more of the corporation's voting stock. These provisions may have the effect of delaying, deferring or preventing a change in control of us without further action by the stockholders.

Our Restated Certificate provides that stockholder action can be taken only at an annual or special meeting of stockholders and may not be taken by written consent. The Bylaws provide that special meetings of stockholders can be called only by the board of directors, the chairperson of the board, or by the president. The bylaws set forth an advance notice procedure with regard to the nomination, other than by or at the direction of the board of directors, of candidates for election as directors and with regard to business to be brought before a meeting of stockholders.

Transfer Agent and Registrar

The transfer agent and registrar for the common stock is ComputerShare Investor Services, at 250 Royall Street, Canton, MA 02021.

Exhibit 21.01

Subsidiaries of Registrant

Name of Entity	Jurisdiction of Incorporation or Organization
Cimetrix Incorporated	Nevada
Cimetrix International, Inc.	Nevada
Cimetrix Japan KK	Japan
Cimetrix Software (Shanghai) Co., Ltd.	China
PDF Solutions Asia Services, Inc.	Delaware
PDF Solutions Canada Ltd.	Canada
PDF Solutions GmbH	Germany
PDF Solutions International Services, Inc.	Delaware
PDF Solutions KK	Japan
PDF Solutions Pacific Services, Inc.	Delaware
PDF Solutions SARL	France
PDF Solutions Semiconductor Technology (Korea) Limited	Korea
PDF Solutions Semiconductor Technology (Shanghai) Co. Ltd.	China
PDF Solutions Semiconductor Technology Taiwan Ltd.	Taiwan
Syntricity, Inc.	California

Exhibit 23.01

CONSENT OF INDEPENDENT REGISTERED PUBLIC ACCOUNTING FIRM

We hereby consent to the incorporation by reference in the Registration Statements on Form S-8 (Nos. 333-257792, 333-233070, 333-202455, 333-180324, 333-167533, 333-159211, 333-149281, 333-141660, 333-133332, 333-112728, 333-109809, and 333-102509) of PDF Solutions, Inc. of our reports dated March 1, 2022 relating to the consolidated financial statements and internal control over financial reporting which appear in this Annual Report on Form 10-K.

/s/ BPM LLP

San Jose, California
March 1, 2022

EXHIBIT 31.01

CERTIFICATIONS

I, John K. Kibarian, certify that:

1. I have reviewed this annual report on Form 10-K of PDF Solutions, Inc.;

2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;

3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the period presented in this report;

4. The registrant's other certifying officer(s) and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:

(a) Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;

(b) Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;

(c) Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and

(d) Disclosed in this report any change in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter (the registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and

5. The registrant's other certifying officer(s) and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of registrant's board of directors (or persons performing the equivalent functions):

(a) All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and

(b) Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

/s/ John K. Kibarian
John K. Kibarian
President and Chief Executive Officer
(principal executive officer)

March 1, 2022

EXHIBIT 31.02

CERTIFICATIONS

I, Adnan Raza, certify that:

1. I have reviewed this annual report on Form 10-K of PDF Solutions, Inc.;

2. Based on my knowledge, this report does not contain any untrue statement of a material fact or omit to state a material fact necessary to make the statements made, in light of the circumstances under which such statements were made, not misleading with respect to the period covered by this report;

3. Based on my knowledge, the financial statements, and other financial information included in this report, fairly present in all material respects the financial condition, results of operations and cash flows of the registrant as of, and for, the periods presented in this report;

4. The registrant's other certifying officer(s) and I are responsible for establishing and maintaining disclosure controls and procedures (as defined in Exchange Act Rules 13a-15(e) and 15d-15(e)) and internal control over financial reporting (as defined in Exchange Act Rules 13a-15(f) and 15d-15(f)) for the registrant and have:

(a) Designed such disclosure controls and procedures, or caused such disclosure controls and procedures to be designed under our supervision, to ensure that material information relating to the registrant, including its consolidated subsidiaries, is made known to us by others within those entities, particularly during the period in which this report is being prepared;

(b) Designed such internal control over financial reporting, or caused such internal control over financial reporting to be designed under our supervision, to provide reasonable assurance regarding the reliability of financial reporting and the preparation of financial statements for external purposes in accordance with generally accepted accounting principles;

(c) Evaluated the effectiveness of the registrant's disclosure controls and procedures and presented in this report our conclusions about the effectiveness of the disclosure controls and procedures, as of the end of the period covered by this report based on such evaluation; and

(d) Disclosed in this report any change in the registrant's internal control over financial reporting that occurred during the registrant's most recent fiscal quarter (the registrant's fourth fiscal quarter in the case of an annual report) that has materially affected, or is reasonably likely to materially affect, the registrant's internal control over financial reporting; and

5. The registrant's other certifying officer(s) and I have disclosed, based on our most recent evaluation of internal control over financial reporting, to the registrant's auditors and the audit committee of registrant's board of directors (or persons performing the equivalent functions):

(a) All significant deficiencies and material weaknesses in the design or operation of internal control over financial reporting which are reasonably likely to adversely affect the registrant's ability to record, process, summarize and report financial information; and

(b) Any fraud, whether or not material, that involves management or other employees who have a significant role in the registrant's internal control over financial reporting.

/s/ Adnan Raza
Adnan Raza
Executive Vice President, Finance and Chief Financial Officer
(Principal financial and accounting officer)

March 1, 2022

CERTIFICATION PURSUANT TO
18 U.S.C. SECTION 1350,
AS ADOPTED PURSUANT TO
SECTION 906 OF THE SARBANES-OXLEY ACT OF 2002

In connection with the Annual Report of PDF Solutions, Inc. (the “Company”) on Form 10-K for the year ended December 31, 2021 as filed with the Securities and Exchange Commission on March 1, 2022 (the “Report”), I, John K. Kibarian, President and Chief Executive Officer of the Company, certify, pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002, that, to my knowledge:

(1) The Report fully complies with the requirements of section 13(a) or 15(d) of the Securities Exchange Act of 1934; and

(2) The information contained in the Report fairly presents, in all material respects, the financial condition and result of operations of the Company.

/s/ John K. Kibarian
John K. Kibarian
President and Chief Executive Officer
(principal executive officer)

March 1, 2022

EXHIBIT 32.02

CERTIFICATION PURSUANT TO
18 U.S.C. SECTION 1350,
AS ADOPTED PURSUANT TO
SECTION 906 OF THE SARBANES-OXLEY ACT OF 2002

In connection with the Annual Report of PDF Solutions, Inc. (the “Company”) on Form 10-K for the year ended December 31, 2021 as filed with the Securities and Exchange Commission on March 1, 2022 (the “Report”), I, Adnan Raza, Executive Vice President, Finance and Chief Financial Officer of the Company, certify, pursuant to 18 U.S.C. Section 1350, as adopted pursuant to Section 906 of the Sarbanes-Oxley Act of 2002, that, to my knowledge:

(1) The Report fully complies with the requirements of section 13(a) or 15(d) of the Securities Exchange Act of 1934; and

(2) The information contained in the Report fairly presents, in all material respects, the financial condition and result of operations of the Company.

/s/ Adnan Raza
Adnan Raza
Executive Vice President, Finance and Chief Financial Officer
(principal financial and accounting officer)

March 1, 2022