THE WORLDFOLIO

Crestec, Japan Oct. 23, 2020

Driving the advancement of 5G/6G internet

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Established in 1995, Crestec Corporation develops the Advanced Productive Electron Beam Lithography (ELB) Systems used to manufacture DFB LDs (distributed feedback semiconductor laser diodes) that are essential to the manufacture of the latest optical devices. In this interview, president, Hideyuki Ohyi, discusses some of the company's latest products, which allow for greater speed and efficiency, higher precision and performance, and lower costs in the manufacturing of the latest DFB-LDs for 5G/6G, cloud services, medical sensing and LiDAR.

The SME sector is the most important sector in Japan as it provides more than 50% added value to the GDP, with SMEs making up 95% of the total companies in Japan. In accumulation, SMEs have the largest share of employment in Japan as well. How can these SMEs compete worldwide and serve the best products to the international market?

The company itself was founded in 1995, and the following year we were able to provide a solution to a niche-specific problem. It was a very short time, but we proved it was possible. About 10 years ago, the optical communication industry underwent a major change. In order to keep up with this change, we are developed an Electron Beam Lithography System (EBL) Model CABL-9000C for manufacturing Distributed Feedback semiconductor Laser Diodes (DFB-LDs), which is a system that replaces an optical holography system. Traditionally, a two-optical beam interference exposure machine using holographic interferometry has been used to create diffraction gratings, but this grating machine can only create a couple of gratings. However, with our machine we were able to write many gratings with different pitches on a single wafer.

In our case, we are providing new technologies (patented) such as "Field Size Modulation Function (FSM)" which is one of the major attachments for our EBL. It provides a position solution rather than a pattern solution with the tremendous fine position resolution of 0.001 nanometer (1 picometer). Since the grating pitch is an important part of the DFB-LD, the application itself is for ultra-precision gratings. At that time, the position control of conventional electron beam writers was limited to an integer multiple of the minimum unit of 2.5 nm. On the other hand, we succeeded in

miniaturizing the position resolution of our machine using the FSM function by 1/2500 of the conventional model.

We usually collaborate with our customers to create solutions. For example, NEC has manufactured a distributed feedback semiconductor laser grating that is often used in optical communications. They required a minimum grating pitch difference of 0.0012 nm for wavelength division multiplexing (WDM) light sources. This resolution became 0.008 nm when converted to the wavelength resolution when it became DFB-LD. Therefore, grating formation and pitch control through our EBL is a promising way to precisely control the lasing wavelength of DFB-LDs. Simultaneous fabrication of DFB-LDs with different wavelength has been demonstrated using our EBL, which is a promising technology allowing WDM light source to be made at a reasonable manufacturing costs. In the experiments, 40 DFB-LDs with different wavelengths were fabricated using our EBL. Slightly different pitch gratings from 235.98 nm to 247.68 nm (40 channels) with 0.3 nm steps were formed on a wafer. The λ/4 shifted structure was used for the grating. Finally, we accomplished the lasing spectra for all 40 channels of the DFB-LDs. As a result, a very wide lasing wavelength range of 75 nm from 1518.2 nm to 1593.2 nm was obtained. It is really difficult to reach such a special position resolution and to do this reproducibly. However, we were able to resolve this problem in 2-3 months.

The semiconductor and communication industries are growing a lot. Do you think this will affect your company to grow? Are you excited about the new development of this market?

Yes, definitely. For example, the CABL-9000C, which is one of our EBL products, is essential in the manufacture of DFB-LDs for optical communication devices. The optical communication market grew by CAGR of 14% annually from 2015 to 2019. In the optical active device market, in particular, the “25Gbps DFB-LD market” is expected to achieve CAGR of 30% or more from 2019 to 2025.

Over the five years from 2015 to 2020, global internet protocol traffic tripled and global mobile bandwidth increased nine-fold. In addition, Internet video traffic has quadrupled in five years and cloud services have doubled in five years. You can see that growth is expanding towards the future.

We believe that our EBL can be useful for the production of not only DFB-LDs but also new multiple high value-added compound semiconductor devices used in these industries and contribute to the development of the industry. We are excited about the development of new markets that offer our new challenges.

How is 5G technology going to affect the industry?

5G requires Specified Base Stations and Altitude-Specified Base Stations for transmission and reception, and the Altitude-Specified Base Stations are connected to the cloud by high-capacity optical communication. Current 4G base stations can reach radio waves within a radius of 2 to 3 km, but 5G radio waves can only reach a cell area with a radius of 100 meters, so more Specified Base Stations are needed in smaller areas. Therefore, due to the rapid growth of 5G, more DFB-LDs will be required. The introduction of CABL-9000C is expected to increase, and it can be expected that the business will grow into the future.

In addition, the introduction of 5G is expected to contribute to the creation of new industries and the resolution of social issues through collaboration among various

industries. In particular, we believe that our EBL can contribute to the creation of new cutting-edge semiconductor devices used in smart cities, autonomous driving support, telemedicine, AR/VR, etc. Now we are very excited.

What is your competitive advantage?

Our market share has reached 65% of the global market with the direct write EBL for production, because of our competitive advantage of minimizing the manufacturing cost of DFB-LD devices and creating high-performance products with high-yield rate.

Thereby technology for manufacturing DFB-LDs is the FSM function that can control the multiple grating pitches accurately on the picometer order. With the stable hardware and software that drives the FSM function, all of our customers were able to accurately control the lasing wavelengths of the DFB-LDs by drawing and processing proper and accurate pitch sizes.

The DFB laser diodes produced by our CABL-9000C can be used for batch writing of multi-period gratings, which is a very important technology for manufacturing optical transceivers for DWDM. Our product was able to manufacture 40 different channels or more DFB-LDs at one time. All channels showed stable single-mode oscillations with a side mode suppression ratio (SMSR) of more than 35 dB.

There are a total of 25 existing CABL-9000C installation systems in Japan, the United States and China as the industrial application, and all machines are operating effectively. Our customers are very happy with our machine and want to introduce us to new customers. For example, the University of California, Berkeley introduced the No. 1 optical communications component company who ended up purchasing five of our products.

Recently, we have commercialized and started selling the CABL-AP machine as a successor to the CABL-9000C. The feature of this machine is that DFB-LD devices with an element length of 1500 μm or more can be produced at high speed and with high accuracy. This device is suitable as a light source for image sensors (LiDAR) in self-driving cars and is expected to expand the market.

In the future, which markets show the best potential for growth for Crestec?

In this business, we have two major markets. One is academics, where our clients include top universities such as the University of Cambridge and Tokyo University. The other one is the industrial market. Hence, we can support customers from the scientific research sectors and industrial purpose sectors.

However, at present, we are expanding our sales channels by focusing on both the optical communication components and compound semiconductor device fields. This includes the companies that are developing massively on 5G or 6G components and sub-systems, and we are planning to take advantage of that.

In the future, we will aim for sustainable growth by balancing both the academic and industrial sectors.

What is the importance of R&D in your company?

R&D has played a major role in our company. Without R&D and innovation, our products such as CABL-9000C and CABL-UH130 would not have existed. This product offers various value-added features with the new concept that enables FSM function, high-speed drawing function and self-environment control. We are still promoting two “new cutting-edge system development projects” with a focus on market trends, and one will be released as a new product in the near future.

What is your strategy to go abroad and penetrate your product in the international market?

In the United States, we participate in various exhibitions to introduce our products. In March 2019, we exhibited at the Optical Networking and Communication Conference & Exhibition (OFC) held in San Diego. In May 2019, we exhibited at the International Conference on Electron, Ion, and Photon Beam Technology and Nanofabrication (EIPBN) held in Minneapolis, USA. At this international conference, we made an oral presentation under the title of "Fabrication of sub-10 nanometer half-pitch line and space structure by using electron beam lithography". In this way, we are taking a strategy to attract customers' interest and gain a deeper understanding of our development and technical capabilities by exhibiting at an adjoining exhibition at the same time.

In Europe, we have established two representative offices. The first is in UK and the second is in Spain. We also participated in the LASER World of Photonics held in Munich, Germany in June 2019. These exhibitions are very important because they can connect and extend our network to reach new customers. Last January, we also received an order from the Moscow Institute in Russia and the private company in Belarus.

However, between all the countries, we see potential in China. It is because they have a huge market and so far, we have installed some of our machines for both academic and industrial customers in China. Therefore, we are going to keep the good relationship with them and continuously responding to their demands.

What is your ambition for the next 10 years?

The impact of the coronavirus crisis on the global economy is enormous. However, the information and communication market is expected to recover in a V shape post corona, and we are working hard not to miss it. We anticipate rapid growth in the Data Center, IoT, 5G, 6G, AI and robotics markets.

Many high-performance compound semiconductor devices will be used in these markets. We would like to develop the industrial EB lithography technology cultivated in DFB-LD device production and aim for sustainable growth as a top player of multiple compound semiconductor device manufacturing machines.

On the other hand, in order to strengthen our sales force, we established Quantum World Inc. as a sister company of Crestec in 1 July, 2020 and started their business. In addition to promoting sales in the current target market, we have something planned for project and sales regarding advanced manufacturing equipment that can contribute to innovative next-generation technologies such as quantum computers, quantum communications, and quantum sensors.

By supporting the creation of a system that fuses cyber and physical spaces at a high level, we would like to contribute to the construction of a human-centered society that balances economic development and social problem resolution as Society 5.0.