Top Interview with Compound Semiconductor China - Dr. Limin Zhou MRSI (Mycronic Group)

At the beginning of 2022, Dr. Limin Zhou, General Manager at MRSI Automation (Shenzhen) Co., Ltd., and Senior Director, Strategic Marketing at MRSI (Mycronic Group), was Interviewed by Compound Semiconductor China magazine. In the interview, Dr. Zhou shared his views on the development trends and challenges for the compound semiconductor industry in 2022 and introduced the features and advantages of MRSI's Die bonding solutions widely used by customers in the sector.

Compound Semiconductor: 2022 has arrived, Dr. Zhou. How do you see the compound semiconductor industry going in the coming year? What might happen? What progress can be expected? Some people call 2021 "the first year of the development of the third generation of compound semiconductors." Please list some events or developments that have had an important impact on the industry, and what are your conclusions and insights?

Dr. Limin Zhou at MRSI: In 2022, the compound semiconductor market will continue the growth momentum of 2021. This projection is based on the potential of compound semiconductors to be successful across a broad range of applications, the continuous rapid growth in demand, and our own experience and insights in supplying packaging equipment to the compound semiconductor sector in recent years a as a leading equipment supplier. In addition, with the advent of renewal energy, 5G and IoT markets, compound semiconductors, primarily gallium arsenide (GaAs), indium phosphide (InP), gallium nitride (GaN) and silicon carbide (SiC) have seen rapidly growing markets. Also, the significant increase in the use of RF power semiconductors in aerospace, defense and military applications, has further driven growth. Finally, driven by downstream demand and by the Chinese government's industrial policies, a large amount of capital poured into compound semiconductor's entire value chain of, from substrate, epitaxial growth, midstream manufacturing, packaging to downstream product application. In 2022, compound semiconductor will still be a hot sector for venture capital investment under the encouragement of the government's industrial policy focus. Enterprises who possess

core original technologies with successful application case studies will attract significant investment attention. We also foresee a continued trend for global compound semiconductor industry capacity expansion and M&A activities.

2021 was indeed the year of many important events in the third generation compound semiconductor industry. For example, Hunan SANAN Semiconductor completed their phase I project, with a total investment of 16 billion RMB in China, and was officially put into production. It is the first vertically integrated silicon carbide value chain in China and the third in the world. It can produce 30,0006-inch silicon carbide wafers per month. In addition, the foundation of the third generation semiconductor industry base of Suzhou Nanowin Science Technology Co. Ltd has been laid, as well as those of the third generation semiconductor industrial base of Shenzhen Bronze Technology and Enkris Semiconductor's Headquarters. The agreement for the Nanjing Epitaxy Material Industrial Base of CETC Semiconductor Materials Co., Ltd. has been signed. Many other big ticket investment projects are also moving forward. Internationally, Infineon Technologies and Panasonic have agreed to jointly develop and produce the second generation GaN technology, providing higher efficiency and power density levels. Bosch started a silicon carbide chip mass production plan. ST and CREE extended a SiC long-term supply agreement to over $5.19 billion RMB. Onsemi announced the acquisition of GT Advanced Technologies, a silicon carbide supplier. Showa Denko (SDK) invested heavily in SiC expansion and signed long-term contracts with Toshiba, ROM and Infineon, and SK Group announced that it will invest 700 billion KRW to expand its silicon carbide wafer business.

In summary, the third generation semiconductor materials represented by SiC and GaN have become the development focus of the compound semiconductor industry. Especially in the electric vehicle and PD fast charging markets, the use of the third generation semiconductor materials SiC and GaN has enabled product innovation, and an unprecedented growth opportunity has been ushered in for the compound semiconductor industry. The number of third-generation semiconductor patent applications in China has accounted for 56.79% of the total number of third-generation semiconductor patent applications in the world, although none of the TOP 10 patent applicants with the highest market value in the global third-generation semiconductor industry are from China. This data shows the popularity of the third-generation compound semiconductor in China, but it also shows that China is not strong enough in technology, and that more scientists and entrepreneurs are needed to strengthen the domestic industry.

Compound Semiconductor: With the rapid development of electric vehicles, 5G communications, intelligent Internet of Things (IIoT), new energy, hydrogen energy, and metaverse, there will be many opportunities for the compound semiconductor industry. What challenges and opportunities do you think the compound semiconductor industry will face? Some people say that the third generation semiconductor provides an opportunity for China to overtake competitors via a shortcut. Do you agree or disagree? Are there still risks? Where are the risks? How to avoid them?

Dr. Limin Zhou at MRSI: The high potential of the compound semiconductor market has brought many opportunities for the rapid rise and development of companies, helped by the continuously expanding downstream demand and a strong domestic industrial policies. MRSI is optimistic about the development prospects of the compound semiconductor industry in China, and has established MRSI Automation (Shenzhen) Co., Ltd in China. We believe that one of the opportunities is the superior properties of compound semiconductor materials, which can greatly improve the performance of products to enable many emerging applications. In return, the development of emerging markets has broadened application opportunities for the compound semiconductor industry. The second opportunity is that China is a big market that attracts global attention, holding the world's largest market share in hot sectors such as 5G communication, IOT and renewable energy, which translates into a huge market opportunity for the industry. The third opportunity is that China has a strong advantage in talents. In recent years, the national talent policy has attracted a large number of overseas entrepreneurs to return to China to start businesses, and domestic universities and research institutions also have trained a large number of professionals, laying a talent foundation for the development of compound semiconductor industry. The fourth opportunity is the support of national industrial policies. The development of the compound semiconductor industry has been listed as a key area of support by the state and many municipalities, attracting massive capital investment. In such a once-in-a-century opportunity, there are also challenges. One of the challenges is that the trade war between China and the United States has brought many restrictions. The domestic industry faces many challenges in importing materials, processes and equipment, which brings great constraints to its development. The second challenge is that against the backdrop of great opportunities, some blind investment has taken place, and some projects have been rushed without proper planning, resulting in duplications with limited prospects. The third challenge is that some local governments' and investors' lack professional knowledge and commercialization experience of the compound semiconductor industry, have a weak grasp of market positioning and insufficient understanding of development difficulties, as well as their desire to make quick returns which is in conflict with how the industry develops. The leading compound semiconductor companies are large international players, and they have deep cooperative agreements with many downstream customers. To enter such a fiercely competitive market, the domestic companies must face great challenges in technology and management.

I disagree with the claim that third-generation semiconductors offer an opportunity to overtake via a shortcut. In the past 35 plus years, MRSI has manufactured a family of die bonding products. We have been focusing on providing better die bonders to service the development of compound semiconductor industry and never thought of "overtaking" others via any shortcut. For decades, we have done an excellent job with our products and served our customers well, and we have become a leading player in the international market. And I personally dislike the phrase "overtaking via a shortcut" very much. It risks misleading the development of the compound semiconductor industry. Some "entrepreneurs" don't make a solid effort in research and development or market

development, but rather always thinking about how to "overtake via a shortcut." They created this new phrase to sound like innovation, and to defraud the government for subsidies and market protection with cheap and low-quality products to capture market shares in the name of localization. This will only result in bad products displacing good ones, and is not conducive to the healthy development of the industry. There is also a bigger risk that the overheated industries and this "overtaking" mentality will lead to reckless investment in excess capacity, leaving the domestic industry big but weak and uncompetitive. To avoid these mistakes, we should first encourage those hard working and innovative companies and entrepreneurs to gain long-term recognition of the market and customers with truly innovative technologies. In addition, the government and investors need to abandon the mentality of making quick money. The development of the industry will not happen overnight, and we need to have some patience to work together. The good news is that the government and investors have begun to realize these risks, and companies and entrepreneurs are beginning to be more pragmatic. More and more innovative and fast growing domestic companies are emerging in the compound semiconductor industry.

Compound Semiconductor: Gallium arsenide and indium phosphide, as "veterans" of the second generation of semiconductors, have been silently contributing to the field of visible light, infrared photonics and microwave radio frequency. With the growth of high-speed optical communication, intelligent sensing and other emerging applications, "old materials" have attracted a lot of attention again. Please talk about gallium arsenide (GaAs) and indium phosphide (InP) related technology and future industrialization development?

Dr. Limin Zhou at MRSI: MRSI is a leading provider of high-precision, highly reliable, flexible die bonding solutions for a wide range of second-generation compound semiconductors, with a large customer base in the field. Gallium arsenide (GaAs) is one of the representative materials of the second generation semiconductor. With the development of emerging applications such as 5G communication and artificial intelligence, gallium arsenide has become the mainstream material of mobile radio frequency power amplifiers(PA) and switches, occupying an important position in the 5G era. Photonics devices like VCSEL can be used in 3D sensing, LiDAR and other new application scenarios, which will become a new driving force for GaAs growth. In addition, MicroLED and miniLED display applications will also be a massive market. Gallium arsenide is also expected to create more demand and opportunities in the coming years due to its increasing use in high-power semiconductor fiber lasers and LED light sources. Indium phosphide (InP) is another important second generation semiconductor material. With the rapid development and construction of 5G communication infrastructure and data centers, the demand for high-speed optical transceiver devices is increasing. Indium Phosphide is the key material of 5G transmission and data center transceivers' optics. With the development of high-speed optical communication and artificial intelligence, it is widely believed that the demand for high speed optical transceiver devices will continue to grow rapidly for at least a decade. In addition, indium phosphide is also widely used in medical treatment, high-end LiDAR, sensing and other fields, and its end application market has a high potential.

One of the major constraints of silicon-based photonics is that the silicon material itself does not emit laser. In order to achieve integrated laser-on-silicon, the current effective solution is to bond indium phosphide material to silicon-based materials to generate heteroepitaxy, which is also known as heterogeneously integrated chips. Another solution is to integrate III-IV material chip and silicon chip through chip assembling process. After more than ten years of development, Intel has now shipped the optical transceivers based on heterogeneously integrated silicon photonics technology, and the products have rapidly evolved from 100G to 400G or even higher. The advantage of heterogeneous silicon photonics integration is that the assembly process doesn't rely on optical fiber connection and expensive optical alignment. This technology will have many applications in the future. But for now, heterogeneous integration process is very complex and expensive, and some performance trade-offs have to be made. At present, there are many academic studies, but only Intel can truly achieve an industrial application. MRSI has been following the development of photonics integration and developing assembly solutions. We are also actively involved in the development of the international photonics integrated assembly roadmap. We believe that the trend of silicon photonics development will be the use of different silicon-based materials to realize different optical and electrical functions, integrated with separately fabricated III-V laser chips to provide lower cost chip manufacturing and to allow performance optimization of each individual chip as well as the use of advanced packaging technology for final assembly of optical devices. Currently, most silicon photonics companies such as Cisco adopt this approach. Of course, heterogeneously integrated silicon photonics chips will have certain advantages in some device size-constrained applications. I believe that over a long period of time the two approaches will co-exist and both will have great application potential.

Compound Semiconductor: Dr. Zhou, could you please share your opinion on how China's compound semiconductor industry should learn from the international players and accelerate its development. In this process, disputes over intellectual property rights will inevitably arise, including the increasing number of intellectual property rights dispute among domestic companies in the future. Please expand on that, too.

Dr. Limin Zhou at MRSI: The compound semiconductor industry has developed rapidly in China in recent years. At present there is still a technological gap between Chinese and international manufacturers in this industry. With the strong support of large government venture funds and the continuous development of the domestic players, we believe that the gap will continue to narrow. Presently, the leading companies are all foreign large corporations, and they are actively expanding in China organically and through a very active M&A market. In my opinion, China should learn from foreign companies in the following aspects: first, the companies should position their products or technologies well, focusing on a particular emerging application that leverages their own competitive advantages, and improving the core competitiveness of their products and technologies. A company cannot do everything. Before it can expand, it needs to be competitive enough to survive. Competitive companies are the ones with core technology and for differentiated

applications. New entrants need to focus on their unique core competency that can give them a competitive value proposition in specific niches within whole industry supply chain. Secondly, companies should position their development roadmap well. It is unrealistic for everyone to make their own chips. The complex design of compound semiconductor devices and the resulting packaging requirements are also key factors affecting end product performance. Companies should choose their own development model according to their own technology and management situation and ability. Whether a company is engaged in the whole value chain, a link in the chain, or contract manufacturing for the industry, it needs to have very strong technical expertise and operational capabilities. Companies can survive in the fiercely competitive market only by selecting the right business model based on its core competitiveness.. Thirdly companies must avoid blindly building up excess capacity, All processes are new and complex in the compound semiconductor industry, require expensive state-of-the-art equipment and the use of advanced technology and management. Project construction costs are high. Duplicated buildup will waste a lot of resources, and is not conducive to the long-term and stable development of the industry. The government and investors have started to understand the financial risk of blind investment, and the negative long term impact on the compound semiconductor market such an investment model will cause.

The explosive growth of a hot industry always has some problems. Presently, many domestic start-ups in the compound semiconductor industry are founded by overseas returnees who have brought back advanced technologies and management concepts, which have played a positive role in fostering the development of the domestic industry. But sometimes it also causes some intellectual property rights disputes with their previous employers. In addition, some domestic players have weak awareness of intellectual property rights protection, and some even openly copy others' designs or other intellectual property. As a result there is an increasing number of IP infringement lawsuits in these emerging hot industries. As the industry leader of compound semiconductor assembly equipment, MRSI's patented designs have also been copied by some domestic competitors. We have protected and publicized our intellectual property in the form of patents to remind competitors not to break the law. With the strengthening of the Chinese government's determination to protect intellectual property and the intensification of punishment, the problem of intellectual property infringement will gradually decrease with the increasing publicity of intellectual property protection. We must create a sense of shame within the whole society and industry players on IP infringement.

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