Research and Development of Optoelectronics in China

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Abstract: Active R&D activities for various optoelectronic devices including quantum well DFB LDs, high brightness LEDs of all kinds of colors, Diode Pumped Solid State Lasers, EDFAs, OADM and OXC's etc. are addressed. It is point out that nowadays Chinese government's policy is emphasizing the technical innovation in applications and industry, while the science establishment works on the knowledge base.

Keywords: optoelectronics, R&D activity, technical innovation, technique commercializing, knowledge economy

Optoelectronic technology and industry are to play the role of a propellant towards the realization of information society in the 21st century. It is obvious that optoelectronics and its applications are under intensively attention in China. In the past decade, hundreds of projects for research and development of various optoelectronic devices and their fabrication technology have been launched and actively conducted. They are mainly supported by the government through National High-tech R&D Program (863 Program), National Natural Science Foundation (NSFC), Key Projects of the National 5-Years Plan, Chinese Academy of Science (CAS), and so on. As a result these projects have achieved many scientific research accomplishments as well as made many devices becoming commercially available, which include high speed DFB LDs, high brightness LEDs, Diode Pumped Solid State Lasers, Erbium Doped Fiber Amplifiers and so on. All these efforts and achievements are already laid the foundation of the technology that enables the formation of optoelectronic industry in China.

Universities and research institutes have been playing an important role in R&D activities in the optoelectronics field. Several national laboratories have been established and attached to these universities and institutes. Among them, a joint national lab for Integrated Optoelectronics attached to Tsinghua University, Jilin University and the CAS Institute of Semiconductor, a lab for Solid State Microstructures attached to Najing University, a lab for Infrared Physics attached to the CAS Institute of Technical Physics in Shanghai and a lab for Semiconductor Materials attached to the CAS Institute of Semiconductor in Beijing are excelled. In addition, several National Engineering Research Centers (NERC) are also optoelectronics related including the NERC of Optoelectronic

Devices which attached to the CAS Institute of Semiconductor in Beijing and the NERC of Optical Fiber Communications, which attached to the Wuhan Research Institute of Posts and Telecommunications in Wuhan. The goal of R & D in these institutions in the optoelectronics field is to provide all kinds of necessary key components, devices and subsystems for the applications in high speed optical fiber communication systems and broad band optical networks, flat panel displays, high density optical disk storage, optical power sources for medical and industrial apparatus, optical sensors, optical interconnection and photonic switching technology. In addition to the on-going fundamental research and technological development in universities and research institutes, the optoelectronics research community is now aimed to move their research results and technology from laboratories to industrial production.

This is especially true in the optical fiber communications and networks field. As driven by INTERNET and data services, the evolution of information networks continues at an unprecedented pace. Multi-Gb/s SDH and WDM transmission resulting in capacities in excess of Tb/s on a single fiber meet the explosive demand for bandwidth. To keep up with this evolution and growth, many projects ranging from the growth of quantum well materials to subsystems used in photonic switching have been conducted. The remarkable achievements are: (1) The fabrication and application of DFB laser diodes with 2.5Gb/s and lower bitrate, which based on fully getting the hang of quantum well material growth technology and the design of commercialized modules of optical transmitters and receivers. (2) Mass production of EDFA products, which have been deployed in national and district trunk lines of optical fiber networks. (3) The breakthrough progress in the study of photonic integrated circuit (PIC) and optoelectronic integrated circuit (OEIC), with the fulfil of the 2.5Gb/s and 10 Gb/s monolithically integrated module of DFB LD with EA Modulator, 155Mb/s monolithic integrated optical transmitter and receiver, which incorporated about 20 electronic and optoelectronic devices together. (4) The progress in fabrication of polarization insensitive semiconductor optical amplifiers, which deployed the strained quantum well structure and have been used for optical switch arrays. It is predicted that the market of optoelectronic devices for optical communications will be about 1.2 Billion RMB￥ in China this year, more than one third of them will be supplied by domestic vendors.

In displays field, there is a huge market for all kinds of LED. The total value of LED output in China is predicted as about 7.5 Billion RMB￥ this year, which is the first one among the semiconductor optoelectronic devices. The high brightness LED is studied and developed under the support of 863 program. In addition to the red, orange and yellow high brightness LEDs, the gallium nitride blue LEDs are also developed and begin to be push into mass production. Meanwhile the cubic phase gallium nitride material was successfully grown and blue light emitting was obtained by electrical injection through a p-n junction made of this material. It is highly prospected the future of domestic industry of high brightness LEDs. The products will be widely used in the large scale full-color panel displays, illumination, traffic signs, vehicle exterior, dash lighting and so on. Chinese scientists and engineers are paying great attention to the development of “white –LED”, considering the tremendous potential for this kind of high efficient and energy-

saving devices. The prototype white devices consisting of phosphors and a blue LED chip with brightness of 1 CD have been demonstrated in Peking University recently.

Data storage is an area where the optical disc competes with other technologies. Optical disk market is expected to grow with the rapid expansions of the applications in electronic commerce, digital libraries, medical imaging and also in the computer applications with the DVD format. VCD industry is a big one in China. However, most key components have to be imported from overseas. As consumers shift from VCDs to DVDs and in order to get more benefits from the high density optical disk production such as DVD player and DVD-ROM, researchers have been working on the key components for years, including the high performance 650nm red LD used for optical head. Small amount production of GaInP/AlGaInP 650 nm LED with stained quantum well structure have been realized in NERC of Optoelectronic Devices, ISCAS. It is proved by the company producing the optical head that all the characteristics of the devices can meet the need of their products. However, as many case in China, the devices can be made in the lab, but they are far from the mass manufacturing stage. To overcome this bottle-neck, NERC-OED and an investment company have established a joint venture aimed to put the red LD into mass production. The plan is to possess the production ability of 500 thousand pieces per month in one year and then increase it to 1 million pieces per month in the second phase.

High power semiconductor laser diodes and their application are an attractive and also a successful field in China. The CW LDs of a few watts output power and QCW LD and LD arrays of a hundreds to thousands watts output power are commercialized in NERC-OED, ISCAS already. More than half of the products is supplied to international market. This institute also makes every effort in applications of high power LDs and LD arrays in industry, medicine and surgery, and many other areas. Diode pumped solid-state lasers are sources of coherent optical radiation and they are efficient, compact and all solid state. The miniature diode pumped solid-state green lasers have been rapidly developed supported by 863 program. The research team that carried out the research project has moved their focus to production. By attract risk investment a star-up company is established and successfully operated in Institute of Optics and Fine Mechanics, CAS in Changchun. A series green DPSSLs with various performance entered both the domestic and overseas market. The company fabricates this green DPSSL products is now one of the major vendors in the word.

Research policy in China is directed by the Ministry of Science and Technology. Nowadays Chinese government’s policy is emphasizing the technical innovation in applications and industry, while the science establishment works on the knowledge base. Recently Chinese government announced new regulations to further encourage scientist and technology experts to commercialize their knowledge through high-tech ventures. This will exert profound and lasting inferences to the optoelectronic research community. According to the policy and supported by the 863 program, five optoelectronic products industrializing bases have been established which are located in Beijing, Shijiazhuang, Wuhan, Shenzhen and Changchun respectively. In these 5 bases enterprises, universities, research institutes and local governments are incorporated together to promote

technical transfers, joint R&D projects, establishing high-tech start-up companies and so on. It is a trend that enterprises are playing more active role in optoelectronics research and development from now on, and optoelectronics in China will go along the path between basic research and commercializing production. The researchers in Optoelectronics are expected to get more support from industry as well as from government. Over the next decade, research and development will continue focus on optical fiber communications, optical networks, optical storage, enhanced imaging and optical signal processing technologies. The efforts will try to grasp the opportunity to develop optoelectronics by means of its integration with microelectronics, signal processing, optics, micromechanics and so on.