

Optoelectronics in Poland

A. JELEŃSKI

Knowledge based economy

At the end of the XX century the internet helped to begin the transformation of the Industrial Society into the Knowledge Based Society. The wealth of societies with time is less dependent on the amount of raw materials or heavy industry existing on their territories, since globalisation enables to locate them in places where their exploitation is cheapest and more based on knowledge how to transform these materials into innovative and sometimes even intelligent products.

A close collaboration of the scientific community and the industry is needed to realise this goal. Beginning by a continuous improvement of training standards, through a permanent scientific and technical assistance to the industry, and in particular to Small and Medium Enterprises (SMEs), finally it should help in creation of new innovative enterprises to commercialise research results. This requires an effort from both sides, scientific units (e.g. institutes) in order to prepare (in cooperation with the industry) programmes that will suit the needs of the industry, "opening minds" for new R&D opportunities in the industry in order to find time and resources, which will facilitate such cooperation.

Such collaboration is even more important in Poland, where companies having their own strong R/D laboratories practically do not exist and this cooperation is in practice the only way to ameliorate and create new products and shorten the time from the first concept to market.

The second condition for the success of the innovation policy in Poland, where only limited financial resources exist, is a proper determination of priorities. They must be given to areas in which chances of a fast elaboration of products, satisfying market needs, are the most important.

Why Optoelectronics?

The development of the information society created the need to transmit, transform and store the continuously increasing amounts of information. In the last decade we observed an extremely fast miniaturisation of computers and other electronic systems due to silicon integrated circuits. Despite the fact that silicon roadmap indicates the possibilities of further integration, Intel planning billion transistors on a chip for 2007, already now electrons speed and the bandwidth of electronic circuits are too small to transmit needed amounts of information and it is diffi-

cult to imagine telecommunications and the internet not using photons transmitted through optical fibres. Optoelectronics is the science dealing with the integration of photons into electronic systems. In the large frequency band from infrared to ultraviolet it deals with problems of light generation, detection, transmission, technology of advanced materials needed to manufacture optoelectronic components and their utilisation in various systems not only for telecommunication, but also for medicine, environment protection, industrial and military applications. Recent advances in wide band semiconductor technology (GaN, SiC) enabled us not only the enlargement of utilisation of a much broader optical spectrum for mentioned above applications (blue optoelectronics), but also the creation of semiconductor white light sources, the technology which can replace commonly used light sources, which have not changed much since Edison times. The comparison of smaller than 10¹⁰ These opportunities have been considered also in Poland. The analysis performed by the Committee for Future Studies "Poland 2000+" of the Polish Academy of Sciences indicated optoelectronics as one of the seven research priorities for Poland. Also the study commanded by the Ministry of Economy has shown that optoelectronic market, as one of the fastest growing markets, presents many opportunities and niches for SMEs.

State of art of optoelectronics in Poland

Optoelectronics is still one of areas, in which research in Poland is in touch with the world. It is due to the coordination of research and through the realisation of multiyear and commanded research projects involving research institutes leading in this area. From its beginnings optoelectronics was promoted by the Committee on Electronics and Telecommunication of the Polish Academy of Sciences and the Committee on Optoelectronics of the Association of Polish Electrical Engineers actually chaired by prof. W. Woliński, who directed also a program "Photonics Engineering" on optoelectronic sensors and systems executed by 4 departments of Warsaw University of Technology. SPIE contributed to the enhancement of links between Polish and international optoelectronic community by disseminating results of Polish researchers in its international editions. The, highly evaluated, commanded project "High power laser diodes and solid state lasers pumped by laser diodes" coordinated by the Institute of Electronic Materials Technology, gave the foundations for

the technology of advanced materials for optoelectronic components, solid state lasers and systems for military applications

Another important result of this project was the integration of research and industrial community working in this area. Following the initiative of the Institute of Electronic Materials Technology, the Institute of Optoelectronics of Military University of Technology, the Institute of Applied Optics, and the Centre for Technology Transfer of Warsaw University of Technology, representing research teams from this university working on Optoelectronics, the Consortium "Polish Optoelectronics" was created. This is an open structure and actually it has 14 members from the research community (universities, Polish Academy of Sciences, other research institutes) and 12 industrial members (mostly SMEs).

The Consortium "Polish Optoelectronics" tries to:

- coordinate research performed by its members and improve it through cooperation
- organise teams to realise targeted and commanded research projects financed by the Ministry of Research and Information and the European Union
- facilitate the utilisation of measuring equipment by members of Consortium
- coordinate purchases of equipment
- facilitate the inclusion of topics needed by SMEs into R/D planned by member Institutes
- facilitate the transfer of research results to the industry.

The Consortium organises during the Poznań Fair Conferences "Optoelectronics'2000n" during which the offer of member research institutes for the industry is presented to a wider public and related to existing opportunities of financing and creation of new innovative products discussed. Several research and targeted projects resulted from this cooperation. The last conference "Optoelectronics 2004" was organised simultaneously with the Engineers Forum "Optoelectronics – chance for innovating enterprises" organised by the National Technical Organisation (NOT). The success of these initiatives led to the common initiation of the Technology Platform "Polish Optoelectronics" which will enable the utilisation of existing NOT regional structures for a better dissemination of research results, response to the SME needs and consultations for people who want to start their own enterprises.

Actually an important for future development of optoelectronics Multiyear Project "Development of Blue Optoelectronics" is realised. The Institute of High Pressures of the Polish Academy of Sciences is developing the technology of GaN crystal growth in high pressures and is researching the application of these crystals for homoepitaxial GaN/AlGaIn blue and UV lasers. The Institute of Electronic Materials Technology is developing heteroepitaxy of III/N compounds on alternative substrates and Schottky and PIN, visible and solar blind photodetectors.

The Institute of Optoelectronics of the Military University of Technology and several SMEs are working on applications of these devices in optoelectronic instruments they are elaborating for military, medical and industrial applications.

Another important result of research performed in the Institute of Electronic Materials Technology (ITME) on new materials for optoelectronics was the attracting of foreign investments. A spin off company "Comsecore" was founded with a large Belgian Company Umicore, which purchased the technology elaborated in ITME and bought the expensive crystal growth equipment for the production of indium phosphide wafers, the basic material for optoelectronics and future telecommunication systems. In another research collaboration agreement ITME received the equipment for crystal growth of silicon carbide to develop this technology. This is a crucial material for the development of high power and high temperature electronics, an excellent substrate for GAN heteroepitaxy. Since the price of one wafer exceeds actually 1000 Euros, elaboration of this technology will enable us to open a new and important research area in Poland.

Planning for the future

The Committee on Electronics and Telecommunication of Polish Academy of Sciences chaired by prof. W. Woliński, Member Correspondent of Polish Academy of Sciences decided to initiate the next step to create the foundations for a further development of optoelectronic research and industry in Poland, and presented a new commanded project "Optoelectronic elements and modules for medical, industrial, environmental and military applications". The success of the previous commanded project on high power laser diodes demonstrated the existing need for new technologies enabling not only a better scientific cooperation within the European Research Area, but also a faster elaboration of innovative optoelectronic products by Polish enterprises in the highly competitive European market. The words used in the title "elements" and "modules" stress the practical character of this project. Research topics were selected on the basis of world tendencies and local market requirements. Its results must be easily adapted or even utilised for the elaboration of innovative products, which will find their place on the local and international markets.

The project, which started the first July 2004 is divided into 8 particular work packages:

- 1) Optoelectronic modules for applications in interferometers.
- 2) Laser modules for applications in military, medical, environmental and industrial technology.
- 3) Optical fibre sensor modules for environmental, medical and industrial applications.
- 4) Semiconductor laser pumps.
- 5) Infrared radiation detector modules.
- 6) Active and non-linear materials.

- 7) Fibre optics elements
- 8) Elaboration of a system for remote detection of chemical and biological weapons.

The project is led by prof. Z. Jankiewicz and is coordinated by the Institute of Electronic Materials Technology. Research teams from Warsaw and Wrocław Universities of Technology, Institute of Optoelectronics of the Military University of Technology, Institute of Electronic Materials Technology, Institute of Electron Technology, Institute of Applied Optics and a private enterprise Vigo

Systems Ltd. realise particular tasks of the project. The Supervisory Board includes delegates of participating institutions, interested ministries (Ministries of National Defence, Economy and Labour, Environment) and the Committee of Electronics and Telecommunications of the Polish Academy of Sciences.

The realization of this project should prove that the opinion expressed in the Ministry of Economy and Labour that "Optoelectronics can become the driving force for Polish Economy" was well funded.