

Institute of Electron Technology - CEPHONA Center



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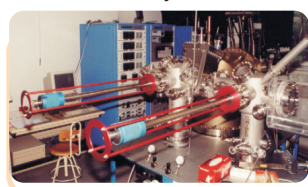
Photonics is based on quantum physics and electromagnetism. To the development of photonics and its applications it is necessary to analyse nonlinear optical processes involved and investigate suitable materials for light generation, guiding and detection. Modern semiconductor photonics is practically limited to semiconductor materials and phenomena occurring in quantum structures. Thus it combines basic physics with nanotechnology. This combination leads to a vast number of innovative research often leading to applications which have a great influence on our everyday life. Photonics seems to be technology of the 21 century, in a sense as microelectronics did in 20 century. In particular, laser light sources and detection devices are rapidly expanding area of applications.

The project combines the scientific, technological and applied objectives with broad range of educational and promotional activities. The main objectives of the Center are: **(1)** Intensification of research in the area of photonic devices and systems on carefully selected topics, which have true scientific value and potential for applications in the area of information technologies, environmental protection and health and quality of life improvement; **(2)** Increasing the number of young people in research and opening the access to our equipment and laboratories to visitors from research institutions and industry (including visitors from foreign countries).

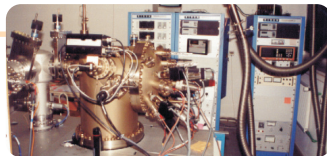
The Center of excellence CEPHONA consists of four departments:

Department of Physics and Technology of Low Dimensional Structures

The activities of the Department of Physics and Technology of Low Dimensional Structures are focused on the development of new photonic device technologies, in particular semiconductor lasers (edge emitting and VCSELS) and microcavity devices. We have very strong research in the field of physics and technology of low dimensional structures made of III-V compounds and a broad spectrum activities in the field of material characterization by optical and electrical methods. The main equipment and characterization techniques include: MBE reactor (Riber 32P), low temperature photoluminescence (PL), high resolution PL mapping, photoexcitation spectroscopy, modulation spectroscopies (photorelectance, thermorelectance), Hall, DLTS, C-V spectroscopy. Beside that we have well equipped device characterization laboratory for semiconductor lasers and a center for computer design and modeling devices equipped with workstations and necessary software. Additionally the Department has an access to the extensive facilities for structural characterisation (advanced x-ray analysis, SEM, EPMA, TEM, AFM, SIMS, RBS, XPS) at the Institute of Physics, Polish Academy of Sciences.



MBE reactor (Riber 32P)



Department of Semiconductors Processing for Photonics

The activities of the Department of Semiconductors Processing for Photonics are focused on the development of new process technologies and device architectures. Facilities include Leybold L-560 Universal Coating System including 4-crucible e-gun and RF sputtering station, three Leybold sputtering systems (Z-400, L400, Z550S), Balzers UTS 350 UHV evaporation system; Oxford Instruments DP 100 PECVD deposition module, Karl Suss MJB-21 double side and MJB-3 DUV mask aligners, Raith Elphy Plus e-beam lithography system, Secon MK-4 RIE system, wet chemical stations; AST SHS 100 RTP system, conventional furnaces for annealing in H₂, N₂, Ar or O₂, extensive facilities for electrical and optical characterisation (including WASE ellipsometry), Tencor® Alpha-step stylus profiler and Tencor® FLX-2320 thin film stress measurements system.

The Center activities comprise: **(1)** Inviting foreign experts, organizing schools and seminars and promoting networking initiatives in the area of photonics; **(2)** The expansion of selected areas of research of the highest importance for building the Institute of Electron Technology reputation as European center for quality research in photonics; **(3)** Responding to the external demand for services ranging from performing specific measurements, producing customer designed structures for research and special applications to offering complete, tested devices; **(4)** Development of new technologies for photonic devices and systems and increase of the level of applied research; **(5)** Education at all levels and demonstration of the social and economic benefits of research to the society; **(6)** Developing new public image of the Institute, promotional and informational campaign.

The mission of the center and its main objectives are to rise the basic research in photonics to European standards and enhance processes of technology transfer to the industry. We also act as the educational center for students, PhDs and engineers from industry, making them aware of new technologies and devices. Thus novelty of the Center is related not only to the innovative research we propose but also to the general approach to solving technical problems and creating models for technology transfer to the industry.

Department of Semiconductor Materials and Structure Research.

Laboratory of Electron Microscopy is a part of the Department of Semiconductor Materials and Structure Research. It consists of two facilities a transmission electron microscopy (TEM) facility and a scanning electron microscopy (SEM) facility. The TEM facility is equipped with the transmission electron microscope JEM 200CX and a wide range of specimen preparation tools allowing to prepare localized cross-sections from semiconductor nanolayers structures, including hard materials like SiC. The SEM facility is equipped with the scanning electron microscope XL-30 with CL detector (operating in a range 400-1300 nm), BSE detectors and EDX spectrometer (detecting light elements), specimen current detector (EBIC).



A Scanning Electron Microscope XL-30: (left) General view; (right) working chamber with detectors



Department of Photodetectors

The activities of the Department of Photodetectors are focused on the development of new process technologies and devices for light detection in the visible and near infrared region. The detectors developed in the department are produced and sold both in Poland and abroad. Among many achievements of the department is recent award of President of the Republic of Poland for the development of silicon avalanche photodiodes. The research results of the CEPHONA activities were presented in 104 papers published international scientific magazines and 129 conference presentations since January 2003. Among educational activities were two workshops have been organized: ♦ 1st CEPHONA Workshop on Computer Simulation and Design of Semiconductor Lasers (chairman Prof. Maciej Bugajski), Warsaw, Nov. 14th, 2003. The participants attended lectures on the latest achievements and prospects for studies of structures used in photonics. The Workshop facilitated deeper understanding of the physics of semiconductors associated with design and simulation of semiconductor lasers. ♦ 1st CEPHONA Workshop on Microscopic Characterisation of Materials and Structures for Photonics (chairman Prof. Jerzy Katcki). Warsaw, Nov. 24th, 2003. The participants, 37 young researchers, attended lectures on fundamental issues of the characterization of materials and structures for photonics. They took part in practical course on preparation techniques used in transmission electron microscopy of semiconductor structures and on methods of investigation of semiconductor structures by means of scanning electron microscopy.