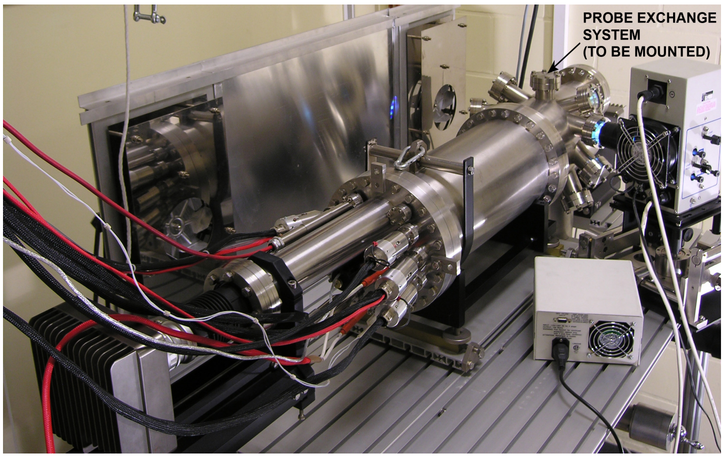
The continuing development of modern optoelectronics and microelectronics is determined by the progress in the scientific research and technological studies that result in better understanding of a physical phenomena characteristic for the new semiconductor structures and their better scientific description.
The scientific investigation of complex semiconductor systems from the AIIIBV-N requires not only an application of the sofisticated instrumental equipment necessary for material engineering and fabrication, but also the utilization of unique analytical and imaging inspection techniques enabling the control and determination of physical features referred to the single atomic layer. Essential for the present research project will be description of the energy and electron exchange processes regarding the semiconductor band structure depending on chemical composition and atomic size of the multilayer structure. It is also extremely important from the point of view of modelled instrumental applications of semiconductor systems to understand the origin and character of complex phenomena present at their surfaces, electronic structure, density of states and morphology. There are many different surface sensitive techniques utilized in the past in the context of above aspects, but one of the most interesting in this field is the Photoemission Microscopy.
Emission Electron Spectromicroscopy is a new and powerful analytical technique for chemically sensitive parallel visualization of surfaces. It utilizes the unique features of Photoemission Electron Microscopy and the advantages of imaging energy filtering. Contrary to the STM and SEM in this kind of electron microscopy based on the cathode immersion lens principle, every point of the illuminated by electrons or photons surface is simultaneously a source of electrons that reflect the topography and local electronic structure of the object.
In the electron optical system of DEEM two complementary images from the real and reciprocal space appear alternately: energy selective microscopic image at the screen 1 and energy selective kII projection (band structure) at the screen 2. In the all previous solutions only one imaging plane could be registered during the experiment. To pass from real imaging mode to k-space mode it was necessary to rearrange the adjustment of lenses and to move the contrast aperture, what is complicated, time consuming procedure. Patented in Europe and USA idea of the double spectroscopic imaging, applied in the DEEM spectromicroscope (built by the Wroclaw company OPTICON Nanotechnology located at Wroclaw Technology Park), allow the quasi-simultaneous, complementary energy selective imaging of real- and k-space.



This unique feature is enabled by the original electron optical system that consists of two parallel-oriented imaging columns and imaging spherical energy analyzer α-SDA. It includes two concentric, complementary oriented hemispheres (coupled by the magnetic deflector): analyzer and compensator, deflecting electron beam by the same, symmetric angle, what results in the parallelism of the electron optical axis after π and 2π deflection. On the both axis: main (2π deflection) and parallel shifted (π deflection) two imaging column for real and reciprocal image (equipped with two screens) are located. Electron beam switching between imaging columns allow the quasi-simultaneous acquisition of the 2D information from the k-space and image space in the real time of going on experiment. Utilization in the spectroscopic experiment the first hemisphere (π deflection) of DEEM as an imaging analyzer leads to the visualization of the electronic band structure of the semiconductor object of investigation. Dispersion aperture located in the gap between hemispheres enables the selection from the energy spectrum a small portion of electrons characteristic for the observed semiconductor and their further use in the imaging process after leaving of the second hemisphere. As a result a series of monoenergetic images can be acquired, correlated to the 2D energy selective projections of the momentum vector in the Brillouin zone related to the electronic density of states. However, this kind of chemical contrast and electronic structure information is accessible only, if the sample is illuminated by sufficiently energetic photon or electron radiation. Because of the limited access to the synchrotron radiation, spectromicroscope DEEM will be equipped with the Auger electron gun for primary energies between 200 and 2000eV and the deep ultraviolet radiation source, what will enable the complementary information about the band structure and surface topography.
Realized in Wroclaw novel Electron Spectromaicroscopy DEEM is thought as an universal imaging analytical technique, that allows not only the simultaneous registration of k (band structure)- and real space, but also of many important parameters describing processes at surface (epitaxy, catalysis, diffusion, segregation, corrosion, desorption, phase transitions, etc.) in function of temperature, time, mechanical stress, exposition time.
Novelty and scientific attractiveness of our DEEM spectromicroscopic technique and its usefulness for the research of new materials has found a wide confirmation in the form of many conference contributions and scientific publications, what proves the legitimacy of the planned project.
The successful elaboration of the new, original methodology will have a decisive impact on the understanding of the correlation between applied technology of semiconductor fabrication and their structural, chemical and electronic final state. To realize this purpose we plan to carry out in the epitaxial facility MOVPE a dedicated investigation of multilayer crystallization process of the semiconductor systems: InGaAsN/GaAs and InGaAs/InP. Further, basing on this knowledge it is planned to fabricate a special

model structures for investigating the relation between the crystal growing conditions and achieved final properties.