JKU JOHANNES KEPLER UNIVERSITÄT LINZ

HFP INSTITUTE OF SEMICONDUCTOR AND SOLID STATE PHYSICS

HALBLEITERPHYSIKKOLLOQUIUM

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X-Ray Diffraction Studies of Layered Nanostructures and 3D Diffraction Imaging of Nano-Scaled Materials

Abstract

A highly advanced experimental-analytical x-ray diffraction technique for the unique determination of material structure is discussed in respect to its possible application to characterize layered nanostructures. The Phase Retrieval X-Ray Diffractometry (PRXRD) technique allows one to determine, in great detail - order of a few Ångstrom, the physical dimensions and fine structure of crystalline materials. The technique has been applied successfully to determine the defects and fine structure of one- and two-dimensional crystal-lattice strain distributions in SiGe- and GaAs-based heterostructures and in silicon crystals implanted with high-energy ions, which are presently used in design of semiconductor lasers, detectors and ultra-high frequency telecommunication devices suitable for space applications.

The same PRXRD technology can also be applied to the characterisation of non-crystalline materials. We developed a method when high-angular-resolution Fraunhofer diffraction data were collected from several samples with interfaces between dissimilar metals and artificial crack in a metal foil using synchrotron x-radiation. The refractive index profile in the vicinity of the interface and crack of each sample was reconstructed with spatial resolution of about 10-50 nm by the PRXRD technique, using only limited a priori knowledge of the sample.

A novel approach to x-ray diffraction data analysis for non-destructive determination of the shape of nanoscale particles and clusters in three-dimensions is illustrated with representative examples of composite nanostructures. The technique is insensitive to the x-rays coherence, which allows 3-D reconstruction of a modal image without tomographic synthesis of a large (over several cubic millimeters) volume of material with a spatial resolution of a few nanometers, rendering the approach suitable for laboratory facilities. We also examined a possibility of performing non-destructive in situ investigations of the growth of weakly-diffracting nanoparticles in the bulk-material as explored by a combination of experiments and simulations.

I will also present recent results of experimental studies performed on model nanostructures: rolled up multilayered structures, silicon nanotubes and gold nano-patterns.

MI, 26.06.2009 **14:00 Uhr** **Bibliothek Halbleiterphysik**