UNIVERSITÄT LEIPZIG

Transmission Electron Microscopy of Alloys, Defects and Interfaces in Semiconductors

Martin Albrecht

Leibniz-Institut für Kristallzüchtung, Max-Born-Straße 2, 21468 Berlin

Analyzing the structure of crystalline materials down to the atomic level is a prerequisite to understand the relation between structure and materials properties. This holds for bulk crystals as well as for nanostructures, where artificial structures are created to realize materials with tailored physical properties. While diffraction based methods provide us with structural data of perfect crystals at high accuracy, structural analysis of deviations from perfect structure that may govern physical properties of materials such as atomic defects, dislocations, grain boundaries or interfaces are difficult to obtain. In most cases their total volume is below the detection limit of these techniques. Information on such structures can only be obtained by imaging methods, i.e. in real space. To construct a "super microscope" that would provide us with structural information at the atomic level has been dreamed of, since de Broglie has postulated the wave character of matter. Since Ruska developed the first transmission electron microscope (TEM) lens aberrations hampered direct interpretation of electron microscopical images. Atomic resolution in the transmission electron microscopy in the past could only be achieved in a number of favorable cases. It required the comparison of simulated images with experimental ones and *ab-initio* based methods to sort out possible structural models. The successful construction of aberration corrected electron lenses in the past decade paved the way for atomic resolution transmission electron microscopy. Besides the mapping of atomic positions with high accuracy, aberration corrected TEM offers the occupancy of atom sites to be determined with high sensitivity. However, in spite of the progress in instrumentation, the quantitative analysis of electron-microscopic images in most cases still requires an iterative process of modeling, contrast simulation and analysis of physical properties.

In this presentation a brief overview on the basic concepts of aberration corrected TEM will be given. The possibilities of aberration corrected TEM to solve atomic structures will be exemplified for the case of

- In fluctuations in InGaN alloys
- Silicon Nitride layers in GaN
- In-situ observation of single polarons in gallium oxide.