HIGH-RESOLUTION X-RAY DIFFRACTION DATA ANALYSIS FROM THE PARTLY RELAXED SEMICONDUCTOR STRUCTURES

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The epitaxially grown thin films are the basic structures for the production of the semiconductor devices. Their electronic properties, quality and operation reliability depend essentially on the strain status of the films with respect to the substrate or underlying layers. The change in the lattice strain due to the relaxation processes causes the appearance of the dislocations and lattice defects, which in turn influences the operation of the semiconductor devices. Therefore, the control of the relaxation degree of the epitaxial layers is of great importance in the production and design of the semiconductor structures.

The analysis of the high-resolution X-ray diffraction data in the case of partly or even fully relaxed epitaxial layers is complicated by the lack of the appropriate dynamical diffraction theory for the modelling of X-ray scattering processes from the laterally mismatched structures. In our work, we developed a method for the calculation of X-ray scattering in case of lateral mismatches of the crystallographic lattice, combined with the matrix approach for the dynamical diffraction from the multilayered systems. The technique is used for the evaluation of the experimental data measured from the typical semiconductor structures, such as SiGe samples based on the strained silicon technology and AlGaN/GaN/AlN multilayers for the broadband applications using high electron mobility transistors.