DIFFUSE X-RAY SCATTERING FROM GaAs/AlAs SUPERLATTICES: NEW THEORETICAL APPROACH FOR DATA INTERPRETATION

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Diffuse x-ray scattering from semiconductor nanostructures contains important information about the morphology and profile of surfaces and inner interfaces. In turn, the quality of interfaces plays crucial role in operating performance of devices based on nanoscale structures like thin solid films, superlattices, quantum wires and dots. Being measured with conventional laboratory x-ray tubes and at synchrotron facilities and interpreted correctly by modern theory, the incoherent signal in x-ray experiments delivers a valuable information on interface roughness, gradient of electron density, defect and dislocation densities and on other imperfections within the studied structures. Therefore the interpretation methods for diffusely scattered x-ray intensity is of special interest for both scientific and industrial applications.

In our report, we propose a new approach for description of x-ray scattering from nanoscale structures based on the gauge transformation for Maxwell equations. In comparison with conventional scheme for distorted wave Born approximation (DWBA), this method uses new form of perturbative operator related to imperfections of scattering surface, deformation and roughness, and further utilizes DWBA for development of perturbation theory. The method has been applied for explanation of experimental data from AlAs/GaAs superlattices. We also compare our results with ones by regular DWBA and discuss the discrepancy in resulting parameter values fitted in the framework of both techniques.