SIMULATION OF X-RAY REFLECTIVITY FROM PERIODICAL SURFACE GRATINGS

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Semiconductor structures with quantum confinement of electrons in two or more dimensions are of special interest during the recent decade [1]. Geometrically the devices based on such a structures are organized in most cases as quantum wires (QW) or quantum dots (QD). X-ray reflectivity is proved to be unique method for investigation of physical properties of QW due to its non-destructive character and sensitivity to the nanoscale imperfections and strain of crystallographic lattice. In view of this fact, the analytical treatment of experimental x-ray data from QW and QD becomes an important part of technological and scientific work on improvement of device quality and reliability.

In our paper, we propose exact analytical solution by gauge transformation method for the x-ray scattering from the periodical surface gratings of arbitrary shape. Our theoretical approach results in matrix analogue of Fresnel formulas. The advantage of the presented method is illustrated by the comparison of our results with the results of conventional perturbation theory, dynamical diffraction theory in two-wave approximation and distorted-wave Born approximation. The new method allows to take into account all kinds of nano-imperfections by developing of further approximations, and is a promising algorithm for future commercial software.
