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Extremely asymmetric x-ray diffraction from multilayers and superlattices: a recursive matrix theory and its experimental check

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The dynamical theory of extremely asymmetric x-ray diffraction (EAXD) from crystalline multilayers with lattice strains perpendicular to the surface has been developed. The theoretical model is based on the expansion of x-ray wave fields over the Bloch waves with the periodicity of atomic planes in each layer. The solution for a multilayer is obtained in the form of recursive equations for (2x2) scattering matrices of individual layers. Far from grazing incidence and exit, the solution is reduced to the scalar recursive equation derived by Bartels, Hornstra and Lobeek [Acta Cryst. A**42** (1986) 539]. The new method is applicable through the whole range of incidence angles from grazing-incidence to normal-incidence x-ray diffraction.

The theory has been confirmed by an EAXD experiment with a strained AlAs/GaAs superlattice carried out at HASYLAB. It has also been found that the conventional non-dispersive scheme of measurements provides a poor resolution, since the shape of the Bragg curves in EAXD strongly depends on the x-ray wavelength. The installation of an additional monochromator selecting a narrow wavelength band considerably improved the resolution.