MODELING OF X-RAY REFLECTIVITY FROM CONTINUOUSLY VARYING PERIODIC STRUCTURES

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The X-ray specular reflectivity techniques are very sensitive to the depth distribution of the electron density of the studied material, thus allowing determination of vertical surface and interface roughness, layer thickness and density, and vertical density profiles. This is due to the fact that for an X-ray specular reflectivity setup, the scattering vector is always perpendicular to the surface.

X-ray optics is usually based on multi-layer structures, which demonstrate relatively high reflectivity for incident angles of up to several degrees. Regular multi-layer structures are usually made of stacks (periodic structures) of identical bi-layers, with the materials of the bi-layer selected to have refraction indexes that are as different as possible. Regular multi-layer structures have abrupt interfaces, with relative small interface roughness.

In this paper, we present modeling of x-ray reflectivity from multi-layer structures made of continuously-changing periodic structures, i.e., the density and the refraction index do not change abruptly, but change continuously with the distance from the surface. If regular multi-layers can be represented with a step function of density with distance from the surface, then the continuously-varying multi-layers presented here can be described with a smoothly-changing function of density and/or refraction index with distance from the surface. Continuously changing periodic structures were not studied before, and can be of interest, especialy if they offer advantages when used as x-ray mirrors.