X-RAY GRAZING-INCIDENCE MAGNETO-OPTICS OF MULTILAYER STRUCTURES UNDER RESONANT SPECTRAL CONDITIONS

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Giant grazing-incidence polarization phenomena at resonant reflection of soft X-rays from rare earth magnetic superlattices have been examined theoretically. The unique combination of the grazing-incidence geometry and the 3d-4f atomic resonance with the well-known resonant enhancement of magneto-optical activity of rare earth elements near M absorption edges is shown to result in the strong dependence of grazing-incidence reflection amplitudes on the polarization state of an incoming X-ray beam and the magnetic state of a reflecting surface layer. Near the critical angle of total external reflection, the corresponding relative magneto- and polarization-sensitive variations of X-ray reflectivity and Kerr effect values may reach of about 80% and are easily detectable. At small glancing angles, the Kerr effect behavior is unique in relating not only to the sharp distinctions between the p and s reflectivities, but also to the large difference in phase between the p and s reflection amplitudes.

All this, taking into account the small tunable penetration depth (1 -200 nm) of soft X-rays under discussed condition, allows us to put forward the "double-anomalous" magneto-optics as a fruitful method for determination of the depth profiles and interface distributions of magnetization in magnetic films and superlattices with a high degree of accuracy. For example, as the depth profile consists in the rotation of a magnetization vector in a surface layer from in-plane to normal direction, a reflectivity change of a few percent may be observed when the width of the layer varies over 10%. The values of the basic structural magnetic and non-magnetic parameters of superlattices are easily derived from reflectivity and Kerr effect values as well. A new method to attack the problem of determination of these parameters from reflectivity measurements based on the direct use of the fundamental Bloch solutions of the Maxwell's equations is developed. Diffraction phenomena in "spiral" rare earth superlattices are examined.

New optical elements with magnetic control for synchrotron radiation beamlines using polarization-sensitive "double-anomalous" reflection from rare earth superlattices are discussed. Such elements - polarization filters, convertors and switches - provide high conversion and filtration efficiency with intensity losses of about 30%.