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Soft X-ray Circular Reflectivity from Transition-Metal Ferromagnetic Thin Films Near the Brewster's Angle : X-ray Resonant Magnetic Scattering Theory

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Soft or hard x-ray resonant magnetic scattering (XRMS) measurement techniques have been widely used to investigate charge, orbital, and spin degrees of freedom in multi-component magnetic materials, because those techniques take advantages of the exceedingly enhanced, element-specific sensitivity to different such orderings at energies close to the absorption edges of a selected element [1]. Due to a variety of microscopic interactions between incident photons and each of the different orderings, and their angular and polarization dependence in the XRMS process, the initial polarization state of incident photons is converted to various polarization states of the scattered photons, which in turn makes it possible to determine element-specific charge, orbital, spin orderings by analyzing the changed polarization states of the scattered soft x rays and their angular and polarization dependence. Any arbitrary polarized states of photons can in principle be described in terms of the orthogonal right- and left-handed circular polarization (RCP and LCP) modes (or opposite photon helicities). Since the RCP and LCP modes are not only the basis of an irreducible representation of rotational symmetries in atomic transition processes, but are also the eigenmodes of photon beams interacting with the different kinds of orderings in broken symmetries, such circular polarizations are useful in the determination of the fundamental atomic transition spectra in the x-ray resonant region for magnetic materials [2]. Thus, in order to obtain better or deeper insight into not only the interactions of incident photons with different scattering sources of charge, orbital, and spins, but also their polarization and angular dependences, theoretical interpretations of XRMS in the framework of the RCP-and-LCP-modes basis is more fundamental than the linear-polarization-modes basis. In this presentation, we first report a novel phenomenon that shows colossal difference in soft x-ray reflectivity from ferromagnetic transition-metal films between the LCP and RCP modes at the resonance near the normal Brewster's angle. Theoretical and numerical studies of XRMS using the circular-polarization-mode basis reveal that this effect arises from a totally destructive interference of photons scattered individually from charge, orbital, and spin degrees of freedom in magnetized thin films that selectively occurs only for one helicity of the opposite circular modes when the required criteria are fulfilled. Across the normal Brewster's angle the polarization state of scattered soft x rays is continuously variable from the RCP to LCP mode or vice versa through the linear s polarization by changing the incidence angle of a linearly *p*-polarized x rays at the resonance.

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REFERENCES

[1] J. B. Kortright, D. D. Awschalom, J. Stöhr, S. D. Bader, Y. U. Idzerda, S. S. P. Parkin, Ivan K. Schuller and H. -C. Siegmann, J. Magn. Magn. Mater. **207**, 7 (1999).
[2] G. van der Laan, Phys. Rev. B **57**, 112 (1998).

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Linear and Nonlinear Magneto-optical Study on Fe Films

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The magnetic properties of Fe films were studied by measuring the linear and the nonlinear magneto-optical properties. The linear and the nonlinear magneto-optic-Kerr-effect (MOKE) measurements were employed to understand the bulk magnetism and the surface and/or interfacial magnetism, respectively. The linear MOKE is an important probe for studying magnetic thin films, and the nonlinear MOKE is a very sensitive tool for investigatingsurface and interface magnetisms of magnetic thin films and multilayers, which enables us to elucidate the skin-depth effect. For the analyses of magnetic films and multilayers, the optical and the magneto-optical properties were also simulated. In the linear-MOKE simulation, the reflection and the transmission coefficients were obtained by assuming the thick film. It was also supposed that the optical medium is absorptive and that the off-diagonal components of the permittivity tensor are linearly dependent onexternal magnetic field. The simulations were performed in the polar, the longitudinal and the transverse modes to obtain the Kerr rotation and the ellipticity of the linear and the nonlinear MOKE. Fe films were prepared by rf-sputtering on glass substrates at room temperature with a capping layer of Cr. The magnetic hysteresis loops were obtained by using a vibrating-sample magnetometer. The linear and the nonlinear MOKE measurements were performed in the longitudinal mode. To determine the skin-depth effect, each sample was made to have different thickness, and the angular dependence of MOKE signals was measured and compared with the simulated one.