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Soft x-ray characterization of structural and magnetic heterogeneity in thin films

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The element-specificity of resonant magneto-optical effects near core levels in the x-ray regime offers numerous opportunities to study the magnetism in high-coercivity think films. By combining reflectivity and small-angle scattering (SAS), variations in both the structural and magnetic properties of heterogeneous films can be determined. At the 1-2 nm wavelengths of interest, SAS is readily measured from lateral inhomogeneities with dimensions comparable to or greater than these wavelengths. SAS experiments provide a quantitative approach to obtain statistically averaged structural parameters such as average grain size and grain-size distributions. By tuning near resonances of selected elements, the scattering contrast can be enhanced and element specific information (both structural and magnetic) determined. These approaches are applied to explore the chemical segregation in CoPtCrB recording media and FePt and TbFeCo films. In appropriate geometries, resonant SAS also arises from magnetic domains. Examples of magnetic scattering from perpendicular CoPt3 films and Co/Pt multilayers will be presented and correlated to atomic and magnetic force microscopy images. Similarly, element-specific magnetic hysteresis loops of composite magnetic structures can be measured. This approach is applied to understand the reversal processes of SmCo/Fe and related exchange-spring magnets.

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