Investigating magnet anisotropy using x-ray magnetic linear dichroism

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Introduction

The measurement of x-ray magnetic dichroism in absorption is becoming a standard tool for the element-specific determination of magnetic moments. The majority of these experiments rely on circularly polarized light and measure x-ray magnetic circular dichroism (XMCD) [1]. More recently, linear light has been used to measure x-ray magnetic linear dichroism (XMLD) [2, 3]. In addition to providing element-specific moment information, recent theory has been developed demonstrating that XMLD also provides anisotropy information [4, 5].

Methods and Materials

Measurements of XMLD are currently being performed at SRI-CAT beamline 2-ID-C using a recently commissioned dichroism end station. This end station contains an electromagnet with pole pieces oriented perpendicular and parallel to the x-ray polarization axis and is capable of generating fields up to 800 G. Absorption can be measured using either total electron yield (TEY) or total fluorescence yield (TFY).

XMLD is measured by collecting two data points at each photon energy. For the first, a field pulse is applied to orient the magnetization parallel to the photon polarization, $\hat{\varepsilon}$. The measurement is then performed in remanance yielding $\alpha_{\|}$. A field pulse is then applied perpendicular to $\hat{\varepsilon}$, the remanance measurement yielding $\alpha_{\perp}$. The difference between these two measurements yields the XMLD (see equation 1):

$$XMLD = \alpha_{\|} - \alpha_{\perp} \qquad (1)$$

Results and Discussion

Figure 1 shows a typical absorption and XMLD spectrum at the L-edge of Fe. The sample is an Fe(001) epitaxial thin film grown on MgO(001).

The shape of the XMLD signal observed is dependent on the relative orientation between crystallographic axis and $\hat{\varepsilon}$ [6]. Furthermore, sum rules for linear dichroism developed by van der Laan demonstrate that the XMLD is proportional to the spin-orbit interaction (and thus the magnetocrystalline anisotropy) [5]. Both of these findings are being developed so that XMLD can be used for investigating the magnetic structure of magnetic thin-film structures. Emphasis is on the investigation of spin-valve structures that are of technological relevance due to their use as read heads in magnetic storage.

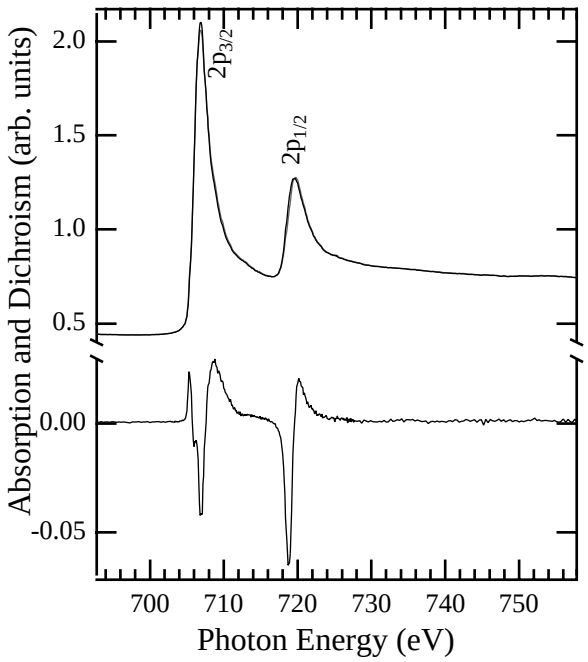

Figure 1: Fe $L_{2,3}$ total electron yield (top) and XMLD (bottom) for an Fe (001) epitaxial thin film.

Acknowledgments

Use of the Advanced Photon Source was supported by the U.S. Department of Energy, Basic Energy Sciences, Office of Science, under Contract No. W-31-109-Eng-38.

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