X-ray magnetic circular dichroism (XMCD) on CrO₂ and RuO₂/CrO₂ bilayers

Manjit Pathak, Krishna Chetry, Dipanjan Mazumdar, Gihan Kwon, Gary Mankey, Arun Gupta, Patrick LeClair

**MINT Center, The University of Alabama**

This project was funded by NSF-DMR 0213985.

**XMCD:**

X-ray magnetic circular dichroism (XMCD) is a powerful experimental technique that provides information about the magnetic moment in a magnetic material. The excitation cross section depends on the projection of the photon spin or helicity onto the electron spin. In the experiment the helicity of the photon is kept constant for two magnetization directions on the film. Subtle changes in the total electron yield for positive and negative magnetization can then be detected and plotted versus photon energy to determine the element specific magnetic moment distribution in a material.

**XMCD sum rules:**

Using the above sum rules we can estimate the spin and orbital magnetic moment from the x-ray absorption (XAS) and the MCD signal. Integrals are evaluated from the background corrected experimental data.

\[
\begin{align*}
M_{\text{spin}} &= -\int \frac{4}{3} \left( \mu_{+} - \mu_{-} \right) d\omega \\
M_{\text{orb}} &= -\int \frac{6}{5} \left( \mu_{+} - \mu_{-} \right)^2 d\omega \\
\end{align*}
\]

**PRL 75 152 (1995)**

In the x-ray absorption edge of Cr, L₂ and L₃ peaks are observed at 577eV and 585eV respectively with strong dichroism signal. The XMCD signal is because of two charged state of Cr i.e. Cr²⁺ and Cr³⁺ which makes the spectra not very straightforward to analyze. XMCD spectra analyzed with the sum rules gives the moments summarized in the following table. Observed interfacial spin moment in (100) textured films is found to be smaller than those in case of (110) textured films and both films have smaller moment than the bulk value of ~1.5 \(\mu_B\) at room temperature. This observed lower moment can be attributed to the surface roughness and other factors. The angular moment calculated within this model using sum rules are found to be much smaller than the spin moment. As the magnetization of a ferromagnetic material increases with decreasing temperature, higher moment is expected at low temperature.

**Conclusion:**

1. Estimated interfacial moment in CrO₂ blanket films using sum rules are found to be smaller than bulk moment. This may be because sum rules are not exactly suitable for a highly correlated system like CrO₂ and other factors such as surface roughness of the samples.
2. Moment analysis of the bilayer samples are in progress.

**Acknowledgement:**

Authors gratefully acknowledge the staff of Syncrotron Radiation Center (SRC), University of Wisconsin for the beam line and help with the experiment.

For more information and reprints contact:
Patrick LeClair, MINT Center.
E-mail: pleclair@mint.ua.edu

**The University of Alabama**