Type of presentation: Poster

**IT-5-P-2232 Distinguishing overlapping EMCD signals on oxidized metals in the TEM**

Thersleff T.[1], Rusz J.[2], Rubino S.[5], Hjörvarsson B.[2], Ito Y.[3], Zaluzec N. J.[4], Leifer K.[1]

[1]Department of Engineering Sciences, Uppsala University, Uppsala, Sweden, [2]Department of Physics and Astronomy, Uppsala University, Uppsala, Sweden, [3]Department of Physics, Northern Illinois University, DeKalb, IL, USA, [4]Electron Microscopy Center, Argonne National Laboratory, Argonne, IL, USA, [5]Department of Physics, University of Oslo, Oslo, Norway

Email of the presenting author: thth@angstrom.uu.se

Energy-loss Magnetic Circular Dichroism (EMCD) is a powerful electron microscopy technique capable of extracting quantitative magnetic information from nano-sized features [1–3]. This technique has potential for high impact in research and industry where understanding interfacial magnetism is crucial to the design of nanostructured magnetic materials yet hampered by a lack of reliable small-volume characterization techniques. A key challenge facing further development of the EMCD technique is to extract reliable data from very small volumes of materials with sufficient quality for quantitative analysis. This is especially difficult for metals, as a thin oxide typically forms on the surfaces of the as-prepared lamella during transfer into the transmission electron microscope. In the case of iron, this surface oxide layer may be itself magnetic, potentially complicating the quantification of an EMCD signal from thin regions.

In this study, we investigate variations in the EMCD signal on an iron thin film with a surface oxide layer. The experimental design is depicted in figure 1 and yields a fully convergent beam with a diameter that can be reduced to approximately 1 nm. Under these conditions, we are able to provide a detailed structural and chemical assessment of the surface oxide. Subsequently we explore the consequences of its magnetization as well as how this modifies the detected EMCD signal (see figure 2). We conclude by proposing a method to quantify this effect and distinguish between the EMCD signals from either the underlying metallic film or its surface layer.

References

[1] P. Schattschneider, S. Rubino, C. Hébert, J. Rusz, J. Kuneš, P. Novák, et al., Detection of magnetic circular dichroism using a transmission electron microscope, Nature. 441 (2006) 486–488.

[2] P. Schattschneider, M. Stöger-Pollach, S. Rubino, M. Sperl, C. Hurm, J. Zweck, et al., Detection of magnetic circular dichroism on the two-nanometer scale, Phys. Rev. B. 78 (2008).

[3] H. Lidbaum, J. Rusz, A. Liebig, B. Hjörvarsson, P. Oppeneer, E. Coronel, et al., Quantitative Magnetic Information from Reciprocal Space Maps in Transmission Electron Microscopy, Phys. Rev. Lett. 102 (2009).

Acknowledgement: The authors acknowledge STINT research grant (1G2009-2017) and the Electron Microscopy Center at Argonne National Laboratory, a U.S. Department of Energy Office of Science Laboratory operated under Contract No. DE-AC02-06CH11357 by UChicago Argonne, LLC. J. R. acknowledges the Swedish Research Council, Göran Gustafsson's Foundation and Swedish National Infrastructure for Computing (NSC center).

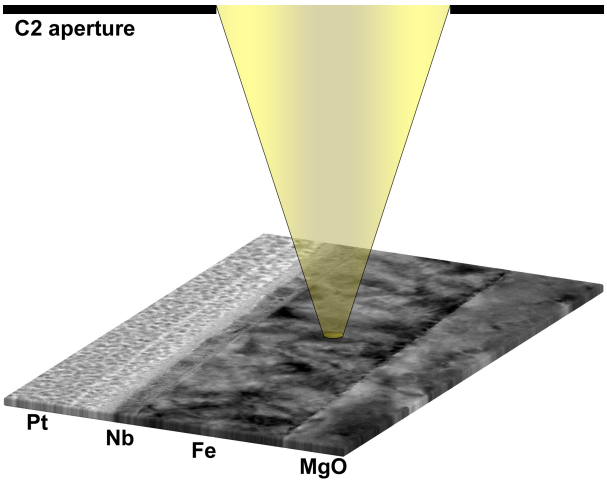


Fig. 1: Figure 1 - Illumination conditions for the EMCD experiment. The probe size is limited by the C2 aperture and can be reduced to approximately 1 nm in diameter.

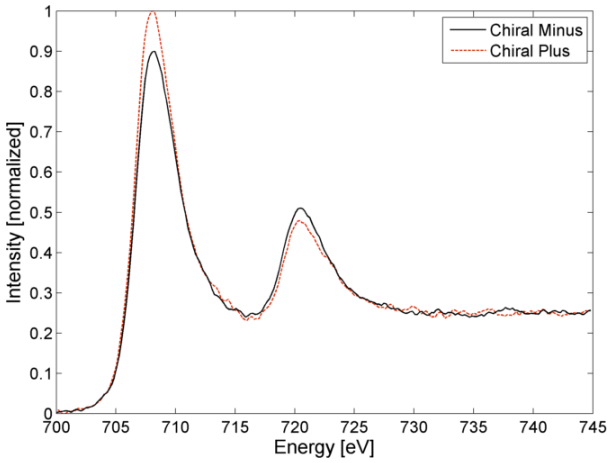


Fig. 2: Figure 2 – ELNES spectra acquired at two detector positions using a probe with a diameter of approximately 1.5 nm. Their difference is an EMCD spectrum.