Dichroism Soft X-ray Absorption Spectromicroscopy and Antiferromagnetic Surfaces and Interfaces

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Synchrotron based dichroism x-ray absorption spectro-microscopy (dichroism XAS) is an excellent tool for the investigation of magnetic heterostructures, because of its ability to address antiferromagnetic (AF), ferromagnetic (FM), chemical and structural order of different elements in an unknown sample. Even more important, dichroism XAS can be used as a contrast mechanism in a photoemission electron microscope (PEEM) to characterize surfaces, buried interfaces and nanostructures with high spatial resolution (~50nm) and temporal resolution (100ps).

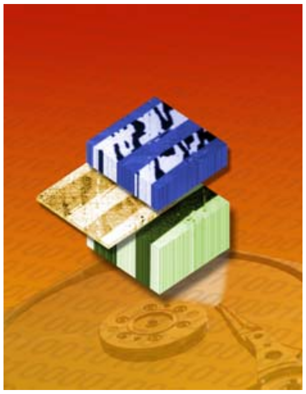

FIG 1: Artist illustration of AF (green, bottom), FM (blue, top) and interfacial (gold, middle) magnetic domains in a Co/NiO(001) bilayer

In my presentation I will present results of our research focusing on *exchange bias* systems. These are systems in which a ferromagnetic and an antiferromagnetic material are in close contact with each other and hence the magnetic properties of the ferromagnet are changed in a very distinct way. In this area dichroism XAS has helped to improve our insight tremendously over recent years because conventional magnetic imaging techniques are not able to address the antiferromagnetic order which is a key ingredient in these systems. For the first time we were able to correlate the antiferromagnetic (AF), ferromagnetic (FM) and interfacial domain structure (see FIG. 1). Furthermore we could identify and analyze the structure of lateral antiferromagnetic domain walls and extract quantitative information about the relevant magnetic anisotropy energies in NiO.

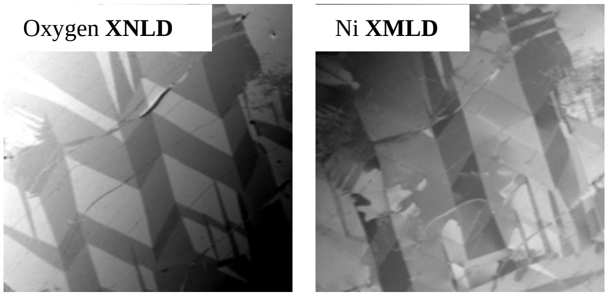

FIG 2: Crystallographic domains (left) and AF domains right on NiO(001), made visible using the polarization dependence of the Oxygen 1s or Ni 2p absorption edge. The field of view is 40 μm.

More recently we investigated the sensitivity of x-ray absorption to deviations of the crystal lattice from the ideal symmetry and we employed this sensitivity to image crystallographic domains in NiO using polarized soft x-rays. For example, in antiferromagnetic NiO each magnetic domain is suspected to correspond to a crystallographic domain which exhibits a distinct lattice distortion. By comparing the magnetic dichroism at the nickel absorption edge with the polarization dependence of the oxygen absorption, the latter one is related to the crystal structure, the correlation between magnetic and crystallographic domains could be unambiguously identified at the (100) surface of NiO (see FIG. 2).

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