Antiferromagnetic domains in epitaxial thin films

Interface and surface effects play a central role in modern magnet structures. Magnetic exchange coupling and bias, spin injection across the boundary between magnetic and non-magnetic layers, and the surface and interface anisotropy in multilayers are examples for interface phenomena that are utilized in magneto-electronics. In particular, the microscopic origin of exchange bias at ferromagnet/antiferromagnet interfaces is still an unsolved problem despite of intense research, driven by the important application of exchange bias in hard disk read-heads and magnetic RAM. Knowledge of the microscopic magnetic structure in antiferromagnetic thin films and surface is of crucial importance for a better understanding of the exchange bias effect. Microscopic experiments on magnetically coupled ferromagnet/antiferromagnets using X-ray Photoemission Electron Microscopy (X-PEEM) now provide a new insight into the microscopic processes at this important interface.

Using a combination of x-ray magnetic dichroism (XMD) and microscopic electron yield detection we have resolved the magnetic structure in LafeO3 and NiO thin films and crystals. The antiferromagnetic domain structure is linked to the crystallographic structure of the material and vanishes approaching the magnetic ordering temperature. Ferromagnetic films grown on the antiferromagnetic substrate show a corresponding ferromagnetic domain structure, an uniaxial exchange anisotropy and a local bias which increases with decreasing domain size, suggesting a statistical origin of the bias effect. The role of uncompensated interface spins will also be discussed. We will present first experiments on magnetic interlayer coupling across metallic antiferromagnets, which suggest a similar origin of bias in full-metallic exchange bias systems.

A. Scholl et al., Science 287, 1014 (2000), F. Nolting et al., Nature 405, 767 (2000), H. Ohldag et al., Phys. Rev. Lett. 86, 2878 (2001)