Tuning Antiferromagnetic spin orientation in epitaxial thin films

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The exchange coupling in in ferromagnetic (FM) / antiferromagnetic (AFM) system is one of the most intensively studied subjects in nanomagnetism research in the past decades due to its application in spintronics devices. AFM system is one of fundamental magnetic systems in condensed matter physics; however, if comparing with the ferromagnetic (FM) system, it is difficult to experimentally determine the AFM spin structure and to tune the AFM spin orientation. Therefore, in order to get a profound understanding on the mechanism of exchange coupling, it is important to tune the spin orientation in AFM thin film.

In this talk, I will report our efforts on tuning the AFM spin orientation in single crystalline CoO and NiO film. The AFM spin orientation was determined by the x-ray linear dichroism effect (XMLD). We found the CoO spin orientation can be controlled by the film strain, and an AFM spin reorientation transition can be observed when the CoO film changes from compressive strain to tensile strain. The surface atomic steps can also induce strong in-plane AFM anisotropy for CoO film grown on miscut MgO(001) substrate. The exchange coupling between CoO and NiO spins can induce NiO AFM spin reorientation in NiO/CoO/MgO(001). Moreover, the exchange coupling in Fe/CoO was systematically studied. The dynamics of the in-plane AFM spin reorientation in Fe/CoO/MgO(001) system was investigated by Magneto-Optic Kerr effect. The CoO AFM domain can be switched by the external film. For the first time, the energy barrier of CoO AFM domain nucleation and domain wall propagation were quantitatively determined through the temperature dependent measurement, which linearly increases with the CoO thickness.