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GMAG Dissertation Award: Exploring new magnetic properties in coupled magnetic nanostructures

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One of the basic building blocks in constructing magnetic nanostructures is a magnetic sandwich in which two ferromagnetic layers are separated by a nanometer thick nonmagnetic spacer layer. Research on coupled magnetic sandwiches has generated fruitful results such as the oscillatory magnetic interlayer coupling and giant magneto resistance. The basic question on this subject is: how does the interlayer coupling generate new magnetic properties of the sandwich? In order to single out the effect of interlayer coupling, it is necessary to measure the two magnetic layers separately. Such experimental capability becomes available after the development of x-ray magnetic circular dichroism (XMCD) technique which enables element-specific measurement. In particular, Photoemission Electron Microscopy (PEEM) technique allows the element-specific magnetic domain imaging of magnetic nanostructures. In this talk, I will discuss our recent effort in using PEEM to study coupled magnetic sandwiches. First, I will discuss results of Co/Cu/Ni and Co/Fe/Ni in which we studied the effect of interlayer coupling on the magnetic phase transitions of the Co and Ni films. We found that a coupled magnetic sandwich undergoes three types of magnetic phase transitions, depending on the two ferromagnetic films' thickness. The differences and characteristics among these three phase transitions will be discussed with the simple simulation based on an Ising model. Second, spin reorientation of coupled sandwich will be discussed. We reveal a universal dependence of the stripe domain width on the magnetic anisotropy and on the interlayer coupling. In the last, I will discuss results of FeMn/Co in which the magnetic frustration between the antiferromagnetic FeMn and ferromagnetic Co modifies the Curie and Neel temperatures of the system.