

The work reported here was a collaborative project between the research groups of Dr. J.L. Robertson at Oak Ridge National Laboratory and Dr. G.J. Mankey at the University of Alabama. The main thrust is developing neutron optical devices and materials for the study of magnetic thin films and interfaces. The project is particularly timely, since facility upgrades are currently underway at the High Flux Isotope Reactor. A new neutron optical device, a multocrystal analyzer, was designed and built to take maximum advantage of the increased flux that the upgraded beamlines at HFIR will provide. This will make possible detailed studies of the magnetic structure of thin films, multilayers, and interfaces that are not feasible at present. We performed studies of the antiferromagnetic order in thin films and crystals using neutron scattering, determined magnetic structures at interfaces with neutron reflectometry and measured order in magnetic dispersions using small angle neutron scattering. The collaboration has proved fruitful: generating eleven publications, contributing to the training of a postdoc who is now on staff at the High Flux Isotope Reactor and providing the primary support for two recent Ph.D. recipients. The collaboration is still vibrant, with anticipated implementation of the multocrystal analyzer on one of the new cold source beamlines at the High Flux Isotope Reactor.

Two graduate students in physics at UA were supported by this grant, Prakash Mani and Ilir Zoto. Both of them completed the requirements for the Ph.D. in the spring of 2006. Dr. Mani's dissertation was entitled "Probing Spin Ordering In Fe-Pt Based Antiferromagnetic Films Using Neutron Diffraction" and Dr. Zoto's dissertation was entitled "Magnetic Properties of Gadolinium / Transition Metal Multilayer Films." In addition, a postdoctoral researcher, Dr. Vemuru V. Krishnamurthy was also supported by this grant. He has since moved to the High Flux Isotope Reactor in Oak Ridge National Laboratory to continue work towards implementing the multocrystal analyzer which was developed at UA.

Of the eleven publications, four were in close collaboration with Dr. Robertson. These include the following:

Magnetic Transitions in lattice-matched, ordered FePt<sub>3</sub> based antiferromagnetic/ferromagnetic films, P. Mani, V.V. Krishnamurthy, J.L. Robertson, F. Klose and G.J. Mankey, J. Appl. Phys. 99, 08C109(2006).

Growth and characterization of epitaxial Fe<sub>x</sub>Pt<sub>100-x</sub> films on MgO(111), P. Mani, V. V. Krishnamurthy, S. Maat, A. J. Kellock, J. L. Robertson, and G. J. Mankey, J. Vac. Sci. Technol. A 23, 785 (2005).

Antiferromagnetic phase transitions in an ordered Pt<sub>3</sub>Fe(111) film studied by neutron diffraction, V. V. Krishnamurthy, I. Zoto, G. J. Mankey, J. L. Robertson, S. Maat, Eric E. Fullerton, I. Nwagwu, and J. K. Akujieze, Phys. Rev. B 70, 024424 (2004).

Spin wave excitations in the antiferromagnetic state of Pr<sub>0.5</sub>Sr<sub>0.5</sub>MnO<sub>3</sub>, V. V. Krishnamurthy, J. L. Robertson, G. J. Mankey, N. Cavadini, Ch. Niedermayer, and J. F. Mitchell, J. Appl. Phys. 95, 7351 (2004).

The seven other publications were developed in collaboration with other groups and are listed below:

Sintering Behavior of Spin-Coated FePt and FePtAu Nanoparticles, J. Appl. Phys. 99, 08N704(2006).

Magnetic properties of uniaxial synthetic antiferromagnets for spin-valve applications, Z. Zhao, P. Mani, G.J. Mankey, G. Gubbiotti, F. Spizzo, S. Tacchi, W.-T. Lee, C.T. Yu and M.J. Pechar, Phys. Rev. B 71, 104417 (2005).

Growth and magnetic properties of epitaxial Au/Fe/Au and Ag/Fe/Au films on  $\alpha$ -Al<sub>2</sub>O<sub>3</sub>, V.V. Krishnamurthy, S.G.E. te Velthuis, S. Srinath, Prakash Mani and G.J. Mankey, *Journal of Magnetism and Magnetic Materials* 286, 432 (2005).

Interlayer exchange coupling in Co/Ru/Co trilayers, G. Gubbiotti, S. Tacchi, G. Carlotti, G. Socino, F. Spizzo, Zhiya Zhao, P. Mani and G.J. Mankey, *Journal of Magnetism and Magnetic Materials* 286, 468 (2005).

Magnetic properties of uniaxial synthetic antiferromagnetic films, Zhiya Zhao, Prakash Mani, W.-T. Lee, and Gary J. Mankey, *J. Appl. Phys.* 95, 7157 (2004).

Shear- and magnetic-field-induced ordering in magnetic nanoparticle dispersion from small-angle neutron scattering, V. V. Krishnamurthy, A. S. Bhandar, M. Piao, I. Zoto, A. M. Lane, D. E. Nikles, J. M. Wiest, G. J. Mankey, L. Porcar, and C. J. Glinka, *Phys. Rev. E* 67, 051406 (2003).

Evidence for a magnetic moment on Ir in IrMnAl from x-ray magnetic circular dichroism, V. V. Krishnamurthy, N. Kawamura, M. Suzuki, T. Ishikawa, G. J. Mankey, P. Raj, A. Sathyamoorthy, Amish G. Joshi, and S. K. Malik, *Phys. Rev. B* 68, 214413 (2003).

Magnetism of Ir in Fe<sub>2</sub>IrSi from Ir L<sub>2,3</sub> edge x-ray magnetic circular dichroism spectroscopy, V. V. Krishnamurthy, J. L. Weston, G. J. Mankey, M. Suzuki, N. Kawamura, and T. Ishikawa, *J. Appl. Phys.* 93, 7981 (2003).