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ABSTRACTS

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CE-03. Mossbauer and X-ray Spectromicroscopy Studies of Hematite (α-Fe_2O_3) Nanocubes.*J. Jalli*[1], Y. Hong[1], C. Kim[2], C. Kim[2], J. Park[1], J. Lee[1], G.S. Abo[1], A. Romero-Herreros[3] and A.F. Rodriguez[3] *1. Department of Electrical and Computer Engineering and MINT Center, The University of Alabama, Tuscaloosa, AL; 2. Department of Nano and Electronic Physics, Kookmin University, Seoul, Korea, Republic of; 3. Departament de Física Fonamental and Institut de Nanociència i, Universitat de Barcelona, Barcelona, Spain*

The hematite becomes weakly ferromagnetic in the range of 961 K (T_N) to 265 K (T_M for bulk hematite) and is antiferromagnetic below 265 K. The Morin transition temperature (T_M) is dependent on particle size and shape [1, 2]. We have reported that the Fe^{3+} spin in the 40 nm spherical hematite particle flips from 90^o (in-plane) to 28^o (the angle between [110] rhombohedral and c-axis) at 220 K (T_M) [3]. In this paper, we report the Mossbauer and x-ray photoemission electron microscopy (PEEM) results of 20 nm hematite nanocubes. Fig. 1(a) shows TEM image of the 20 nm hematite nanocubes. Mossbauer spectra were taken in the range of 4.2 K to 290 K. A sudden change in the quadrupole splitting was not observed like spherical shaped hematite [3], but the site 2 spectrum completely disappears at about 230 K in Fig. 1(b). This is in good agreement with FC and ZFC magnetization curves, which meet at 230 K. This temperature is taken as the T_M in this study. Therefore, it is suggested that the hematite particle shape does not have a key role in determining T_M at nanoscale. Furthermore, we have studied element-specific electronic properties of single hematite nanocube using a combination of PEEM and synchrotron x-ray absorption spectroscopy. In order to obtain local x-ray absorption spectra of single nanocubes, a series of PEEM images around the Fe $L_{2,3}$-edges were recorded. Our preliminary results show that the isotropic spectra of the 20 nm nanocubes cannot be superimposed, after multiplication for appropriate scaling factors, to reference spectra of α-Fe_2O_3 or any other known iron oxide species. This indicates a possible coexistence of different surface for different core stoichiometries of the nanocubes.

[1] M. Sorescu, et al., J. of Appl. Phys., Vol. 85, 5546 (1999) [2] R. D. Zysler, et al., Phys. Rev. B, Vol. 68, 212408 (2003) [3] S. H. Gee, et al., IEEE Trans. on Magn., Vol. 40, 2691 (2004)

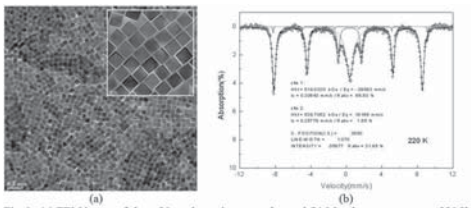

Fig. 1. (a) TEM image of about 20 nm hematite nanocubes and (b) Mossbauer spectrum at 220 K.

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CE-04. Optical and Electrical Investigation of Bismuth Telluride Nanoplates.*M. Eginligil*[1], W. Zhang[2], V. Truong[1], A. Kalitsov[1], X. Lu[2] and H. Yang[1] *1. Department of Electrical and Computer Engineering, NUSNNI-Nanocore, National University of Singapore, Singapore, Singapore; 2. Department of Chemical and Biomolecular Engineering, National University of Singapore, Singapore, Singapore*

Topological insulators (TI) are materials which are similar to band insulators in their bulk but have topologically protected metallic edge or surface states for two dimension (2D) or three dimension (3D), respectively, with spin helicity. Particularly, 3D TI with single Dirac cone at the Γ point is promising for magneto-electric applications. As recently shown by angle resolved photoemission spectroscopy (ARPES), Bi2Te3 is a 3D TI [1] and exfoliated Bi2Te3 films show A1u peak which is a Raman spectrum inactive in bulk [2]. Although there is a direct evidence of topological surface states from ARPES, there is no clear demonstration of these states by electrical transport measurements. Here we show our results of micro-Raman and electrical measurements on ensembles of Bi2Te3 nanoplates synthesized by solvent-based chemical method. We observe A1u peak which is Raman active due to crystal symmetry breaking at 120 cm-1 with laser excitation of 488 nm measured excitation power as low as 70 μW. This peak is comparable to bulk A1g2 and Eg2 in magnitude. We fabricated devices consisting of Bi2Te3 nanoplates with non-magnetic electrodes and studied the tunnelling behavior. Current voltage (I-V) characteristics exhibit a symmetric tunneling behavior in most of the devices which is consistent with our I-V calculations based on a simple Hamiltonian. One device shows symmetric, while the other shows a two-step tunneling behavior. We discuss the results, particularly the latter in terms of randomly distributed impurities. We also investigate the effect of magnetic electrodes where magneto-electric effects play a crucial role.

[1] Y.L. Chen, et al. Science 325 78 (2009). [2] K. M. F. Shahil, et al. Appl. Phys. Lett. 96 153103 (2010).

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CE-05. Evidence for Highly Suppressed Magnetostructural Transition Temperature in Nanostructured FeRh.*R. Barua*[1], F. Jimenez-Villacorta[1], H. Jiang[3], J.E. Shield[3], D. Heiman[2] and L.H. Lewis[1] *1. Department of Chemical Engineering, Northeastern University, Boston, MA; 2. Department of Physics, Northeastern University, Boston, MA; 3. Department of Mechanical Engineering, University of Nebraska, Lincoln, NE*

Magnetostructural transitions, comprising simultaneous magnetic and structural phase changes, have the potential to deliver extremely large functional effects in response to small excursions in magnetic field, temperature and strain. In this study, the effects of nanostructuring on magnetostructural transitions are of interest. To this end, a phase-separated system of $(FeRh)_5Cu_{95}$ was synthesized via melt quenching under Ar atmosphere (wheel speed: 50 m/sec) with the goal of precipitating nanoscaled FeRh in a Cu matrix upon isochronal vacuum annealing for 30 minutes in the temperature range 100 K ≤ T ≤ 800 K. The magnetic and structural properties of the $(FeRh)_5Cu_{95}$ ribbons were compared with bulk FeRh which exhibits an abrupt antiferromagnetic - ferromagnetic transition accompanied by a unit cell volume change of 1% at T ~ 370 K. SQUID magnetometry, transmission electron microscopy (TEM) and X-ray diffraction (XRD) were used to determine the magnetic behavior and phases of the $(FeRh)_5Cu_{95}$ ribbons. While the annealed ribbons are a complex mixture of spin glass, ferromagnetic and paramagnetic phases, removal of the background Pauli paramagnetic susceptibility signal in the annealed ribbons reveals the presence of a magnetic phase transition at T_t = 130 K. This phase transition becomes more pronounced upon annealing at higher temperatures and is highly reminiscent of the bulk FeRh magnetostructural transition at 370 K. XRD data indicates presence of only Cu with a slightly expanded lattice parameter; however, TEM imaging confirms the presence of coherent nanoscaled precipitates (~10-15 nm diameter) that are hypothesized to consist of FeRh. If indeed the noted unusual magnetic response arises from the presence of FeRh nanoparticles, this result represents an unprecedented reduction in magnetic transition temperatures due to nanoscaling. Research supported by the U.S. Department of Energy, Office of Basic Energy Sciences, Division of Materials Sciences and Engineering under Award No. DE-SC0005250.