

AS-08. A 10 and 300 K EPR study of the effect of doping Ceria with 5% Co or Ni ions prepared at varying annealing temperatures.

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Nanoparticles of CeO₂ doped with transition metal ions exhibit interesting room-temperature ferromagnetic (FM) properties. Several samples of CeO₂ nanoparticles, doped with 5% Ni or 5% Co ions, annealed at 200, 300, 400 or 500 C, were investigated by EPR (electron paramagnetic resonance) at 10 and 300 K. Magnetic properties and EPR/FMR spectra of these nanoparticles depend on the annealing temperature and dopant ions. EPR studies provide more details about the roles of the doped ions and oxygen defects in the observed magnetic properties. EPR at 10 K. EPR signals of localized Co and Ni ions were observed only at liquid-helium temperature together with ferromagnetic (FM) resonance lines. (i) Ni. (S=1) was observed in the sample annealed at 200 C and similar to ref. 1. For the spectra in the samples annealed at 300 and 400 C, Ni spectra correspond to S=1/2, rather than to S = 2, characterized by a strong anisotropy of the g-tensor, indicating that Ni ions are in the Ni⁺ or Ni³⁺ state. A strong narrow line with g = 2.0, due to oxygen defects appears. (ii) Co. EPR signals of the Co²⁺ ions were observed in all the samples (g_x=1.2, g_y=2, g_z= 5.4, A_x = 9 G, A_y = 9 G, A_z = 49 G). Additional narrow Co EPR signals appear in the samples annealed at 400 and 500 C due to oxygen defects. It is clear from the EPR data that the local environment around Ni and Co changes systematically with annealing temperature. EPR at 300 K. (i) Ni. Simulation of EPR spectra for these ions revealed that they consist of two parts: FM and superparamagnetic (SPM), with the SPM contribution increasing with annealing temperature. (ii) Co. No EPR spectrum is observed for Co²⁺ ions due to its short relaxation time, and so these spectra showed only FM signals. EPR spectra of oxygen defects were also found for samples annealed at 300, 400 C and doped with Ni and Co ions. Furthermore, the surface of nanoparticles changes considerably, leading to a complete disappearance of the EPR spectrum of oxygen defects for 500 C annealing temperature.

AS-09. Fluence dependence of disorder and resulting effect on magnetism in Mn-implanted 6H-SiC single crystal.

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n-Type 6H-SiC(0001) substrates were implanted with three fluences of Mn⁺ 5×10¹⁵ (Mn content: 0.7 at.%), 1×10¹⁶ (2.2%), and 5×10¹⁶ cm⁻² (7%) with implantation energy of 80 keV and at substrate temperature of 365°C to promote re-crystallization. The samples were characterized using XRD, RBS/C and SQUID techniques. The aim was twofold: (i) first to investigate implantation-induced defects upon fluence and amorphization threshold; (ii) second to study any correlation between disorder-composition and magnetic properties. RBS/C spectra were fitted using McChasy code, and the corresponding results show that 50% of Mn occupy substitutional sites for the lowest dose (0.7 at%), while highly disordered implanted zone for intermediate Mn content (2.2%) was observed, and finally an almost amorphization occurred for the highest dose (7%). Surprisingly, the magnetization measured at 3 kOe decreases as the Mn content increases regardless the measurement temperature between 4 and 300 K. The hysteresis loops of the two samples with lowest doses have a ferromagnetic-like shape while that for the highest dose does not saturate up to 10 kOe at 4 K, typical of a paramagnetic system. The strain deduced from the analysis of high resolution XRD spectra shows the same trend, i.e. decreasing with Mn content confirming the incorporation of Mn in substitutional sites. In fact the highly implanted samples present strained crystalline zones as evidenced from XRD analysis. The Mn depth profiles deduced from RBS reflect the same implanted zone (the same end of range) for all samples with a Gaussian shape centered at around 50 nm, while the maximum accumulated damage (represented by a parameter ρ_D varying

from 0 for perfect crystal to 1 for amorphous phase) shifts from 50 nm for 0.7% to 75 nm for 7%. Furthermore, we have performed ab initio calculations on Mn-doped 6H-SiC considering a number of configurations. An attempt to explain the trend of magnetic properties versus defects will be discussed.

AS-10. Room temperature ferromagnetism of Na and Co co-doped ZnO nanoparticles. M. Yan¹ and H. Gu¹. *1. Department of Materials Science and Engineering, Zhejiang University, Hangzhou, China*

Recent works have documented that for the appearance of ferromagnetism in transitional metal(TM) doped ZnO samples. The presence of additional carriers plays an important role in stabilizing or enhancing the magnetic couplings by the co-doping ions [1-3], but contradiction on mechanism of room temperature ferromagnetism still exists. Since Na locates in IA and without its own 3d electrons to interfere with magnetic ordering, Na co-doping as carrier in ZnO-based DMSs has been lack of work and it is desirable to explore the role of Na and the influence to the magnetic properties. The ferromagnetism of Na and Co co-doped ZnO (Zn_{0.95-x}Co_{0.05}Na_xO) prepared by sol-gel method was investigated. X-ray diffraction (XRD) measurements of Zn_{0.95-x}Co_{0.05}Na_xO (x = 0.01, 0.05, 0.07, 0.10) nanoparticles showed highly crystalline wurtzite ZnO without any stray peaks corresponding to impurity phases. High-resolution transmission electron microscopy (HR-TEM) imaging, selected area electron diffraction (SAED), and energy dispersive x-ray spectroscopy (EDS) studies indicated that no trace of Co or Na related clusters can be observed in the sample, which means that all Co and Na ions enter into the ZnO lattice. X-ray photoelectron spectroscopy (XPS) revealed that substituted Co is in the +2 oxidation state and Co metallic precipitation was not detected in the ZnCoO sample. Magnetization hysteresis loops of Zn_{0.95-x}Co_{0.05}Na_xO were S-shaped, and the observed ferromagnetic behavior at room temperature can be ascribed to the indirect exchange via defects generated by Na⁺ coupled with magnetic Co ions. The saturation magnetization shows a continuous drop with the increase of Na concentration. The ferromagnetic state is more stable below 5% doping of Na, while above 5%, spin-glass state become predominant with the accretion of defects concentration. Hall measurement showed all samples were n-type and the carrier densities decreased with the increment of Na concentration, and this tendency is consistent with the variation of magnetizations.

[1] N. A. Spaldin, Phys. Rev. B, vol. 69, p. 125201, 2004. [2] M. H. F. Sluiter, Y. Kawazoe, Parmanand Sharma, A. Inoue, A. R. Raju, C. Rout, and U.V. Waghmare, Phys. Rev. Lett., vol. 94, p. 187204, 2005. [3] K. Sato, and H. Katayama-Yoshida Semicond. Sci. Technol., vol. 17, p. 367, 2002.

AS-11. Structural and magnetic properties in Tb₆Fe_{1-x}Co_xBi₂ (x=0, 0.125, 0.25, 0.375) compounds. L. Jia¹, M. Koehler¹, D. McCarthy¹, M. McGuire² and V. Keppens¹. *1. Department of Materials Science and Engineering, The University of Tennessee, Knoxville, TN; 2. Materials Science and Technology Division, Oak Ridge National Laboratory, Oak Ridge, TN*

Structural and magnetic properties of Tb₆Fe_{1-x}Co_xBi₂ (x=0, 0.125, 0.25, 0.375) compounds are investigated experimentally. All of the compounds crystallize in the hexagonal Zr₆CoAs₂-type structure at room temperature. Lattice parameters *a* and *c* are calculated from the X-ray diffraction data and change linearly from 8.287 to 8.305 Å and 4.201 to 4.166 Å (respectively) as Co content increases from 0 to 0.375, leaving the volume of the unit cell relatively unchanged. Low temperature X-ray diffraction measurements on the Co-doped samples Tb₆Fe_{0.75}Co_{0.25}Bi₂ and Tb₆Fe_{0.625}Co_{0.375}Bi₂ show a splitting of the Bragg peaks, indicating a structural phase transition at ~50 K. Magnetization measurements as a function of temperature (5 - 300 K) show two magnetic transitions. While the higher temperature transition (T_{C1} ~ 250 K) corresponds to the ferromagnetic ordering of the Tb moments [1], the nature of the lower transition (T_{C2} ~ 60 K) is less clear but is most likely linked to the structural transition. With the Co content *x* increasing from 0 to 0.375, T_{C1} decreases from ~250 K to ~240 K and T_{C2} from ~60 K to ~44 K. There is no thermal and magnetic hysteresis found around T_{C1} for all compositions. The transition related to T_{C2}, in contrast, shows pronounced magnetic hysteresis.