Session AP
FERRITES AND GARNETS I
(Poster Session)
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AP-02. Effect of Substrate Temperature on Magnetic Properties of Highly c-axis Oriented Ni86Zn14Fe2O4 Thin Films.
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AP-03. An easy way to increase the resonance frequency of CoFe2O4 nanocubics.
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AP-04. Mössbauer studies of Zn doped NiFe2O4 nanoparticles with bio-plasma treatment as hyperthermia application.

AP-05. Tuning magnetic properties of MgCuZn ferrites via CoO doping.
J. Liu1, W. Liu1, Z. Zhang1, H. Jia1, Y. Nie1, X. Wang1 and R. Gong1 1. School of Optical and Electronic Information, Huazhong University of Science and Technology, Wuhan, China

AP-06. Patterning and Substrate Effects on Coercivity for Cobalt Ferrite and Nickel Ferrite.
A. Cruz1 and J. Schwartz1 1. Materials Science, North Carolina State University, Raleigh, NC

AP-07. New effective parameter synthetically evaluate the high permeability, broadband frequency band of low loss NiCuZn ferrite.
W. Liu1, Z. Zhang1, F. Chen2, H. Luo1, Z. Feng1, X. Wang1, R. Gong1 and Y. Nie1 1. School of Optical and Electronic Information, Huazhong University of Science and Technology, Wuhan, China

AP-08. Investigation of spin reorientation in Ga substituted Ba1.3Mg0.7Fe11.88Ga0.12O22 Y-type hexaferrite based on Mössbauer spectroscopy.
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artificial multiferroic composites and heterostructures. We have chosen Ni$_{0.7}$Zn$_{0.3}$Fe$_2$O$_4$ for the present investigation as this composition exhibits the highest saturation magnetization in the entire Ni–Zn series along with high magnetic curie temperature ~ 600 K. NZFO thin films were grown by pulsed laser deposition (PLD) at different substrate temperature in the range of 500-800°C using a KrF excimer laser (λ=248 nm) on LaNiO$_3$ buffered (001) oriented (LaAlO$_3$)$_{b}$($Sr_2AlTaO$_6$)$_{c}$ (LSAT) substrate under an oxygen pressure of 150 mTorr followed by annealing at their subsequent growth temperature for 30 min in oxygen at a pressure of 300 Torr. The highly c-axis oriented growth containing only (004) diffraction peak of NZFO films along with in plane epitaxial relationship were confirmed by high resolution X-ray diffraction measurements. From the atomic force micrographs it was observed that all the films were densely packed, smooth, free from micro-crack and particulates with uniform grain-size distributions. XPS measurements confirmed that in all films the Ni, Zn and Fe elements retain their same oxidation states irrespective of growth temperature. The saturation magnetization ($M_s$) of NZFO was found to enhance systematically with increasing of growth temperature. The resistance of all NZFO films were found to decrease with increasing temperature indicating insulating behaviour. All these films showed positive magneto resistance at low magnetic fields. Detailed studies on dielectric, magnetic, magneto resistance and transport properties of NZFO films grown at different temperature will be discussed.

AP-03. An easy way to increase the resonance frequency of CoFe$_2$O$_4$ nanocubes. N. Song$^1$, S.z. Gu$^1$, J. Zhou$^1$, W. Wang$^1$, Q. Wu$^1$, Y. Ming$^1$, H. Yang$^2$ and Z.H. Cheng$^1$. 1. College of Science, Beijing University of Chemical Technology, Beijing, China; 2. Institute of Physics, Chinese Academy of Sciences, Beijing, China; 3. College of Materials Science and Engineering, Beijing University of Technology, Beijing, China

The miniaturization and rapid increase in frequencies of electric devices require magnetic materials with high permeability ($\mu$) and high resonance frequency ($f_r$). Although the resonance can be enhanced by introducing magnetic anisotropies, it is still a great challenge to increase both $\mu$ and $f_r$ simultaneously due to the Snook$^*$ limit for traditional magnetic materials.$^{[1]}$ In our previous work, a novel technique was reported to tune cut-off frequency of Fe$_3$O$_4$ nanoparticles exceeding the natural resonance frequency via superparamagnetic relaxation controlled by dipolar interaction.$^{[2]}$ The superparamagnetic relaxation of magnetic nanoparticles can also be tuned by controlling the volume, shape, anisotropy and so on.$^{[2]}$ And the effect of superparamagnetism on high frequency properties is still not well understood. In this paper, the superparamagnetic/ferromagnetic relaxation induced high frequency property of CoFe$_2$O$_4$ nanocubes (NCs) controlled by particle size was investigated. It is observed that the as-synthesized CoFe$_2$O$_4$ samples show regular cubic morphology and the size is 13, 20 and 40 nm respectively with a narrow size distribution as shown in Fig. 1. The ZFC and FC curve (Fig. 2a) indicated that the 13nm CoFe$_2$O$_4$ NCs show superparamagnetic but the 20nm and 40nm CoFe$_2$O$_4$ NCs are in ferromagnetic state. The size dependent high-frequency property was shown in Fig. 2b and 2c. It can be observed that the resonance frequency increase from 6.0 to 6.3 GHz with the decreasing of particle size from 40 to 20nm. With further decreasing of particle size to 13nm (superparamagnetic statue), the $\mu$ decreases monotonically with increasing frequency from 4 to 10 GHz and no resonance frequency could be found. This work provides a simpler approach to enhance the resonance frequency beyond the Snook’s limit and further understanding about the effect of superparamagnetism on high frequency properties.


Figure 1 TEM images of CoFe2O4 NCs with different size (a) 13nm, (b) 20nm, (c) 40nm.

Figure 2 M–T curves and frequency dependence of $\mu$ for 13nm, 20nm, and 40nm CoFe$_2$O$_4$ NCs.


We have studied crystal, magnetic and thermal properties of Ni$_{1-x}$Zn$_x$Fe$_2$O$_4$ (x = 0, 0.25, 0.50, 0.75, 1.0) nanoparticles based on XRD, VSM, magneTherm and Mössbauer spectroscopy. The crystal structure was confirmed to be cubic spinel structure (space group: Fd-3m). As the Zn-ions increase, the lattice constant increase from 8.3431 Å (x = 0) to 8.4274 Å (x = 1). The saturation magnetization and self-heating temperature of all samples by VSM measurement and magneTherm device were determined as 58 emu/g and 61 °C, which is the highest among the samples studied. Therefore, the Ni$_{1-x}$Zn$_x$Fe$_2$O$_4$ (x = 0.75) nanoparticles were treated with atmospheric pressure Ar plasma for 30 min. As a results, the values of the saturation magnetization and self-heating temperature for Ni$_{1-x}$Zn$_x$Fe$_2$O$_4$ (x = 0.75) nanoparticles increased with bio-plasma treatment, as 63 emu/g and 65 °C. To investigate the enhanced magnetic and thermal properties by bio-plasma treatment, we were performed using Mössbauer spectroscopy from 4.2 to 295 K. We have fitted the Mössbauer spectra of Ni$_{1-x}$Zn$_x$Fe$_2$O$_4$ (x = 0.75) based on the random distribution of Fe and Zn-ions on the tetrahedral (A) site and the probability for the octahedral (B) site having nearest-neighboring Zn-ions. Also, we have performed the Mössbauer measurements up to high external field of 5 T at 4.2 K and the spin canting angles of Ni$_{1-x}$Zn$_x$Fe$_2$O$_4$ (x = 0.75)