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ABSTRACTS

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GF-08. Magnetic Properties and Ferromagnetic Resonance of Co-Ni-Fe-N Soft Magnetic Thin Films with the Film Thickness.
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In order to apply Co-Ni-Fe-N soft magnetic thin films for high frequency magnetic devices, the thickness effects on the magnetic properties and microstructures of these films have been studied. Co-Ni-Fe-N soft magnetic thin films, which composition ranges are $Co_{21-24}Ni_{27-30}Fe_{43-49}N_{2-5}$, were deposited using rf reactive magnetron sputtering method. The high frequency characteristics and magnetic properties of these films were investigated as a function of film thickness with the range of 0.01-1.0 μm. Saturation magnetization of Co-Ni-Fe-N films is changed from 16 to 19 kG with the Fe content. Coercivity, electrical resistivity, and magnetic anisotropy field H_k of these films are increased 1.1 to 7.9 Oe, 53 to 188 μΩcm, and 18 to 65 Oe, respectively, with the decrease of film thickness. The initial permeability of these films is about 850, which is maintained above 700 MHz below 0.3 μm thickness. Therefore, Co-Ni-Fe-N films show the excellent high frequency characteristics, which is interpreted to be due to the high electrical resistivity and magnetic anisotropy field.These films below 0.1 μm thickness are constituted of amorphous phase, which gradually are changed to crystalline structure as the film thickness increases. It is considered that high electrical resistivity below 0.1 μm thickness is partly due to the amorphous phase.Also, in order to investigate the change of magnetic phases and in-plane anisotropy field with the film thickness, the angular dependence of the ferromagnetic resonance spectra of these films at 9.43 GHz has been measured, using the TE_{011} cylindrical cavity resonator. H_k is increased from 20 to 68 Oe with the decrease of film thickness, which plays an important role in enhancing the high frequency characteristics in Co-Ni-Fe-N thin films. From the resonance peaks of these films, it is certain that there exist two different resonance modes in Co-Ni-Fe-N films below 0.5 μm. As the film thickness increases, the resonance intensity of the amorphous phase decreases whereas the intensity of the nanocrystalline phase relatively increases. Above 0.5 μm thickness, the amorphous phase resonance is no longer evident. The g value of these films decreases 2.09 to 2.24 with the increase of film thickness, which implies that the contribution of the spin-orbital interaction in the Co-Ni-Fe-N films decreases with the increase of film thickness.

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GF-09. Magnetic properties and domain structure of the amorphous FeCoBSi thin films prepared by laser deposition.
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Laser ablation has been used recently as a powerful method for preparation of different magnetic materials [1]. Here we describe our experience in soft amorphous laser ablated thin films preparation. Amorphous FeCoBSi thin films of various thickness of 0.1-0.5 μm were prepared by pulsed laser deposition at room temperature in vacuum to avoid oxidation. A KrF excimer laser with repetition rate of 2-11 Hz and 80 mJ pulse energy was used to ablate a solid Fe67Co18B14Si1 target. The glass substrates of different roughness were used and some samples were deposited onto a Cu buffer layer. The X-ray diffraction has confirmed the amorphous state of the samples. The magnetic properties were measured by conventional inductive technique. The magnetic properties of the films depends critically on the thickness of the magnetic film, the roughness of the substrate, the thickness of the additional Cu layer, and the in-situ heat treatments at the temperatures 500-700 K, i.e. below the crystallization temperature of the amorphous films. Coercive forces between 500-6000 A/m were obtained depending on the conditions of the film preparation. The films had in-plane magnetic anisotropy with different value of the anisotropy constant depending on the preparation conditions.Additional heat treatments were performed by laser radiation treatment at very low energy of 5 to 10 mJ using the target rotating system of the same chamber as for the film preparation. This treatment leads to the magnetic properties and local domain structure changes depending on the laser energy, repetition rate and velocity of the sample rotation. For example, a decrease the coercive force and the in plane anisotropy were obtained by short period radiation treatment in vacuum.

[1] R. López Antón, M.L. Fdez-Gubieda, M. Insausti, A. Garcia-Arribas, and J. Herreros, Journal of Non-Crystalline Solids, in print.

10:48

GF-10. Mössbauer and magnetic properties of Co-Ti substituted barium hexaferrite nanoparticles.
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Co-Ti substituted M-type hexagonal barium ferrite nanoparticles $BaFe_{12-2x}Co_xTi_xO_{19}$ ($0 \leqq x \leqq 1.0$) have been prepared by a sol-gel method. Magnetic and structural properties of the powders were characterized with a Mössbauer spectroscopy, vibrating sample magnetometer, x-ray diffraction, thermogravimetry (TG), and differential thermal analysis (DTA) as well as Fourier transform infrared spectroscopy. The decomposition of amorphous hydroxides in the dried precipitate continued until 570 °C, according to a TG-DTA analysis. The result of XRD measurements shows that the a and c lattice parameters increase with increasing x from a=5.882 Å and c=23.215 Å for x=0.0, to a=5.895 Å and c=23.295 Å for x=1.0. The ^{57}Fe Mössbauer spectra were fitted by a least-squares technique with four subpatterns of Fe sites in the structure and corresponding to the $4f_2$, $4f_1$+2a, 12k, and 2b sites. The relative spectra areas of $BaFe_{10}CoTiO_{19}$ at 295 K were 15, 27, 50, and 8 % for $4f_2$, $4f_1$+2a, 12k, and 2b subspectra, respectively. The 2b site had a very large quadrupole splitting. The isomer shifts indicated that the valence states of the Fe ions were ferric. The magnetization slightly decreases and the coercivity drops dramatically from about 5,014 to 228 Oe as x increases from 0.0 to 1.0. Co-Ti substituted barium hexaferrite to be controlled to reduce their coercivities without a decrease of their magnetization.

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GF-11. Enhanced magnetization in sputter deposited copper ferrite thin films.
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Copper ferrite (Cuf) can crystallize in tetragonal and cubic structures. The tetragonal structure has a lower magnetization ($4\pi M_s$) ~1700 G, in comparison to the cubic one. However, only the tetragonal structure is stable at room temperature. In Cuf powders, it was possible to enhance the $4\pi M_s$ to a value of ~2300 G by quenching from high temperatures [1], without making structure actually cubic. In the present paper, we report the sputter deposition of Cuf thin films on quartz substrates. XRD and TEM studies indicated that the as deposited films are cubic but nanocrystalline with low $4\pi M_s$ of ~1120 G and coercivity of 70 Oe. The films were annealed at 800 °C and cooled at different rates. Fig.1 shows the M-H loops of the slowest (Cufs) and fastest (Cuff) cooled film. It shows that the $4\pi M_s$ in Cuff is ~3050 G while for Cufs, it is ~1600 G. Coercivity for Cuff is about 65% smaller than Cufs. Coercivity for Cuff is about 65% smaller than Cufs. Fig. 2 shows the XRD of Cufs and Cuff films. The splitting of (333) and (511) peaks is observed only in Cufs and not in Cuff. This indicates that the Cufs is tetragonal. We carried out a systematic study on the films as a function of annealing temperature. Coercivity and M_r/M_s ratio are observed to increase monotonically with annealing temperature. The results could be explained on the basis of grain growth and phase transformation from cubic to tetragonal and lead to the possibility of depositing Cuf films with controlled magnetic properties.

[1] Ph. Tailhades et al., J. Solid State Chem. 144, 56 (1998).