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Influences of Film Thickness on the Electrical and Magnetic Properties of CoFeAlO Films

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Surface magnetism is a topic of growing interest in the world of thin films. This is because symmetry breaking in thin films causes considerable modifications in their near-surface magnetic behavior [1,2]. One of the most pressing issues relating to surface magnetism is nowadays to understand what factors realistically determine such differences in the magnetic properties of the thin films from the corresponding bulk materials.

In this work, the influences of film thickness on the electrical and magnetic properties of CoFeAlO films have been systematically investigated via means of vibrating sample magnetometer, permeability spectra and magneto-optical Kerr effect. The film samples with varying thickness of t = 600, 800 and 1200 nm were fabricated by the RF magnetron reactive sputtering technique, using Si (100) substrate under a field of 120 Oe that was applied parallel to the substrate plane. The input power and the mixed Ar + O_2 (3%) pressure were 300 W and 2 mTorr, respectively. It has been shown that the electrical resistivity (ρ) decreases when the film thickness increases; ρ= 412.5 for the t = 600 nm sample decreases to = 368.2 for the t = 1200 nm sample. The coercive force and anisotropy field, measured along the easy-axis direction, decreases as the film thickness increases. It is interesting to note that, along the hard-axis magnetization direction, the magnetic hysteresis loop is reversed and the coercive force is negative for t = 600 and 800 nm samples. However, this peculiar feature disappears in the case of the t = 1200 nm sample, which is probably attributed to the microstructural change occurring in the sample with regard to increasing film thickness. A two layers model has been proposed to explain the reversed magnetization phenomenon in the films. It has also been found that, at a frequency of 1GHz, the effective permeability measured along the hard-axis magnetization direction decreases from 1252 to 1000 as the film thickness increases from 600 to 1200 nm, respectively. This is likely related to the decrease in the hard-axis anisotropy field as confirmed by VSM and MOKE. The results obtained from VSM and MOKE reveal an increase in magnetic anisotropy in the near-surface region of the film.

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RE01

Exchange Coupling in FePt-FePt3 Nanocomposite Films

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Exchange coupling between a ferromagnet (FM) and an antiferromagnet (AF) is the result of the interaction between FM and AF moments at their common interface [1]. In this study, the structural and magnetic properties of exchange coupled nanocomposite FePt-FePt3 films were investigated. The [Pt(20 Å)/Fe(15 Å)]10/Pt(30 nm) multilayers were prepared by using a ion-beam deposition technique [2]. X-ray diffraction and transmission electron microscopy results showed that the as-deposited Pt/Fe multilayers consisted of f.c.c. Pt (a= 3.93 Å) and b.c.c Fe (a= 2.91 Å) phases. After rapid thermal annealing (600 C, 6min.), the samples consisted of a FM f.c.t. FePt (a= 3.84 Å, c= 3.72 Å) phase and an AF f.c.c. FePt3 (a= 3.85 Å) phase. Annealing created an ordered FePt phase that resulted in a large room temperature coercivity (H_c~ 3200 Oe) compared to the as-deposited film (H_c~ 25 Oe). While no exchange bias field (H_{ex}~ 0) was measured at room temperature, the annealed sample showed significant H_{ex}~ 500 Oe at low temperatures (150 K $\leq$ T $\leq$ 250 K), indicative of exchange coupling between FePt and $FePt_3$. The nanocomposite FePt-$FePt_3$films exhibited a strong temperature dependence in H_c. Surprisingly, by contrast to the typical H_c(T) behavior observed in bilayer FM/AF thin films, the H_c(T) of the nanocomposite FePt-$FePt_3$films decreased with decreasing temperature. Further increasing the annealing temperature to 700 °C resulted in the decrease of Hex. This is attributed to the transformation of $FePt_3$ into FePt phase (evidenced by enhanced H_c) at higher annealing temperature.

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