MATERIAL PROPERTY CHARACTERIZATION OF COBALT- PLATINUM THIN FILMS

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ABSTRACT

Cobalt (Co) based alloy thin films have attracted a lot of attention, due to their excellent magnetic properties desirable in magnetic recording media applications. Alloying Co with metals like Platinum (Pt) changes some of its intrinsic magnetic properties such as increasing the magneto-crystalline anisotropy constants of the alloy. Co-Pt thin films and multilayers are more suitable for ultra high-density magnetic recording media because they have high-magnetic anisotropy, chemical stability, excellent coercivity and resistance to corrosion [1, 2]. However, very little work is reported in the area of developing Co_3Pt as a means for achieving enhanced magnetic properties [3].

In the present study, Co-Pt alloy films were deposited on Si substrate using dual electron beam co-evaporation. The Co-Pt alloy thin films are vacuum-sealed and annealed for 2 hours at 300°C and 400°C to study the annealing effects on structural and magnetic properties. All the films were characterized using scanning and transmission electron microscopy, EDS, electron microprobe, and profilometry. In Co-Pt alloy films, Co and Pt were present in the atomic ratio of 3:1.

A mixture of hexagonal close packed and face centered cubic structure Co_3Pt was present in both as-deposited and annealed films along with the presence of ε-Co and NaCl type CoO. The lattice constants of hcp Co_3Pt are $\boldsymbol{a}$ =2.64 Å and $\boldsymbol{c}$ = 4.21 Å and the lattice constant of fcc Co_3Pt is $\boldsymbol{a}$ = 3.69 Å. ε-Co is a metastable phase of elemental Co, having simple cubic structure and is much softer when compared to other forms of Co and also fcc and hcp Co_3Pt [4]. Annealing enhanced the grain size and coercivity of the as-deposited Co_3Pt film. However, the presence of ε-Co decreased the coercivity of the Co-Pt film annealed at 400°C. In the EDS spectrum of as-deposited and annealed Co-Pt alloy thin films, the presence of O was observed. Hence, it can be concluded that the CoO was present in these alloy thin films.

The grain structure and diffraction pattern of as- deposited Co_3Pt is shown in figure 1.

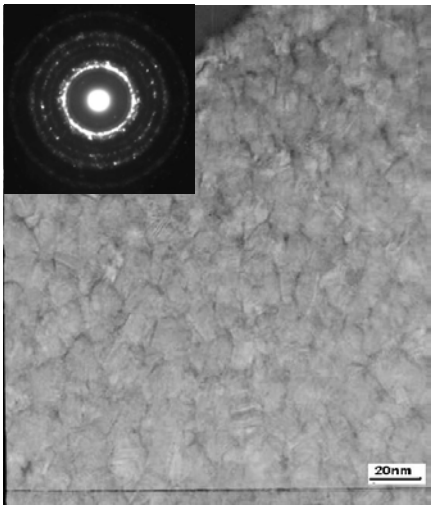

Figure 1: HRTEM showing the grain structure of as-deposited Co-Pt alloy thin film.

The magnetic measurements were conducted at 300°K and 10°K in both perpendicular and parallel orientations in magnetic property measurement system (MPMS). In parallel measurement, the field is applied along the easy axis of the film and the hysterisis loop is expected to be a square in shape. The magnetic saturation and coercivity can be measured directly from the loop. In perpendicular measurement, the field is applied along a hard axis that produces the linear M, H relation [6].

The results from analytical and characterization techniques showed the addition of Pt to Co increased the coercivity of the films. Symmetry in magnetic hysterisis loop is observed in these films at 300°K. But a shift in the hysterisis loop to the left of the applied field is observed when measured at 10°K. This shift may be attributed to exchange coupling taking place at the interface of the

antiferromagnetic CoO and ferromagnetic Co_3Pt and Co. Figures 2 and 3 show the hysterisis loops of as-deposited Co_3Pt alloy thin films measured at 300°K and 10°K respectively in parallel orientation.

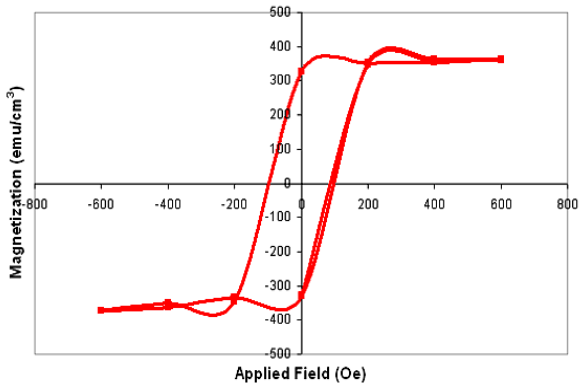

Figure 2: Hysterisis loop of a Co-Pt as-deposited film at 300°K.

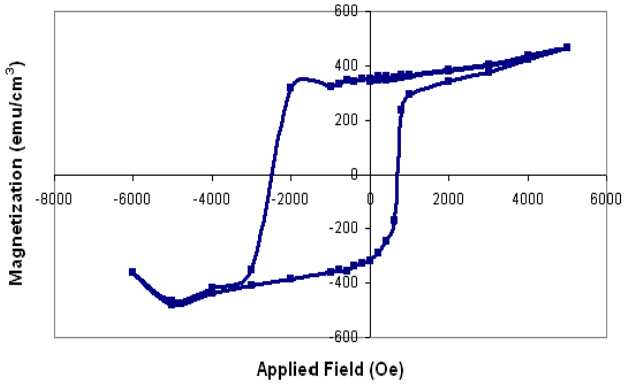

Figure 3: Hysterisis loop of a Co-Pt as-deposited film at 10°K.

Asymmetry in the hysterisis loops was observed for all films at 10°K. The antiferromagnetic CoO and ferromagnetic Co and Co_3Pt undergo exchange coupling at the interface and give rise to exchange anisotropy leading to the shift in the hysterisis loop [5]. This property of the Co-Pt alloy thin film system may find its application in the magnetic sensor systems, like spin valve and magnetoresistance devices.

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