Thickness and growth temperature dependence of soft magnetic properties of (FeCo)-Si alloy thin films

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Iron-based crystalline alloys with low effective damping parameter have potential applications for future high-frequency devices. Recent work on Fe-Co-Al alloy thin films report an effective damping parameter as low as about 0.0004 for a composition of $Fe_{73}Co_{25}Al_2$ measured by FMR over a frequency range from 12 to 66 GHz.[1,2,3)] Although (FeCo)-Si alloy thin films have been extensively studied,[4,5)] very little information can be found in literature about the relation between effective damping parameter and structural properties. In this paper, the thickness and growth temperature dependences of soft magnetic properties of $(Fe_{75}Co_{25})_{95}Si_5$ alloy thin films are presented.

Multilayers of [Fe(0.35 nm)/$Fe_{66}Co_{34}$(1.1 nm)/Si(0.14 nm)] × N were sputter-deposited onto MgO (100) single crystal substrates using DC magnetron sputtering, where N is the number of repetitions. Deposition was carried out in Ar atmosphere of 4 mTorr. The substrate-deposition temperature T_s was varied from ambient to approximately 300 ℃. An in-plane field of 50 Oe was applied during deposition to induce a uniaxial magnetic anisotropy. A 5 nm thick Ru layer was over-coated to prevent oxidation. Structural analyses were performed by XRD and TEM. Measurements of magnetic properties were carried out by VSM and longitudinal MOKE. The magnetization dynamics was evaluated by ferromagnetic resonance (FMR) at room temperature over a frequency range from 12 to 66 GHz.

Figure 1 shows the dependence of (a) saturation magnetization M_s, (b) coercivity H_c, and (c) effective damping parameter α_{eff} on film-thickness d at different T_s. It is seen that M_s tends to decrease slightly with d from about 1,700 to 1,500 emu/cm^3. while H_c initially increases with d, and then decreases. The α_{eff} rapidly decreases with d, and then slightly increases for both the deposition temperatures.

The work is in part supported by the MINT-TDK collaboration program.

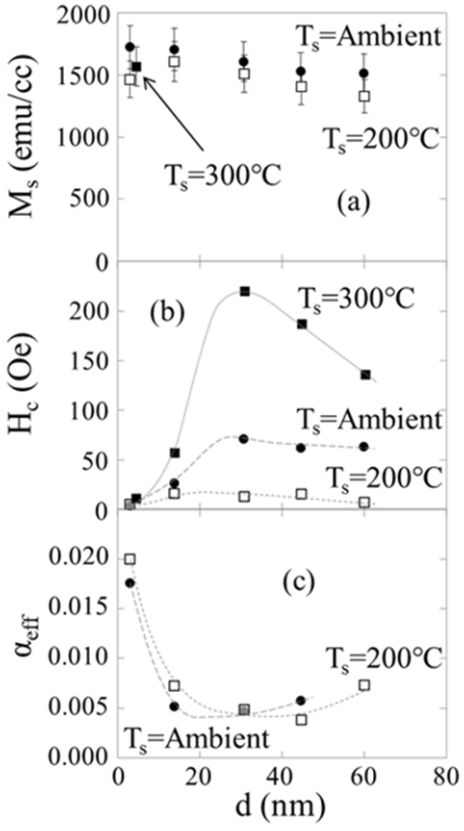

Fig. 1 Thickness dependence of (a) saturation magnetization M_s, (b) coercivity H_c, and (c) effective damping parameter α_{eff} for $(Fe_{75}Co_{25})_{95}Si_5$ films deposited onto MgO(100).

References

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