SE01

Control of the Resonance Frequency of Soft Magnetic CoFeHfO Thin Films by Strip Patterning

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Magnetic properties of CoFeHfO thin film is contribution by nanocrystaline CoFe embedded in amorphous HfO2 with an in-plain uniaxial anisotropy exhibit a gyromagnetic resonance. Although that films is optimum to application for high frequency but it generally exhibits the resonance frequency lower than 2 GHz and permeability up to 1000. Therefore, it is necessary to optimum this parameter to application for high frequency device. A convenient way to increase this frequency is to take the advantage of controlled demagnetizing effect of the strip of width w, parallel to the easy axis, separated by a gap of width l is etched in the layer of thickness d of strip. By the playing with the geometrical parameters w, l, d, it is possible to adjust the resonance frequency. The results show that by using this technique, we can shift resonance frequency up to 3 GHz while also keep permeability is stable.

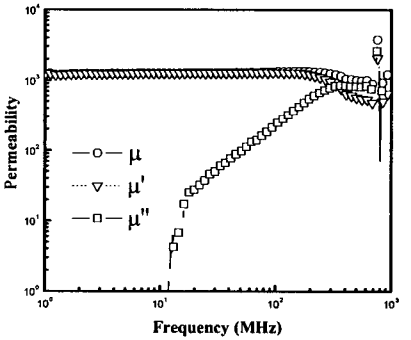

Fig. 1. Permeability spectrum of 300 nm thick CoFeHfO, l= 52 μm and w=60 μm.

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SE02

Longitudinal and Transverse Incremental Permeability of CoFeHfO Magnetic Films

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A new class of Co-Fe-Hf-O thin films has attracted particular attention from the materials science community because a desirable combination of the excellent soft magnetic properties and high electrical resistivity is ideal for high-frequency applications [1,2]. However, a complete understanding of the complex nature of high-frequency magnetic behavior in these films is still lacking but needed.

In this context, we have made a thorough study of the longitudinal and transverse incremental permeability of $Co_{19.35}Fe_{53.28}Hf_{7.92}O_{19.35}$ magnetic films, which were deposited on Si(100) substrates by using the oxygen reactive RF-sputtering method, with varying thicknesses (t = 1, 1.5, 1.8, and 2.4 μm). The percentage change of incremental permeability, i.e., the permeability ratio (PR), with applied dc magnetic field has been expressed as PR(%) = 100% x [$\mu(H)$ - $\mu(H_{max})$]/$\mu(H_{max})$. The longitudinal permeability ratio (LPR) is defined as the PR measured in the direction parallel to the external magnetic field. Similarly, the transverse permeability ratio (TPR) is defined as the PR measured perpendicular to the external magnetic field. The PR measurements were conducted along the easy and hard axis of the film sample using an impedance analyzer HP 4191A in the high-frequency range of 100 MHz - 1 GHz. The external dc magnetic field, created by a solenoid, was swept through the entire cycle equally divided by 800 intervals from -300 Oe to +300 Oe. The results obtained reveal that there is an anomalous change in the PR vs magnetic field curves for all the samples measured above 710 MHz, indicating considerable variations in the magnetic softness of the films in the high-frequency region. It is likely that the large variation in the permeability of the films is associated with the ferromagnetic resonance effect. The LPR and TPR profiles measured along the easy axis of the sample show a single-peak feature, whereas those measured along the hard axis of the sample show a double-peaks one. This indicates an existence of uniaxial magnetic anisotropy and its dispersion in the films. Furthermore, it is shown that as the thickness of films increases, the LPR and TPR values increase significantly, indicating the considerable change in magnetic softness of the film - which is in reasonable agreement with the microstructural change. It is therefore concluded that the study of LPR and TPR changes can be an alternative way in characterizing the soft magnetic softness in thin-film type materials.

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