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The shape anisotropy effect of patterned FeTaN thin films for ultra-high frequency applications.

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1.INTRODUCTION

Recently, FeTaN films for ultra-high-frequency electromagnetic device applications have been widely investigated due to their high saturation magnetization ($4\pi Ms$), high anisotropy field (Hk), and low coercivity.[1] Magnetic anisotropy of the soft magnetic thin films such as FeTaN is an important factor for the film inductor application. In this paper FeTaN film inductor application were fabricated using reactive sputtering and the effect of shape anisotropy on the high frequency magnetic characteristics of FeTaN films was investigated. Patterned FeTaN films were prepared by lift-off process and SiO_2 was used for insulating materials between stripe lines. FeTaN films exhibited excellent soft magnetic properties such as Bs of 15KG, Hk of 12 Oe and μ' of 3500 at 100 MHz.[2-4] Compared to unpatterned FeTaN films with Hk of 12 Oe, patterned FeTaN films with stripe lines exhibited higher Hk of 21 Oe. Roll-off frequency of permeability was also enhanced and it resulted from the increased anisotropy of patterned FeTaN films

2.EXPERIMENTAL METHODS

FeTaN films were deposited onto Corning glass(#1737) substrate (19×19 mm) by reactive sputtering to thickness of 5000 Å with a total pressure of 1.5mTorr. And patterned FeTaN films were fabricated by lift-off process and SiO2 was used for insulating materials between stripe lines Ta composition was controlled by the area fraction of a Ta chip on the Fe target. Process gas was mixture of 15% N_2 and 85% Ar in flow ratio. Prepared samples were magnetic field annealed for 30 min at 400-500 °C with heating and cooling rates at 10°C/min. A magnetic field of 700G was applied to the samples during magnetic field annealing(MFA). The coercivity (Hc) and the saturation magnetization ($4\pi Ms$) of annealed samples were measured using the vibrating sample magnetometer, and effective permeability μ' was measured by the one turn coil method up to the frequency range of 800MHz. The magnetic anisotropy field Hk was determined from the B-H hysteresis loop of the easy and hard axis of the film.

3.EXPERIMENTAL RESULTS AND DISCUSSION

To investigate the frequency characteristics, changes of hard axis permeability μ' are measured against applied frequency up to 800MHz. Unpatterned FeTaN films shows the rapid reduction of μ' about 100MHz. In contrast, the μ' of the patterned films with large Hk about 21Oe remains unchanged up to 800MHz. We also calculated the roll-off frequency *fr*, which is defined as the frequency at which the μ' becoms half of the low frequency value, based on the ferromagnetic resonance. For this we used reported formula,[5] $fr=(\gamma Hk)/(2\pi\alpha)$, where γ is gyromagnetic constant and α is the damping constant. The equation is valid when Hk is less than α^2 Ms, which is true in this work. Taking $\gamma=2.1 \times 10^5$ m/A□s for Fe-based alloys. $\alpha=0.05$ and experimental Hk of 10 Oe for unpatterned films, and 21 Oe for patterned films, the *fr* values are calculatd to be 530 and 1060 MHz for unpatterned and patterned films.

4.CONCLUSION

Patterned thin films were fabricated using the FeTaN films. Patterned thin films showed excellent soft magnetic properties with Hk of 20 Oe, Hc of 0.5 Oe, μ' of 1500, and 4πMs of 12kG. The permeability of the film remained unchanged up to a frequency as high as 800MHz. The roll off frequency increased about twice to compare the effective permeability of a patterned thin films with that of unpatterned thin films. The increased Hk, which is caused by shape anisotropy, appears to have a most effect on the upper result.

5.REFERENCE

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