

High Frequency Characteristics and Soft Magnetic Properties of FeCoBN Nanocrystalline Films

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Recent developments in electronic devices have led to a demand for higher frequency operation of soft magnetic thin films, especially in the GHz ranges. Thus, Fe₇Co₃ based thin films have received much attention because of high saturation magnetization ($4\pi M_s$) and magnetic anisotropy (H_k). However, a few papers showed good high frequency properties up to 3 GHz because the coercivity (H_c), H_k and domain structures of these films were very sensitive to the stress and thickness.

In this study, (Fe₇Co₃)BN thin films, in which B and N were added for controlling microstructures, were grown by a reactive rf magnetron sputtering method. During deposition, processing parameters, such as working pressure, bias field, extrinsic magnetic field, composition and etc., were carefully controlled. These as-deposited FeCoBN thin films showed $4\pi M_s$ of 15 ~ 23 kG and coercivity (H_c) of 2 ~ 100 Oe. The electrical resistivity (ρ) and H_k of these films were measured 40 ~ 200 $\mu\Omega\text{cm}$ and 60 ~ 200 Oe, respectively. In particular, Fe_{61.7}Co_{27.9}B_{5.2}N_{5.2} magnetic film revealed $4\pi M_s \sim 16\text{ kG}$, $\rho \sim 160\ \mu\Omega\text{ cm}$, and $H_k \sim 110\text{ Oe}$. As shown in Figure 1, the effective permeability and ferromagnetic resonance frequency (f_{FMR}) of the sample were measured ~ 150 and 4 GHz, respectively. Moreover, we obtained high f_{FMR} values of $\sim 4\text{ GHz}$ from other FeCoBN films with various thicknesses of ~ 100 to $\sim 320\text{ nm}$ or different compositions. It indicates that the high frequency properties of Fe₇Co₃ based films can be enhanced by controlling the processing parameters.

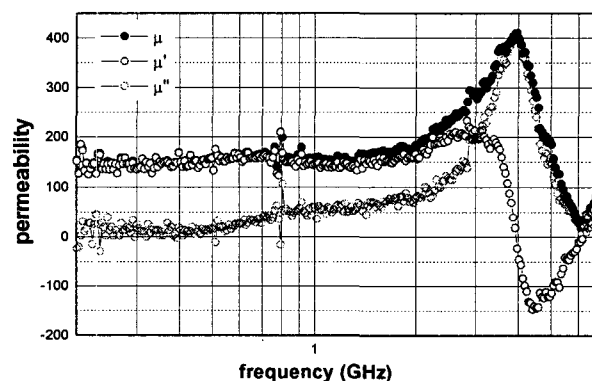


Fig.1. Frequency dependency of permeability for Fe_{61.7}Co_{27.9}B_{5.2}N_{5.2} films