Analysis of magnetic near field noise suppression of multilayered Co-Zr-Nb film integrated on MSL

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1. Introduction

As the IC technology becomes finer and its switching speed becomes faster, a radio frequency integrated circuit (RF IC) chip in a receiver of wireless communication system is tend to be led to a failure of signal processing [1], due to inductive and conductive noise couplings generated by magnetic flux and displacement currents. Therefore, a blocking of those coupling paths is required. Soft magnetic film integration has advantage in suppressing near field [2] and conduction noises [3] without increasing footprint on a die, owing to the performance of ferromagnetic resonance (FMR). In order to develop better soft magnetic film, it is necessary to understand the mechanism of noise suppression. Therefore, a microstrip line (hereafter MSL) with an eight-layer crossed-anisotropy Co-Zr-Nb film on the top is chosen as a basic structure to substitute the complicated film-integrated RF IC chip which is consisted of many power and ground lines.

2. Approach

Figure 1 shows the experimental setup in this work. The multilayered magnetic film is deposited on a glass substrate. The film is placed upon the top surface of MSL whose signal line is 160 µm wide and 20 mm long, and corresponding characteristic impedance is 50 Ω. A magnetic near field probe with a planar shield loop type sensing coil is placed 600 µm above the film to measure the magnetic field intensity. A network analyzer provides input power of -5 dBm along frequency range of 0.1 to 4 GHz

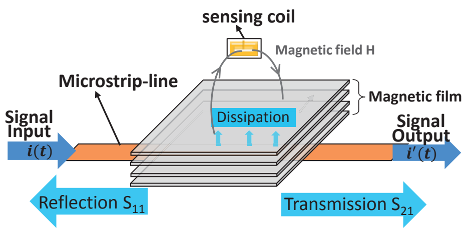

Fig. 1 Experimental setup

3. Results and discussion

The experimental results and the simulation results agree in both magnetic field and conduction loss, respectively. Additional simulations are performed to analyze the suppression effect of near field noise. The FMR and eddy current loss are considered as the main reasons for near field shielding effectiveness. Therefore, the contributions of frequency-dependent complex permeability and film resistivity into shielding effect is studied separately. Different permeability and resistivity through case B to case E are assumed as shown in Table 1. The corresponding results are shown in Fig.2.

Table 1. Assumed relative permeability and resistivity

Case	e.a. orientation	Permeability parameter, μ_r μ_r'	μ_r''	Resistivity, ρ, µΩ·cm
A [a]	MSL//e.a.	$\mu(f)$		120
B	Isotropic	780	≈ 0	≈ ∞
C	Isotropic	780	≈ 0	120
D	MSL//e.a.	$\mu(f)$		≈ ∞
E	Isotropic	1	≈ 0	120
F [b]	Blank (without film)	1	0	≈ ∞
G	MSL//e.a.	$\mu(f)$		60
H	MSL//e.a.	$\mu(f)$		1200

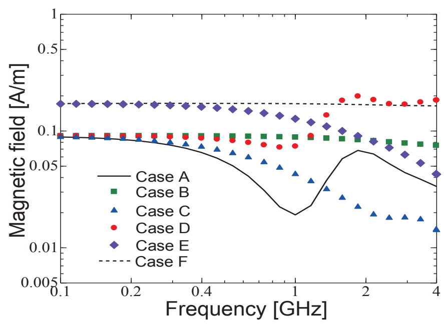

Fig. 2 simulation results of case A to F

4. Conclusion

In this paper, the magnetic near field shielding effectiveness and conduction noise suppression of four-layer uniaxial anisotropy Co-Zr-Nb film were investigated by both measurement and simulation. The eddy current and FMR losses were analyzed separately by controlling film resistivity and frequency-dependent complex permeability in simulation. The contribution of eddy current and FMR loss in near field shielding were explained. The results clarified that both eddy current and FMR are contributing significantly to magnetic shielding, wherein the quantitative degree of near field noise suppression is significantly controlled by eddy current loss, while the frequency of maximum near field suppression was dominated by FMR frequency.

Reference

1) T Sudo, et al. (2004),IEEE Transactions on Advanced Packaging, vol. 27, No. 2, pp. 304-314.
2) J Kim et al. (1998), Electronic Components and Technology Conference, vol. 48, pp. 610-614.,
3) Y Kayano, et al. (2004), IEEE Transactions on Electromagnetic compatibility, vol. 46, no. 1, pp. 46-53..