E-03

Conduction Noise Attenuation by Fe_3O_4 Thin Films Prepared by Reactive Sputtering

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Ferromagnetic thin film materials of high magnetic permeability in gigahertz frequencies draw more attention for their high potential application to noise suppressors in miniaturized electric circuit and electronic devices. For this purpose, many granular thin films were investigated to get both high permeability and high electrical resistivity. In this study, Fe_3O_4 thin films were fabricated and their magnetic, electric, and noise absorbing properties are investigated[1].

Fe_3O_4thin films were fabricated by reactive sputtering of Fe targets with variation of oxygen partial pressure during deposition. Microstrip line was designed with characteristic impedance of 50 Ω and a length corresponding to the center frequency of 3 GHz. After calibration by OSL (open, short, load) method, the fabricated microstrip line showed the ideal reflection and transmission parameters (S_{11}<-60 dB and S_{21}=0 dB). Attaching the thin films (with size of 2cm×2cm×2• m) on the microstrip line, reflection and transmission parameters (S_{11}, S_{21}) were measured by HP8722D network analyzer in the frequency range of 0.5~6 GHz.

The structure of thin films is very sensitive to the oxygen partial pressure during deposition. X-ray diffraction pattern shows that the major component of the film is $Fe_3O_4$and minor peaks of Fe_2O_3 were observed. VSM measurements indicate that saturation magnetization is 690 emu/cc and coercive force is about 500 Oe. Noise absorbing characteristics was determined by measuring S_{11} and S_{21} parameters of microstrip line attached with the thin films. $S_{11}$is increased from -60 dB (without film) to about -15 dB (with film). The small value of reflection parameter (about 5% in power) is due to high electrical resistivity of Fe_3O_4 films. S_{21} is reduced to about -5 dB (about 70% in power) in the frequency range of 1?6 GHz, which is due to magnetic loss of the Fe_3O_4 films. Power absorption (defined by the ratio of power loss to input power) was calculated from the measured S_{11} and S_{21} values. Power absorption shows increases with frequency and saturated to maximum value (about 0.5) in the frequency region 4-6 GHz. It is, therefore, suggested that the Fe_3O_4thin films are one of the good potential materials for noise suppressors in gigahertz frequencies.

[1] S. Yoshida, Y. Takase, O. hashomoto, and Y. Shimada, IEEE Trans. Magn. 40, 2853(2004)

Table. 1. Typical sputtering condition of Fe_3O_4 thin films.

Target	Fe (99.9%)
Target diameter	2 inch
Target to substrate distance	7.5 cm
Initial pressure	1.6×10^{-5} Torr
Working pressure	2×10^{-2} Torr
Substrate rotation rate	4 rpm
Substrate temperature	300 ℃
Ar flow rate	80 sccm
O2 flow rate	0 ~ 3.2 sccm
RF input power	300 W
Presputtering time	10 min
Deposition time	60 min

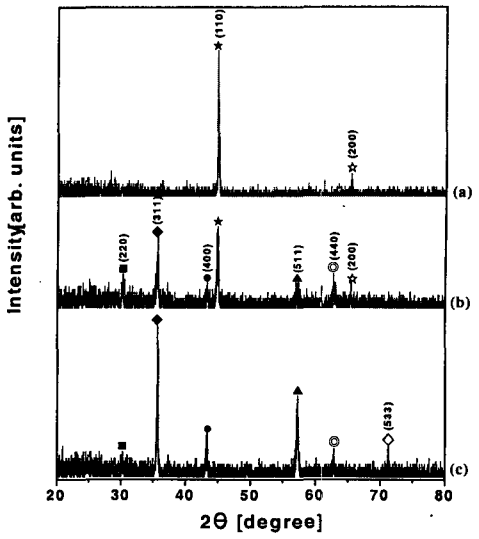
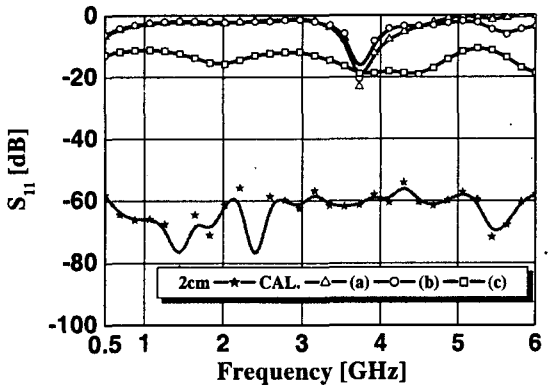


Fig. 1. The X-ray diffraction patterns of Fe_3O_4 thin films by various O_2 gas ratio from 0 to 3.2 sccm.; (a) 0sccm, (b) 1.6sccm, (c) 3.2sccm. The films were deposited for 60min(about (a)2.5㎛, (b)2.5㎛ (c)1.5㎛) and at 300℃. The RF input power was 300W.



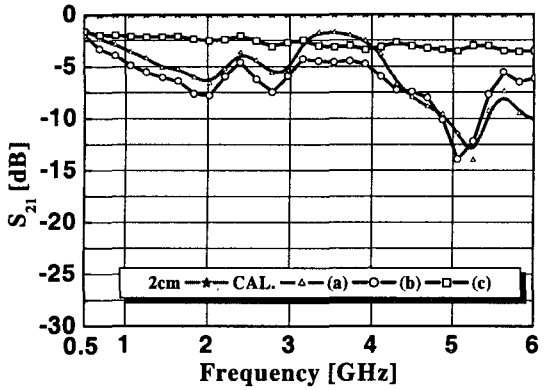


Fig. 2. S_{11} and S_{21} measured in the microstrip line covered with Fe_3O_4 thin films (a) Fe, (b) Fe_3O_4+Fe and (c) Fe_3O_4.

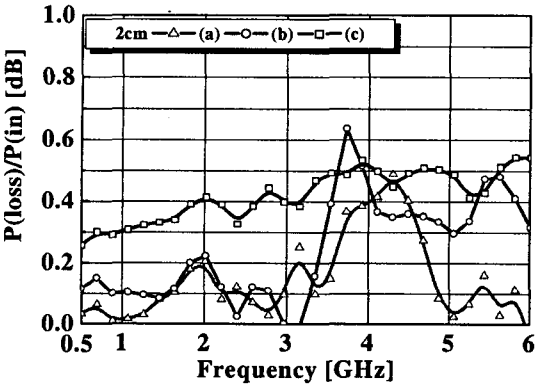


Fig. 3. S_{11} and S_{21} measured in the microstrip line covered with Fe_3O_4 thin films (a) Fe, (b) Fe_3O_4+Fe and (c) Fe_3O_4.