EM Wave Absorbers with Au Coated Conductive Sheets

Jae Man Song[1] · Kyeung Jin O[2] · Dong Il Kim[2]

Abstract

In this study, EM wave absorbers based on Au coated conductive sheets were prepared, and their reflection and transmission coefficients were investigated. An Au coated conductive sheet showed the transmission loss higher than 40 dB in 1 ~ 18 GHz. Ba ferrite EM wave absorbers with an Au coated conductive sheet showed enhanced EM wave absorption and shield to compare with Ba ferrite EM wave absorbers without conductive sheets. Proposed EM wave absorbers with conductive sheets are useful to protect EM machines from EM interference by strayfields.

Key words : Reflection, Transmission, Conductive Sheet, Ba Ferrite, Mn-Zn Ferrite.

Ⅰ. Introduction

There are so much unwanted EM(Electromagnetic) waves radiated from EM machines in spaces which affect EM machines and human bodies. EM wave absorbers and shields are used to protect EM machines and human bodies from the unwanted EM wave radiations. EM wave absorbers absorb EM wave energy, and translate it into thermal energy. Thus, translated thermal energy disappears into spaces. However, EM wave shields only shield EM wave energy, and the shielded energies are not translated into thermal energy. Thus, the shielded energy can affect component parts in near vicinity.

Magnetic materials, such as soft magnets(Mn-Zn and Ni-Zn ferrites) and hard magnets(Ba and Sr ferrites) are important materials as EM wave absorbers because of their high magnetic loss, which contributes to the EM wave absorption[1]~[4].

Conductors, such as Au, Ag, and Al, are important material as a shelter because of their high conduction rate.

EM wave absorption bands of EM wave absorbers with thin thickness is narrow, usually. The other hand, EM wave shields, even though its thickness is thin, can shield EM waves in a broad-band.

Thus, in this research, we fabricated EM wave absorbers with Mn-Zn and Ba ferrites, and pasted them on conductive sheets to give both of absorption and shield of EM waves. Proposed EM wave absorbers with conductive sheets showed advanced absorption and shield properties comparing with EM wave absorbers without conductive sheets.

Ⅱ. Sample Preparation and Measurements

Al coated conductive sheets with the thickness of 0.5 mm and surface resistance of 60 Ω/cm^2, and Au coated conductive sheets with the thickness of 0.1 mm and surface resistance of 0.1 Ω/cm^2 were used for shields of EM waves. Figs. 1 and 2 are photographs of Al and Au coated conductive sheets, respectively. SEM(Scanning Electromagnetic Microscope) micrograph of Au coated sheets is shown in Fig. 3. To prepare paint-type EM

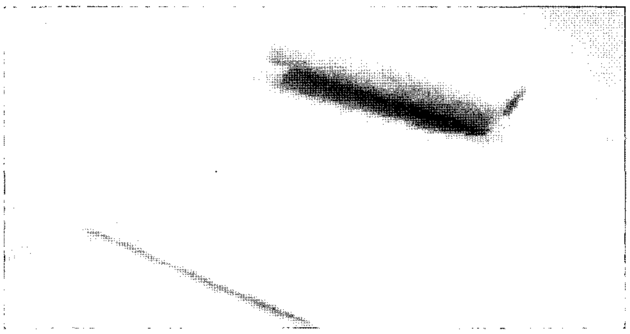

Fig. 1. Al coated conductive sheet.

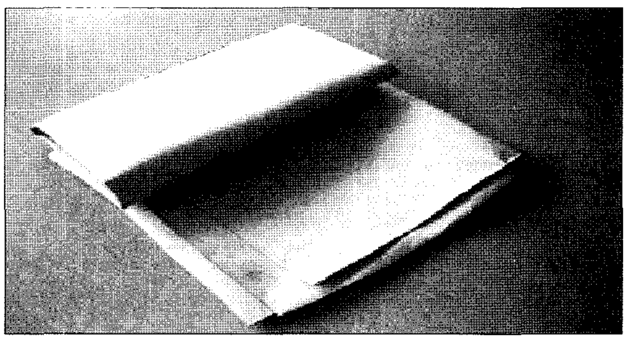

Fig. 2. Au coated conductive sheet.

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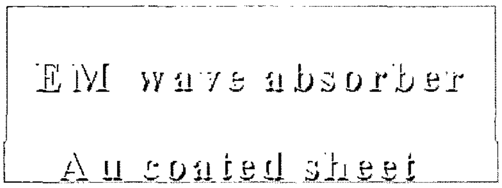
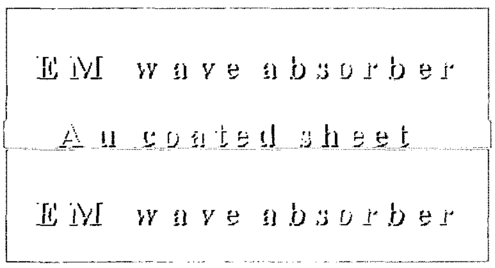
Fig. 3. SEM micrograph of an Au coated sheet(by 350).



(a)



(b)

Fig. 4. Diagram of EM wave absorber pasted on a side (a) and both side, (b) of a conductive sheet.

wave absorbers, pulverized Mn-Zn and Ba ferrites were mixed with enamel paints. The prepared paint-type EM wave absorbers were pasted on the conductive sheets to make EM wave absorber/shields. Fig. 4 shows diagrams of EM wave absorber pasted on one side and both sides of a conductive sheet.

For the investigation of the reflection and transmission coefficients, the prepared EM wave absorber/shields were punched into a toroidal shape with an inner diameter of 3.05 mm and an outer diameter of 6.95 mm. The reflection and transmission coefficient of the samples were investigated with a HP-8753D network as a cable method. analyzer. Figs. 5 and 6 are diagrams of measurement system and the sample holder, respectively.

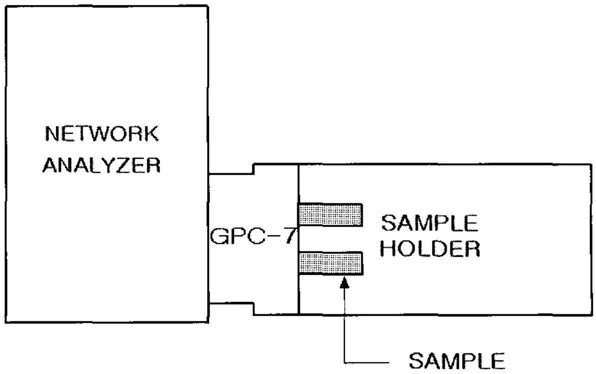


Fig. 5. Measurement system for the reflection and transmission coefficient.

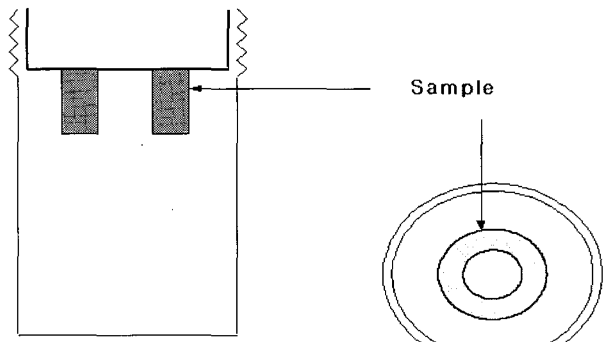


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Fig. 6. Sample holder.

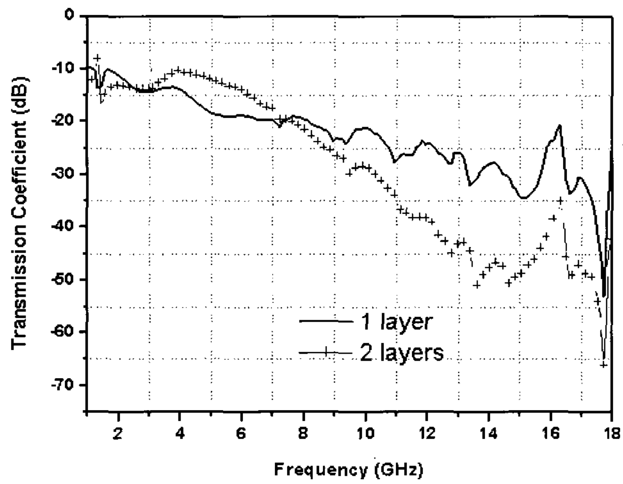

Fig. 7. Transmission coefficient of an Al coated conductive sheet as a function of frequency.

Ⅲ. Results and Discussion

We investigated transmission coefficient of Al and Au coated conductive sheets, and show the result in Figs. 7 and 8. Au coated conductive sheets which have lower surface resistance than Al conductive sheets show the transmission loss higher than 40 dB, which is larger than Al coated sheets in 1~18 GHz. Thus, we selected

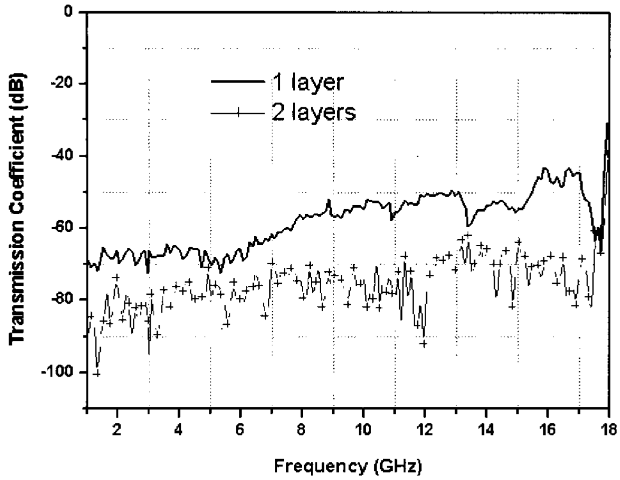

Fig. 8. Transmission coefficient of an Au coated conductive sheet as a function of frequency.

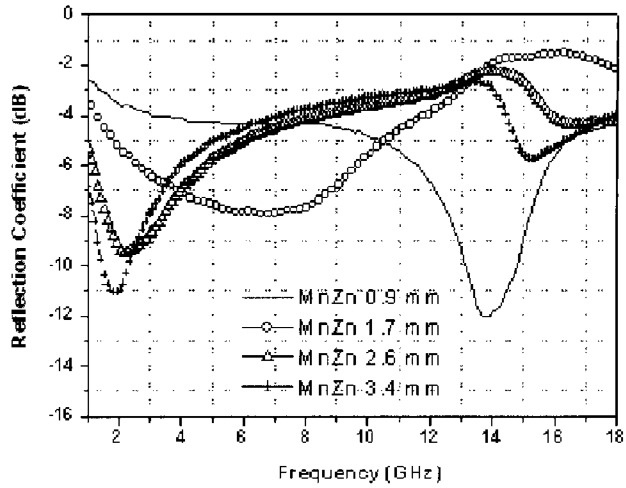

Fig. 10. Reflection coefficient of Mn-Zn ferrite EM wave absorbers as a function of frequency without a conductive sheet.

Au coated conductive sheets for absorber/sheltes.

Reflection coefficients of Au coated conductive sheets as a function of frequency are shown in Fig. 9 which shows very small absorption in 1～18 GHz.

Fig. 10 shows reflection coefficient as a function of frequency for Mn-Zn ferrite EM wave absorbers without a conductive sheet. It shows that central frequency decreases with increasing sample thickness, which satisfies (1)[5].

$$d = \frac{c}{2\pi\mu_r''} f \tag{1}$$

where, d, c, μ_r'', and f are sample thickness, light velocity, imaginary part of permeability, and central frequency of absorption, respectively.

To compare with reflection coefficient between a Mn-Zn ferrite EM wave absorber without conductive sheets and a Mn-Zn ferrite EM wave absorber with an Au coated conductive sheet, reflection coefficient of them were investigated and presented in Figs. 10 and 11, respectively. There is no big difference in absorption between two samples(Figs. 10 and 11). As we mentioned before, Au conductive sheets have shielding effect as shown in Fig. 8. However, samples without conductive sheets have no shielding effect. Thus, the proposed Mn-Zn ferrite EM wave absorbers with conductive sheets can be a useful material to protect EM machines from EM interference by strayfields because it has both of absorption and shield properties simultaneously.

Fig. 12 shows reflection coefficient of Ba ferrite EM

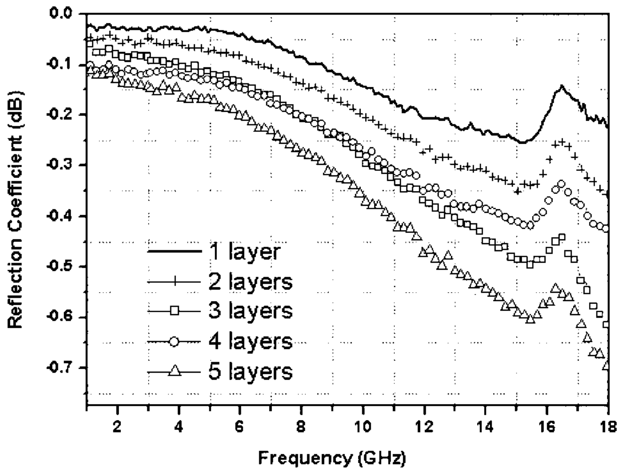

Fig. 9. Reflection coefficient of Au coated conductive sheets as a function of frequency.

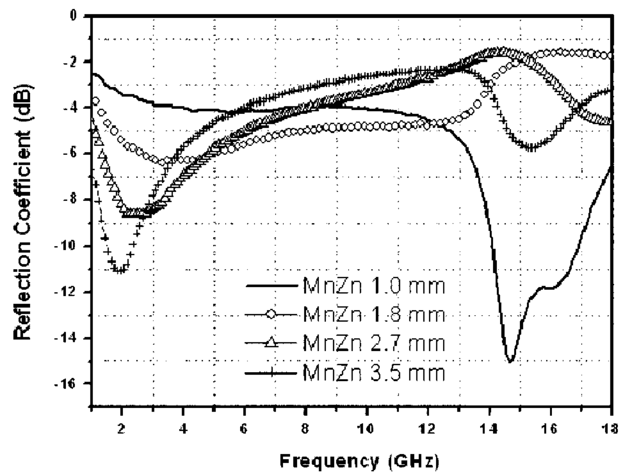

Fig. 11. Reflection coefficient of Mn-Zn ferrite EM wave absorbers with an Au coated conductive sheet.

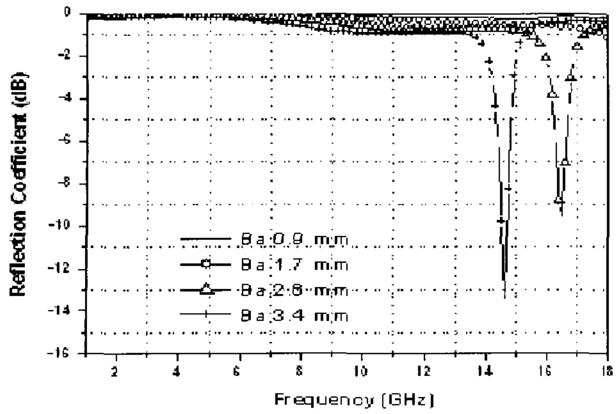

Fig. 12. Reflection coefficient of Ba ferrite EM wave absorbers as a function of frequency.

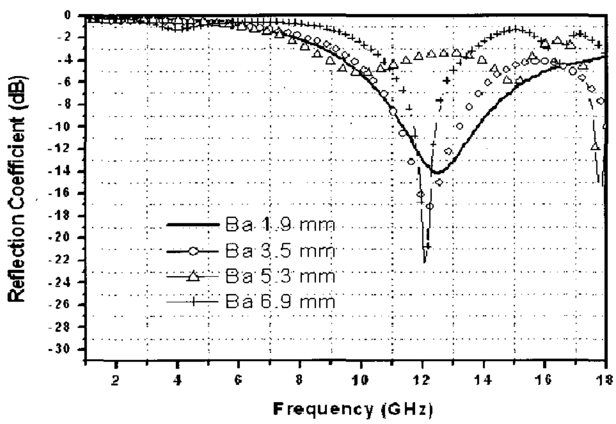

Fig. 13. Reflection coefficient of Ba ferrite EM wave absorbers pasted on both side of Au coated conduction sheet.

wave absorbers without conductive sheets as a function of frequency. These absorbers in Fig. 12 have narrow band-widths of absorption in 15~17 GHz. However, Ba ferrite EM wave absorbers with Au coated conductive sheets in both sides, show enlarged absorption band as shown in Fig. 13. From the result, we can conclude that Ba ferrite EM wave absorbers pasted on both side of an Au coated conductive sheet are useful materials to protect EM machines and human bodies because they have both properties of absorption and shield simultaneously.

Ⅳ. Conclusions

Prepared EM wave absorbers based on conductive sheets are light in weight, thin in thickness, and don't allow transmission waves. Prepared Ba ferrite EM wave absorbers with conductive sheets better than Ba ferrite EM wave absorbers without conductive sheets in transmission and reflection coefficients. The prepared Mn-Zn and Ba ferrite EM wave absorber/shields can be used to protect EM machines and human bodies from unwanted EM waves.

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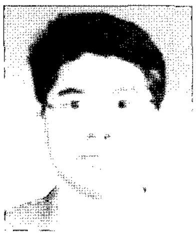

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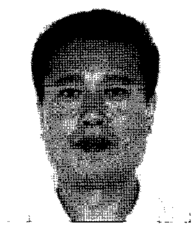

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