Journal of the Research Institute of Industrial Technology. Vol. 23, 2006

EM Wave Absorbers Based on Conductive Sheet

*Kyeung Jin O** · *Jae Man Song*** · *Dong Il Kim**

**Department of Radio Science and Engineering, Korea Maritime University, Busan, 606-791, Republic of Korea*
*** Research Institute of Industrial Technology, Korea Maritime University, Busan, 606-791, Republic of Kore*

ABSTRACT : *In this study, EM wave absorbers based on conductive sheets were prepared, and their reflection and transmission coefficients were investigated. An Al conductive sheet and an Au conductive sheet showed 10 dB, and 40 dB over of transmission coefficient in 1~18 GHz, respectively. Ba ferrite EM wave absorbers with an Al, and an Au conductive sheet showed advanced EM wave absorption and shield to compare with Ba ferrite EM wave absorbers without conductive sheets.*

KEY WORDS : Reflection, Transmission, Conductive sheet, Ba ferrite, Mn-Zn ferrite.

1. Introduction

There are so much unwanted EM (Electromagnetic) waves radiated from EM machines in spaces which affect EM machines and humans. EM wave absorbers and shelters are used to protect EM machines and humans 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 shelters 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][2][3][4][5].

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 shelters, 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 made with Au and Al. Proposed EM wave absorbers with conductive sheets showed advanced absorption and shield properties compare with EM wave absorbers without conductive sheets.

2. 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 shelters of EM waves. Figures 1 and 2 are photographs of Al and Au coated conductive sheets, respectively. Paint-type EM wave absorbers were prepared with Mn-Zn and Ba ferrites as a general method. The prepared paint-type EM wave absorbers were pasted on the conductive sheets to make EM wave absorber/shelters.

For the investigation of the reflection and transmission coefficient, the prepared EM wave absorber/shelters 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 analyzer. Figures 3 and 4 are diagrams of measurement system and the sample holder, respectively.

* songjm97@mail.hhu.ac.kr 051)410-4785

** dikim@mail.hhu.ac.kr

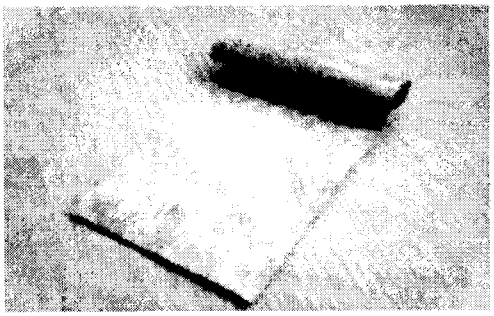

Fig. 1 Al coated conductive sheet.

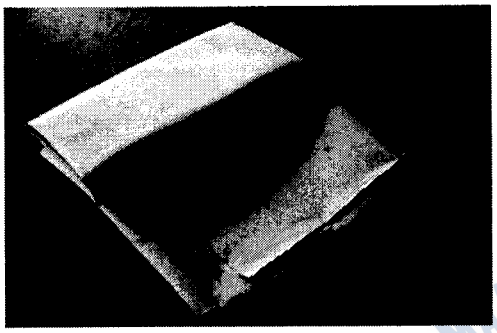

Fig. 2 Au coated conductive sheet

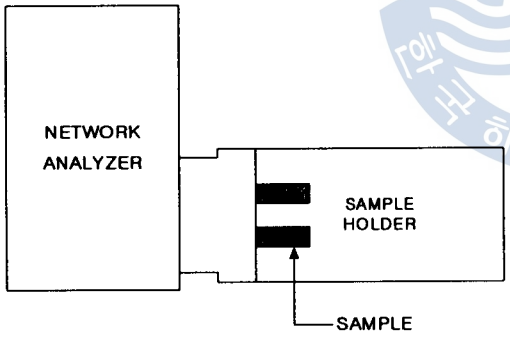

Fig. 3 Measurement system for the reflection and transmission coefficient.

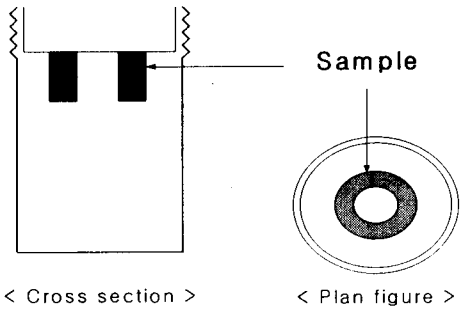

Fig. 4 Sample holder.

3. Results and discussion

We investigated transmission coefficient of Al and Au coated conductive sheets, and show the result in Figs. 5 and 6. Au coated conductive sheets which have lower surface resistance than Al conductive sheets show more large transmission coefficient in 1~18 GHz. The both of conductive sheets had shielding effect of 90% above in 1~18 GHz. Thus, they are useful as a shelters.

Figure 7 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 equa. (1) [6].

$$d = \frac{c}{2\pi \mu_r'' f} \qquad (1)$$

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

To compare reflection coefficient between a Mn-Zn ferrite EM wave absorber without conductive sheets and a Mn-Zn ferrite EM wave absorber with an Al, and an Au coated conductive sheet, reflection coefficient of them were investigated and presented in Figs. 8 and 9, respectively.

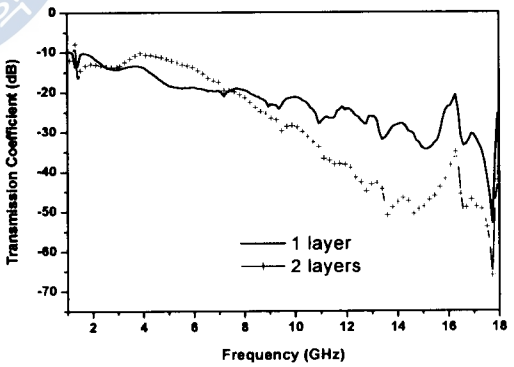

Fig. 5 Transmission coefficient of an Al coated conductive sheet as a function of frequency.

There are no big difference in absorption among three samples(Figs. 7, 8 , and 9). As we mentioned before, samples of Figs. 8 and 9 with conductive sheets have shielding effect as shown in Figs. 5 and 6. However, samples of Fig. 7 has 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 have both of absorption and shield properties simultaneously.

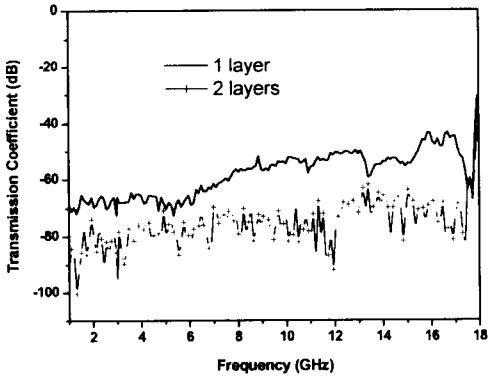

Fig. 6 Transmission coefficient of an Au coated conductive sheet as a function of frequency.

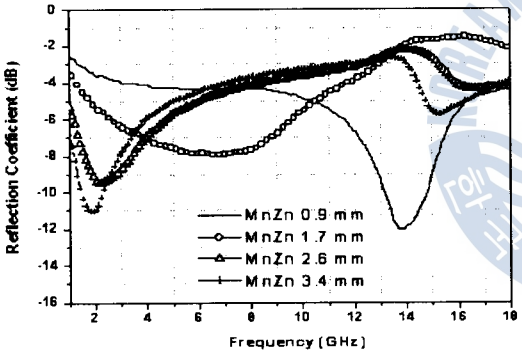

Fig. 7 Reflection coefficient of Mn-Zn ferrite EM wave absorbers as a function of frequency.

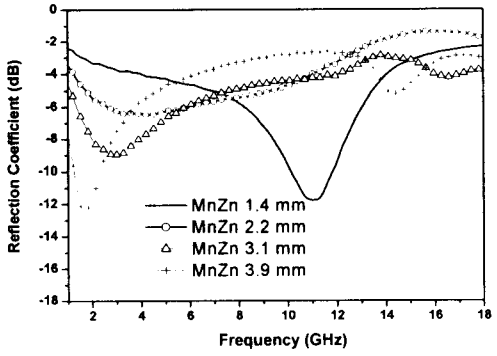

Fig. 8 Reflection coefficient of Mn-Zn ferrite EM wave absorbers pasted on one side of Al coated conduction sheet.

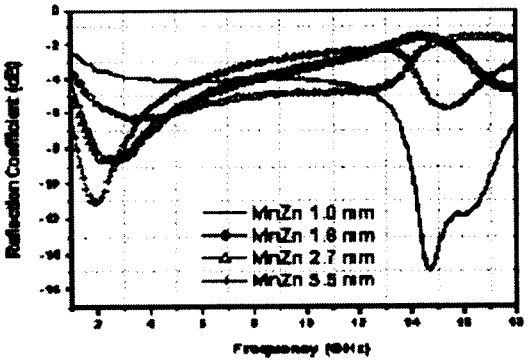

Fig. 9 Reflection coefficient of Mn-Zn ferrite EM wave absorbers pasted on one side of Au coated conduction sheet.

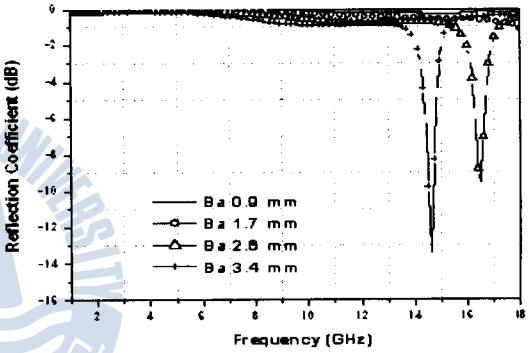

Fig. 10 Reflection coefficient of Ba ferrite EM wave absorbers as a function of frequency.

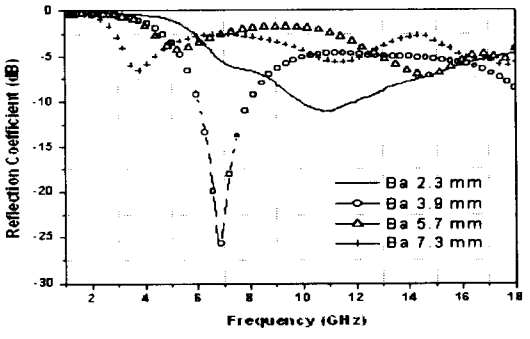

Fig. 11 Reflection coefficient of Ba ferrite EM wave absorbers pasted on both side of Al coated conduction sheet.

Figure 10 shows reflection coefficient of Ba ferrite EM wave absorbers without conductive sheets as a function of frequency. These absorbers have narrow band-widths of absorption in 15~17 GHz. However, Ba ferrite EM wave absorbers with Al, and Au coated conductive sheets in both sides, respectively, show enlarged absorption band as shown

in Figs. 11 and 12. From the result, we can conclude that Ba ferrite EM wave absorbers pasted on both side of an Al, and an Au coated conductive sheet are useful materials to protect EM machines and humans because they have both properties of absorption and shield simultaneously.

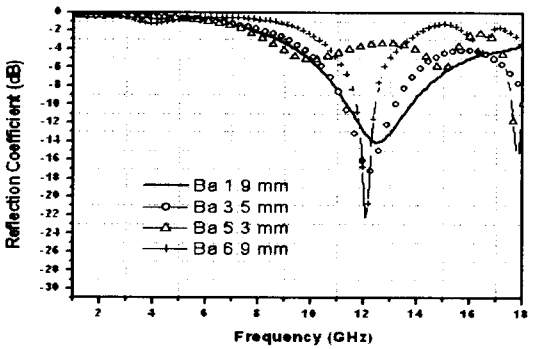

Fig. 12 Reflection coefficient of Ba ferrite EM wave absorbers pasted on both side of Au coated conduction sheet.

4. 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/shelters can be used to protect EM machines and humans from unwanted EM waves.

ACKNOWLEDGEMENT

This work was supported by the Korea Research Foundation Grant (KRF-2005-005-J00502).

REFERENCES

[1] J. M. Song, H. J. Yoon, D. I. Kim, S. J. Kim, S. M. Ok, B. Y. Kim, K. M. Kim, Journal of Korean Physical Society 42 (2003) 671.
[2] S. Sugimoto, K. Okayama, S. Kondo, H. Ota, M. Kimura, Y. Yoshida, H. Nakamura, D. Book, T. Kagotani, M. Homma, Materials Trans, JIM, 39 (1998) 1080.
[3] A. Verma, R. G. Mendiratta, T. C. Goel, D. C. Dube, J. Electroceramics, 8. (2002) 203.
[4] S. H. Moon, S. J. Shin, J. M. Song, D. I. Kim, K. M. Kim, Journal of Korea Electromagnetic Engineering Society, 14 (2003) 1329.
[5] M. Cao, J. Zhu, J. Yuan, T. Zhang, Z. Peng, Z. Gao, G. Xio, S. Qin, Materials and Design, 23 (2002) 556
[6] Y. Naito, *Electromagnetic Wave Absorbers*, (New Ohm, Tokyo, 1987), p.86.

Received : 1 December 2005
Accepted : 13 January 2006