Coating Effects on Electromagnetic Wave Absorbers Prepared with Mn-Zn Ferrites

Jae-Man Song[1] · Dong-Il Kim[2] · Seung-Hun Che[2] · Yun-Seok Choi[2] · Ki-Man Kim[2] · Keel-Soo Rhyu[3]

Abstract

We prepared Mn-Zn ferrite Electromagnetic(EM) wave absorbers. The Mn-Zn ferrite EM wave absorbers were coated with Sr ferrite powders and $Al(OH)_3$ powders. The coated Mn-Zn ferrite EM wave absorbers show improved absorption compared with non-coated Mn-Zn EM wave absorbers.

Key words : EM Wave Absorber, Mn-Zn Ferrite, Sr Ferrite, $Al(OH)_3$ Coating, Reflectivity.

Ⅰ. Introduction

There are so much unwanted electromagnetic(EM) waves radiated from EM machines in spaces. The unwanted EM waves affect EM machines and humans. EM wave absorbers are used to protect EM machines and humans from the unwanted EM wave radiation. Magnetic materials, such as soft ferrites(Mn-Zn, and Ni-Zn ferrites), hard ferrites(Ba and Sr ferrites), and Alnico magnets are important materials as EM wave absorbers because of their high magnetic loss, which contributes to the EM wave absorption[1]~[6].

A lot of research of EM wave absorbers for broad-band absorption has been done in study of design and additions[1]~[7].

Mn-Zn ferrite EM wave absorbers show EM wave absorption in lower frequency than Sr ferrite EM wave absorbers, because the magnetic loss of soft ferrites with spinel structure decreases quickly in the GHz range[2],[3]. Sr ferrites are used as EM wave absorbers in the GHz range, because the magnetic loss of them increases at natural resonance[2],[3]. In this research, we coated Mn-Zn ferrites with Sr ferrites, and compared EM wave absorption between a Mn-Zn EM wave absorber without coating and a Mn-Zn EM wave absorber coated with Sr ferrites.

EM wave absorbers translate EM wave energy into thermal energy. In the transition of energy, magnetic loss and electric loss are one of very important factors. We coated Mn-Zn ferrites with $Al(OH)_3$ because Al $(OH)_3$ has high resistivity, and compared their EM wave absorption with non coated EM wave absorbers. This is technical paper for broad-band EM wave absorbers.

Ⅱ. Sample Preparation and Measurements

In this research, we used Mn-Zn ferrites as a starting material for preparing sheet-type EM wave absorbers. The bulk-type Mn-Zn ferrites were smashed with a hammer, pulverized with a vibration mill, and coated with Sr or $Al(OH)_3$.

In general, the coating process needs high temperature over 1,100 ℃ in a furnace. But in this research, we coated Mn-Zn ferrite powders by a very simple method. The powders were mixed with aqueous solution of carboxy methyl cellous(CMC), and coated with Sr ferrite powders or $Al(OH)_3$ powders. The Mn-Zn ferrite powders coated with Sr or $Al(OH)_3$ were cured at 70 ℃ for 30 min in an oven, after that the cured powders were mixed with chloride poly ethylene(CPE) by using an open rollers.

For the investigation of the EM wave absorption of the samples, the prepared sheet-type absorbers were punched into a toroidal shape with an inner diameter of

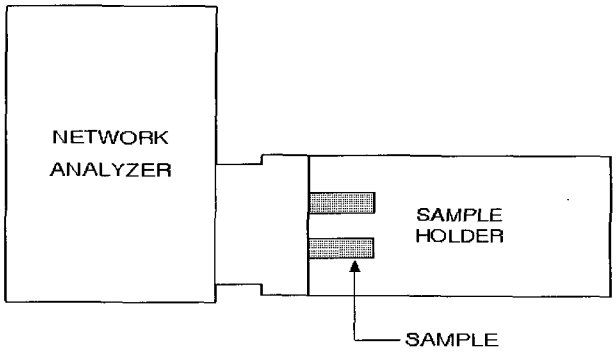

Fig. 1. Measurement system for the reflection coefficient.

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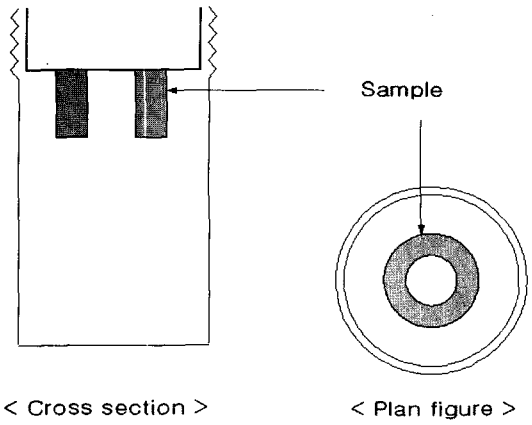
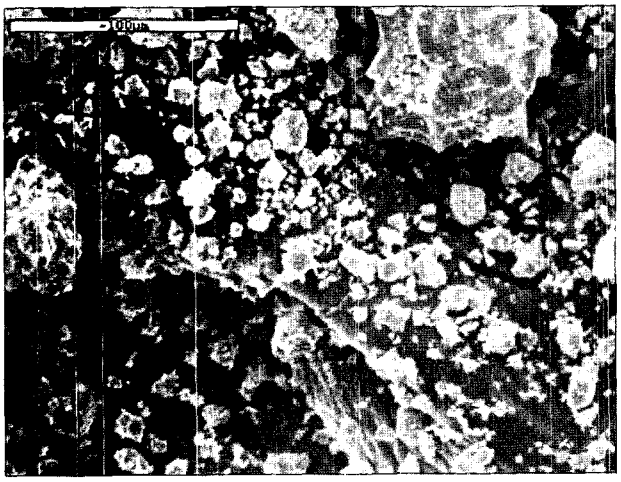


Fig. 2. Sample holder.

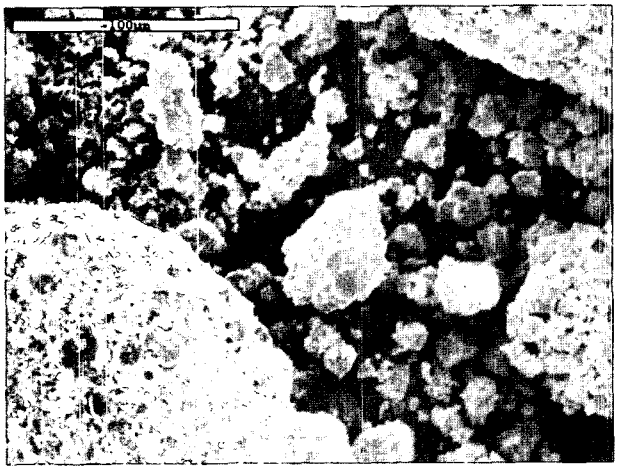
3.05 mm and an outer diameter of 6.95 mm. The absorption properties of the samples were investigated with a HP-8753D network analyzer. Figs. 1 and 2 are diagrams of the measurement system used for the reflection coefficient and the sample holder, respectively.

III. Results and Discussion

To investigate the effect of Sr ferrite coating on Mn-Zn ferrite EM wave absorber, we coated Sr ferrite powders on Mn-Zn ferrite powders. To confirm the coating of Sr ferrites on Mn-Zn ferrites, we took scanning electron microscope(SEM). Fig. 3 presents SEM micrographs of non-coated Mn-Zn ferrite powders and Mn-Zn ferrite powders coated with Sr ferrites of 20 wt%. As we explained in the section of II, even though, Mn-Zn ferrites were coated with Sr ferrites without high temperature, we could confirm that the Mn-Zn ferrites

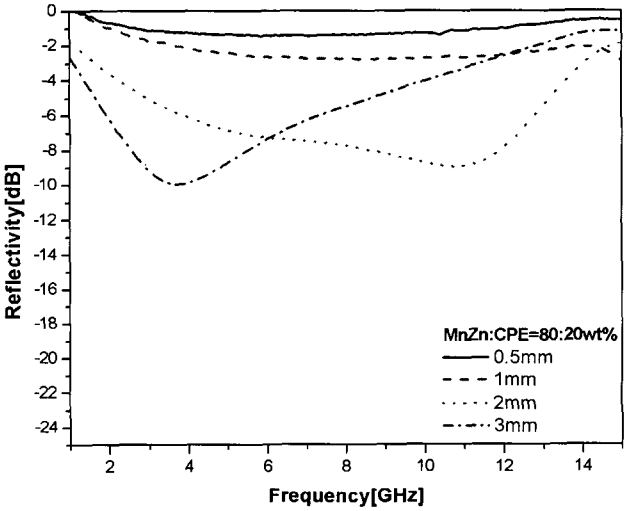


(a) Without coating

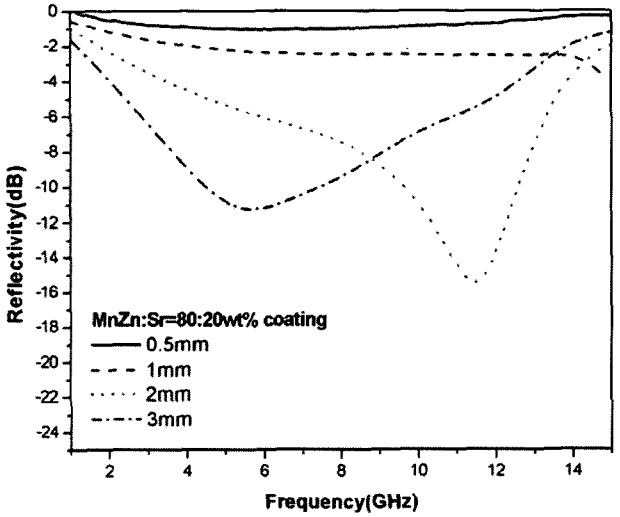


(b) Coated with Sr ferrites of 20 wt%

Fig. 3. SEM micrographs of Mn-Zn powders.



(a) Non-coated Mn-Zn ferrite EM wave absorbers



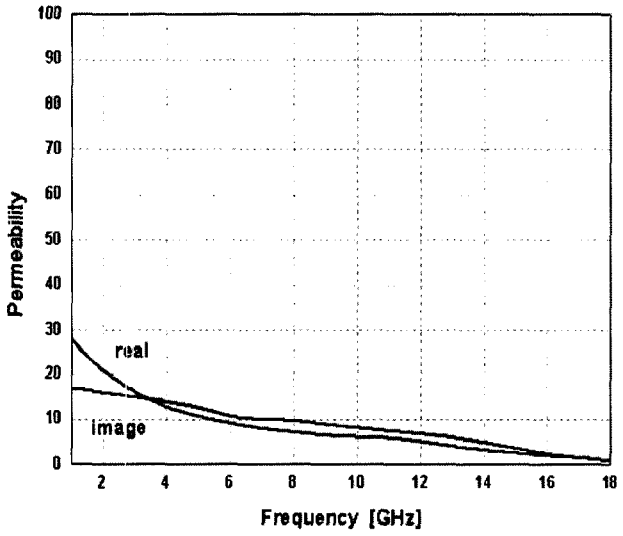
(b) Mn-Zn coated with Sr of 20 wt% ferrite EM wave absorbers

Fig. 4. Reflectivity as a function of frequency for Mn-Zn ferrite EM wave absorbers.

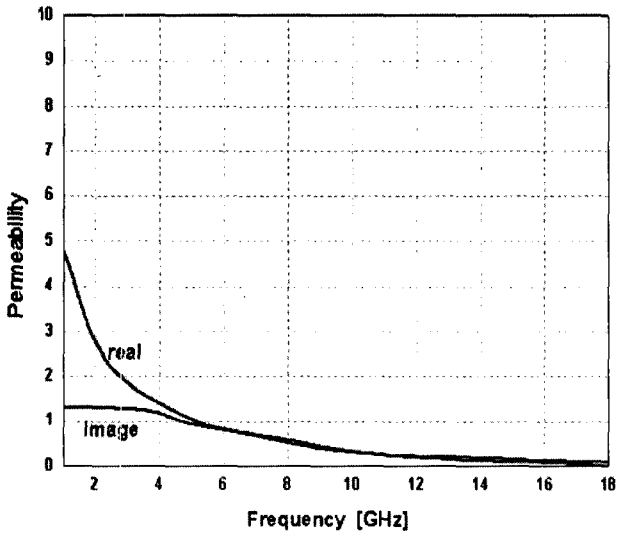
were coated with Sr ferrites comparing Fig. 3(a) with (b). Thus, the suggested coating method is useful to coat Mn-Zn ferrites with Sr ferrites.

Fig. 4(a) shows reflectivity as a function of frequency for non-coated Mn-Zn ferrite EM wave absorbers with the sample thickness of 0.5 mm, 1 mm, 2 mm, and 3 mm, and 4(b) shows it for Mn-Zn coated with Sr ferrites EM wave absorbers.

From the comparison Fig. 4(a) with 4(b), it is clear that the Mn-Zn EM wave absorbers coated with Sr ferrites are broader than the non-coated Mn-Zn EM wave absorbers in absorption frequency. Thus, we conclude that the coating of Sr ferrites on Mn-Zn ferrites is a useful way to extend absorption band. Also, central frequency to show maximum absorption in Fig. 4(b) is higher than Fig. 4(a). The EM wave reflectivity in magnetic materials depends on magnetic loss strongly, the magnetic loss is larger in the frequency of loss tangent(tan δ)>1 than tan δ<1[8], Fig. 5(a) and 5(b) show that the frequency of tan δ=1 is 3 GHz and 6 GHz, respectively. Thus, we can say that the result of Fig. 4 consists with this phenomenon.



(a) Mn-Zn ferrite EM wave absorbers



(b) Mn-Zn coated with Sr ferrite EM wave absorbers

Fig. 5. Permeability as a function of frequency for Mn-Zn ferrite EM wave absorbers.

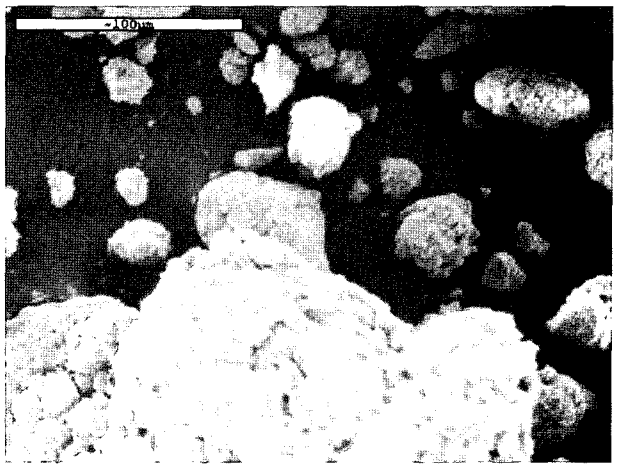


Fig. 6. SEM micrographs of Mn-Zn ferrite powders coated with $Al(OH)_3$ of 20 wt%.

Fig. 6 shows SEM micrographs of Mn-Zn ferrite powders coated with $Al(OH)_3$. It is sure that Mn-Zn ferrite powders were coated with $Al(OH)_3$ to compare Fig. 6 with Fig. 3(a). In this study, we used aluminum hydroxides with high resistivity of 10^{11} Ω cm. To compare Fig. 7 with Fig. 4(a), we confirm that the Mn-Zn ferrite EM wave absorbers coated with high resistive material have broad-band absorption. Thus, we conclude

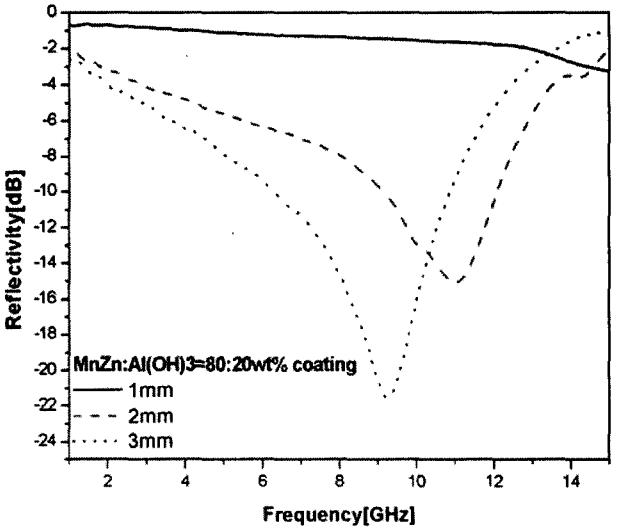


Fig. 7. Reflectivity as a function of frequency for Mn-Zn ferrite EM wave absorbers coated with $Al(OH)_3$ of 20 wt%.

that the coating with $Al(OH)_3$ on Mn-Zn ferrite powders is a very useful way to get a broad-band EM wave absorber. When we compare Fig. 7 with Fig. 4(b), Mn-Zn coated with $Al(OH)_3$ EM wave absorbers give more broad-band than Mn-Zn coated with Sr ferrite EM wave absorbers.

Ⅳ. Conclusions

We suggested a new simple way of coating for EM wave absorbers and investigated the coating effects of Sr ferrites and aluminum hydroxide on Mn-Zn ferrite EM wave absorbers.

The coating of Sr ferrites and aluminum hydroxides on Mn-Zn ferrite powders are very useful way to extend absorption band.

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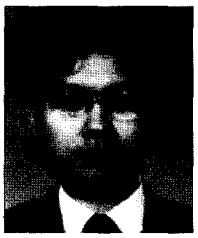

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