TE06

Double-layered microwave absorbers composed of ferrite and carbon fiber composite laminates

Sun-Hong Kim[1], Yong-Gon Park[1], and Sung-Soo Kim*[1]
[1] Department of Materials Engineering, Chungbuk National University, Cheongju 361-763, Korea
*Corresponding author: sskim@chungbuk.ac.kr, Phone: +82 43 261 2418, Fax: +82 43 271 3222

A conventional ferrite absorber in tile or composite form is attached on the existing metal structures and thereby reduces the wave reflections from such conductive substrates. For this metal-backed (short-circuited) absorber, many studies were carried out to design the zero-reflected absorber and to improve the microwave absorbing properties.[1,2] However, in movable semi-anechoic chamber or other types of moving vehicles, the structures are preferable as light as possible. For this demand, the metal parts can be replaced by carbon fiber polymer composites with high mechanical strength and low weight. The purpose of this study is to investigate the microwave absorbing properties of ferrite composite attached on the carbon fiber polymer composite substrate.

The absorbing layer was prepared from the mixture of ferrite filler and epoxy resin. The stoichiometric compound of $(Ni_{0.4}Zn_{0.6}O)(Fe_2O_3)$ composition was prepared by solid-state reaction at 1250℃ in N_2 atmosphere. The mixing ratio of ferrite to resin was 1 in weight (approximately 20 in ferrite vol. %). Commercially available carbon fiber-epoxy composites were used as a substrate material. The complex permeability and dielectric constant were determined by using HP/8720B network analyzer. Measurements were made in the C- and X-band frequencies (4-12 GHz).

The complex permeability ($\mu_r=\mu_r'-j\mu_r''$) and permittivity ($\varepsilon_r=\varepsilon_r'-j\varepsilon_r''$) was determined in the ferrite-epoxy composites. In this specimen, μ_r' is nearly constant (about 1) and $\mu r''$ decreases as the frequency increases (0.63 at 4 GHz, 0 at 12 GHz). Nearly constant value of ε_r' and ε_r'' (4.6 and 0.3, respectively) are observed in the frequencies. High dielectric constant and considerable loss was observed in the carbon fiber composites, which is due to space charge polarization and conduction loss along the carbon fibers. Nearly constant value of μ_r' (equal to free-space permeability) was observed and μ_r'' was negligibly small, which is due to nonmagnetic properties of constituent materials. On the basis of transmission line theory, microwave reflectance was predicted in the double-layered absorbers composed of ferrite and carbon fiber composites. As compared with the reflection loss of metal-backed absorber, a much reduced microwave reflectance is predicted.most reduced reflection loss is predictedthe absorber 5 mn in thickness and at the frequency of 6.9 GHz. The result indicates that the microwave absorbance can be greatly improved by the replacing the metals with the quasi-reflective carbon fiber composites as a substrate material,is attributed to the non-zero surface impedance of the carbon-fiber composites. In this way, the microwave absorber for structural applications can be suggested.

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TE07

Fabrication and characterization of Co_2Z-type hexaferrite by a glycine/nitrate method

J. H. Choi[1], J. Kim*[1]
[1] Dept. of Metallurgy and Materials Engineering, Hanyang University, Ansan 425-791,Korea
Corresponding author: jina@hanyang.ac.kr, phone:+82 31 400 5228, Fax: +82 31 417 3701

A recent rapid development of information and communication technology has forced electro-magnetic devices to increase their operation frequency over GHz. However, most of widely used ferrites cannot meet the property requirements for high frequency operation. For example, the magnetic loss of Ni-Zn ferrite with a spinel structure gradually increasesin the range over 100 MHz [1,2], which is well known as Sneoek's limit [3]. This designated that it is impossible to use this spinelferrite as an electrical material in GHz region. Thus, hexaferrites have been attracted much attention for microwave devices and mini-antennae operating in 1-2 GHz region because they, especially Co_2Z-type hexaferrite, are good soft magnetic properties and low loss factor. However, the conventional powder method is known to be difficult to synthesize Co_2Z-type hexaferrite. In this experiment, a glycine/nitrate methodwas adopted to fabricate Co_2Z-type hexaferrites. In order to obtain the precursor solution, metal nitrates, such as $Ba(NO_3)_2$, $Co(NO_3)_2 \cdot 6H_2O$ and $Fe(NO_3)_3 \cdot 9H_2O$, and glycine (H_2NCH_2COOH), were dissolved in an appropriate ratio in distilled water. Using a stainless-beaker and a hot plate, the solution was evaporated and finally turned into viscous gel with the increment of temperature. The viscous gel dried at 100℃ and then reacted auto-combustion over about 150℃. The combustion rate was controlled by the ratio between metal nitrates and glycine. Obtained powders were calcined at 1100℃ for 4 hr and then pressed and sintered at 1300℃ for 4 hr.

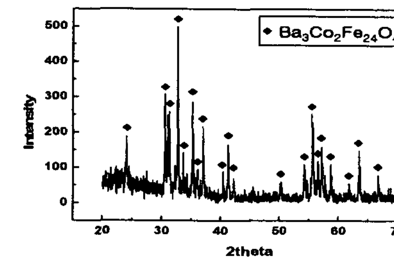

Fig. 1. XRD data of sintered Co_2Z-type hexaferrite.

The micro-structures of sintered Co_2Z-type samples were investigated by XRD and SEM. As a result, the sintered samples with a grain size of ~ 100 nm are composed of a single phase Co_2Z-type ferrite, as shown in fig. 1. The magnetic properties of the samples were measured by VSM and the initial permeability by Ryowa permeameter in the range of 0.1- 9GHz. It was shown that the permeability was around 12 over 1 GHz and Hc was less than 150. Therefore, the fabrication of Co_2Z-type samples by a glycine/nitrate method is proven to be a relatively simple and effective method compared to the conventional powder process.

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