S-2

Lightweight Microwave Absorbers Composed of Hollow Ceramic Microspheres Coated with Co-Fe Thin Films

Seon-Tae Kim, Sung-Soo Kim
Department of Materials Engineering, Chungbuk National University
Cheongju 361-763, Korea

In recent years, microwave absorptive materials draw more attention because of its widespread applications for many EMC (electromagnetic compatibility) purposes. A number of materials have been described in the prior arts, which are capable of absorbing electromagnetic radiation. However, the conventional absorptive materials such as metal powder and ferrites are quite heavy, which restricts their usefulness in applications requiring lightweight mass. Moreover, those materials have difficulties in increasing the permeability in GHz region because of Snoek limit for ferrites or eddy current loss for magnetic metals. In this study, conductive and magnetic microspheres are fabricated by plating of Co-Fe alloy films on hollow ceramic microspheres of low density for the application to lightweight microwave absorbers.

Commercially available hollow microspheres were obtained from PQ Cooperation (Valley Forge, PA, USA). The microspheres have a hollow ceramic (silicate) shell of a few μm thickness and thus having a low density of 0.2 g/cc. Metals (Co and Co-Fe alloy) plating was carried out in a two-step operation in which the surface of microspheres is first sensitized by treatment with salts of metal ($PdCl_2$-$SnCl_2$), followed by chemically reducing the salts of metals ($CoSO_4 \cdot 7H_2O$ and $FeSO_4 \cdot 7H_2O$) using a mild reducing agent of $NaPH_2O_2 \cdot H_2O$.

Uniform coating of the film with about 2 μm thickness was identified by SEM. High-frequency magnetic and microwave absorbing properties were determined in the rubber composites containing the metal-coated microspheres. Due to conductive and ferromagnetic behavior of the Co-Fe thin films, high dielectric constant and magnetic loss can be obtained in the microwave frequencies. In particular, the magnetic loss increases with Fe content in the alloy films and its frequency dispersion can be explained by ferromagnetic resonance theory. Due to those electromagnetic properties, high absorption rate and thin matching thickness are predicted in the composite layers containing the metal-coated microspheres of low density (about 0.8 g/cc) for the electromagnetic radiation in microwave frequencies.