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A R T I C L E I N F O

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A B S T R A C T

The development of stealth technology for military applications and increasing concerns of electromagnetic pollution have garnered interest to design microwave absorbing materials with wide absorption bandwidth and effective absorption properties. Two batches of samples as a potential radar absorbing material were prepared in this study: single-layer and double-layer nanocomposite mixtures of graphite and barium hexaferrite nanoparticles. Characterizations of electromagnetic and microwave absorbing properties were carried out in the frequency range of 8 − 12 GHz (X-band) and 12 − 18 GHz (K_u-band). Single-layer samples with thickness of 2 mm showed optimal absorption properties with minimum reflection loss of -20.5 dB at 11.8 GHz for X-band and -20.7 dB at 14.7 GHz for K_u-band, displaying bandwidths of 0.6 GHz for the former and 3.8 GHz for the latter at -10 dB. On the other hand, double-layer samples made of 1 mm thick barium hexaferrite matching layer and 2 mm thick graphite absorbing layer showed optimal absorption properties with minimum reflection loss of -30.0 dB at 9.2 GHz for X-band with narrower bandwidth of 0.6 GHz. The microwave absorption properties of these nanocomposites were attributed to combined effect of dielectric loss from graphite and magnetic loss from ferrite.

1. Introduction

In recent years, the development of stealth technology for military applications and the growing of electromagnetic pollution have garnered interest to design microwave absorbing materials with wide absorption bandwidth and effective absorption properties. To achieve significant absorption, the materials must possess electric and/or magnetic dipoles which interact with the electromagnetic fields of the radiation. Thereby, complex permeability ($\mu^* = \mu' - j\mu''$) and permittivity ($\varepsilon^* = \varepsilon' - j\varepsilon''$) of materials determine the reflection and attenuation characteristics of electromagnetic wave absorbers.

M-type hexaferrite, particularly $BaFe_{12}O_{19}$ is a promising material for permanent magnet, advanced recording, and microwave devices [1] as it possesses many outstanding properties including fairly large magnetization, excellent chemical stability, and corrosion resistivity as compared to other hexaferrites [1,2]. Such properties should be modulated to suit various applications [3]. $BaFe_{12}O_{19}$ has been extensively used in the development of potential microwave absorbers in higher GHz range [4–11], particularly owing to its large tunable anisotropy field [11]. Therefore, $BaFe_{12}O_{19}$ is selected as one of the microwave absorber components in this study. However, ferrites display reduction of magnetic permeabilities with weak resonance absorption and narrow operating bandwidths at the higher GHz frequency range.

Alternatively, carbon material is incorporated in microwave absorbing materials. Carbon materials including graphite, graphene, carbon fibre and carbon nanotube are highly of interest as microwave absorber since they are electric loss type microwave absorbers and offer high complex permittivity values, attributing to their superior electric

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