Materials and Design 32 (2011) 570–574

Contents lists available at ScienceDirect

Materials and Design

journal homepage: www.elsevier.com/locate/matdes

Influence of SiO_2 fillers on microwave absorption properties of carbonyl iron/carbon black double-layer coatings

Liyang Chen, Yuping Duan *, Lidong Liu, Jingbo Guo, Shunhua Liu

School of Materials Science and Engineering, Dalian University of Technology, Dalian 116085, China

ARTICLE INFO

Article history:
Received 28 May 2010
Accepted 13 August 2010
Available online 18 August 2010

Keywords:
A. Polymer matrix composites
C. Coatings
E. Magnetic
E. Microwave absorption

ABSTRACT

Epoxy resin (ER) based double-layer composite coatings were prepared with the thickness of 1.2 mm, employing carbonyl iron (CI) and carbon black (CB) as absorbents in the matching layer and absorption layer respectively. Especially, SiO_2 was introduced into the matching layer as wave-transmission material to improve the matching impendence. The complex permittivity, complex permeability and absorption properties were investigated in 2–18 GHz. With increasing SiO_2 content in the matching layer, the reflection loss (RL) was enhanced in the range 2–18 GHz. When the coating with the optimized SiO_2 and CI weight concentration (SiO_2:CI:ER) of 2:5:1, the optimal *RL* got to −17.3 dB and the effective absorption band (*RL* better than −4 dB) reached 5.7 GHz. In comparison, the minimum *RL* value was only −5.9 dB and the bandwidth (*RL* better than −4 dB) was just 4.1 GHz for the SiO_2-free composite coating.

1. Introduction

The rocketing development of information technology gives rise to unprecedented growth in the development of microwave electronic systems and telecommunications in high frequency. However, many problems have occurred along with it, which are the misoperation of precise electronic equipment and leaks of secret information occurred by leakage of electromagnetic wave [1,2]. In order to solve above problems, the electromagnetic (EM) wave absorbers with wider absorption bandwidth and more effective absorption properties are constantly becoming very important, which have aroused intense interest of the researchers [3–5].

Different methods have been used to improve the absorption efficiency and the effective absorbing bands of the absorbers, such as adding optimized absorbent [6], compounding different types of absorbents [7], using multi-layer structure [8,9]. It has been indicated that multi-layer structural absorbers, which have been devised by superimposing a variety of absorbent materials, possess wider absorption bandwidth and larger reflection loss (*RL*) [10,11]. In previous study, Feng et al. [12] have prepared double-layer absorbers employing carbonyl iron (CI) and barium ferrite powders as absorbents in the matching layer and absorption layer, respectively. The *RL* exceeding −13 dB was obtained in the frequency range of 6–18 GHz, but the disadvantages were high costs and heavy weight. Giannakopoulou et al. [13] designed double-layer microwave absorber with large magnetic and dielectric losses materials. The calculations results indicated that the absorption properties were improved effectively by contrast with that of those only with magnetic losses or dielectric losses. Wang and co-authors [14] prepared double-layer absorbers employing CI and carbon black (CB) with a total thickness of 4 mm. The effective absorption band (*RL* better than −8 dB) reached 6.5 GHz. However, the thickness of the absorbers imposed restrictions on their application. In addition, they just took the contents of absorbents into account without considering additional matching fillers to achieve proper electromagnetic impedance match.

In this study, double-layer microwave absorption coatings were fabricated using CI and CB as absorbents in the matching layer and absorption layer, respectively. SiO_2 was firstly introduced into the matching layer to improve matching impendence and provide tunnels for EM. The microwave absorption properties of these samples were then evaluated.

2. Experimental

2.1. Materials and preparation of wave-absorbing coating

CI powders used as magnetic fillers were prepared via a conventional thermal decomposition process of iron pentacarbonyl. The main characteristics taken from product information are: the content of α–Fe > 99.5 wt.%, particles are spherically shaped with mean size of 4.8 μm and a loose density of 2.08 g/cm^3. SiO_2 was purchased from Sinopharm Chemical Reagent Co., Ltd. with the average diameter of 75 μm. The CB was milled in a ball mill for 5 h and heat-treated at 700 °C for 30 min in flowing argon, which could reduce the size and activate the CB.

* Corresponding author. Tel.: +86 411 84708446; fax: +86 411 84709284.
E-mail address: duanyp@dlut.edu.cn (Y. Duan).

0261-3069/$ - see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.matdes.2010.08.021