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Electronic Materials Based on $Co_{0.5}Zn_{0.5}Fe_2O_4$/ $Pb(Zr_{0.52}Ti_{0.48})O_3$ Nanocomposites

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The reduction of the radar cross-sectional area achieved in stealth technology has been a major challenge since the Second World War, being accomplished by covering the metallic surfaces of aircraft, ships, tanks, etc. with radar-absorbing materials. Nowadays, the development of lightweight microwave-absorbing materials with reduced thickness has a greater impact due to their excellent microwave-absorbing properties. In this study, the microwave-absorbing properties of nanocomposites based on Zn-substituted cobalt ferrite and lead zirconium titanate have been investigated in the X-band (8.2 GHz to 12.4 GHz) region. Zn-substituted cobalt ferrite (CZF) and lead zirconium titanate (PZT) nanoparticles were prepared by the coprecipitation and homogeneous precipitation method, respectively. Nanocomposites were developed by dispersing these nanoparticles with different compositions into an epoxy resin matrix. All the composite materials showed more than 90% microwave absorption in the X-band region. The nanocomposite containing CZF/PZT (3:1) with 2 mm thickness displayed maximum return loss of −47.87 dB at 12.23 GHz. The microwave absorbers based on epoxy resin polymeric matrix exhibited better absorbing properties when the dielectric contribution matched the magnetic contribution, and the loss mechanisms were mainly due to the dielectric loss.

Key words: Zn-substituted cobalt ferrite, lead zirconium titanate, return loss, complex relative permittivity and permeability

INTRODUCTION

Along with the development of modern science and technology, the problem of electromagnetic interference is an important issue due to the wide-ranging applications of electromagnetic waves in the microwave frequency range for radio detection and ranging (radar) systems, local area networks, wireless communications, mobile phones, etc.[1,2] Therefore, microwave-absorbing materials are not only used in stealth technology, but also in people's daily life. We have focused upon the progress of microwave-absorbing nanocomposites to reduce radar cross-sectional area, mainly for military purposes, i.e., for camouflage applications in defense.[3–5] Such types of materials are coated on the metal surfaces of aircraft, tanks, ships, etc. to shelter them from electromagnetic radiation. Nowadays, the development of nanocomposites with excellent radar-absorbing properties is a challenging issue. Microwaves consist of time-varying electric and magnetic fields perpendicular to each other. To eliminate both the electric and magnetic components, several types of materials are used as radar absorbers, including dielectric and magnetic materials.[6–9] From a survey of the literature, it can be observed that various types of radar-absorbing materials (RAMs) are being developed with high magnetic and electric losses.[10–14] To evaluate these loss mechanisms, the complex relative permittivity ($\varepsilon_r = \varepsilon' - j\varepsilon''$) and permeability ($\mu_r = \mu' - j\mu''$) of the developed nanocomposites were measured by employing a vector network analyzer (PNA E8364B) in the X-band (8.2 GHz to 12.4 GHz) region. We calculated the characteristic input impedance of the absorbers by using the measured values of the complex relative permittivity and complex permeability.[15] The ε' (real part of permittivity) values

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