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ELECTROMAGNETIC PERFORMANCE OF SYNTHESIZED CNT ON Ce-SUBSTITUTED BARIUM FERRITE VIA CVD METHOD

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Abstract: In this work, first, Ce-substituted barium ferrite, $BaCe_{0.05}Fe_{11.95}O_{19}$, was prepared via sol-gel method as substrate and then carbon nanotubes (CNTs) was synthesized on the surface of substrate by chemical vapor deposition (CVD) technique. The structure, morphology and electromagnetic performances of the synthesized nanocomposites were characterized by XRD, FE-SEM, and VSM. Also, the electromagnetic properties including complex permittivity (ε_r), the permeability (μ_r), and electromagnetic wave absorption properties were investigated using a vector network analyzer. Due the presence of CNTs, the reflection loss (RL) widely increased. The maximum reflection loss in the frequency range of 8-12 GHz for 2.5 mm thickness was -49.61 dB at 9.0 GHz. The results suggest that this nanocomposite can be applicable as the electromagnetic wave absorbing coatings.

Keywords: Ce-substituted barium ferrite, Chemical vapor deposition, Carbon nanotubes, Electromagnetic wave absorbing material, Reflection loss..

1. INTRODUCTION

High performance electromagnetic (EM) wave absorbing materials with high absorption efficiency and wide absorption frequency range are used due to EM wave pollution and EM interference[1].They can absorb EM waves and then convert EM energy into thermal energy or dissipate microwaves by interference. Absorption properties are influenced by the factors of relative permeability, relative conductivity, impedance match of EM and structural design, etc. Among magnetic materials, The hexagonal-type ferrite ceramics are currently the focus of considerable interest because of their properties such as high anisotropic field, high saturation magnetization, significant value of permeability (>1), excellent chemical stability and have wide application as electromagnetic wave absorption materials[2]. Barium ferrites, which possess large saturation magnetization and high natural resonance frequency, have been well known as special kinds of absorbing materials[3]. There are several different synthetic methods used to generate ferrites as reported in the literature, including aqueous colloidal precipitation, sol–gel, and hydrothermal techniques. Sol–gel processes have attracted much attention recently, owing to the well-known inherent advantages of the sol–gel technique for generating glass/ceramic materials. Due to typical relaxation characterization, rare earth elements (RE) may magically affect the electromagnetic properties of ferrites. Recent investigations have shown that saturation magnetization, coercivity and anisotropy are improved after Ba^{+3} or $Fe^{+3}$is substituted by RE, which results in the change of the magnetic interactions[4,5]. The cerium element (Ce) is known as a dopant applied in the field of absorbers [3].

The main advantages of using hybrid dielectric-magnetic nanoscale materials are increasing the relative complex permeability and permittivity. Carbon nanotubes are used for electromagnetic applications because of large permittivity, electromagnetic interference shielding, their nanometric dimensions and chemical stability[6] Although CNTs do not show magnetic loss during microwave absorption, their absorption characteristics are limited, but could be improved by using low decorating ratios of magnetic materials. It has been reported that combination of CNTs with hexa ferrites enhanced the magnetic properties of the CNTs [7].

There have been electric arc-discharge, laser vaporization and catalytic CVD techniques for synthesis of carbon nanotubes with inorganic metals which lead to mtallic or semi-conducting properties for CNT. The first two methods have low productivity and high cost. Therefore, among various techniques developed for the production of CNTs, Catalyst Chemical