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Synthesis and characterization of $Li_{0.5}Fe_{2.5-x}Gd_xO_4$ ferrite nano-particles: a potential candidate for microwave device applications

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Abstract

The effect of Gd substitution on the microstructure, dielectric, impedance and magnetic properties of $Li_{0.5}Fe_{2.5-x}Gd_xO_4$ ($0.0 \leq x \leq 0.2$) ferrite nano-crystals prepared by sol-gel auto-combustion method has been investigated. The X-ray diffraction analysis confirmed the cubic spinel phase formation and broadness of reflection peaks indicates the formation of smaller sized particles. The crystallite size was observed to increase from 25.2 nm to 31.1 nm with increasing Gd substitution. The surface morphology and stoichiometric ratio of the compositional elements were analyzed using scanning electron microscopy equipped with energy dispersive X-ray spectroscopy. Dielectric and impedance measurements were carried out in the frequency range of 100 Hz-10 MHz. The dielectric properties of the present ferrite system were improved much by the substitution of Gd ions. The low dielectric loss at higher frequencies identifies the potential of these ferrites for high frequency applications. The impedance spectroscopy technique was used to study the effect of grain and grain boundary on the electrical properties. An enhancement in the value of saturation magnetization and Curie temperature has been obtained with Gd concentration, which is useful for technological aspects. The coercivity was also observed to decrease with Gd doping, except for the sample with x = 0.20.

Keywords: Dielectric properties; Impedance spectroscopy; Magnetic properties; Curie temperature

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1. Introduction

Ferrites are able to fulfill a wide range of applications from microwave to radio frequencies and are of importance from both fundamental and applied research point of view. Ferrite nano-