



On the structural and magnetic properties of La-substituted NiCuZn ferrites prepared using egg-white

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Abstract

Ni_{0.50}Cu_{0.25}Zn_{0.25}La_xFe_{2-x}O₄ ferrites (with $x = 0.00$ – 0.09) were prepared by a simple method using metal nitrates and freshly extracted egg white. The proper calcination temperature for ferrites formation was estimated using thermo-gravimetry technique (TG). The samples were characterized using X-ray diffraction (XRD), transmission electron microscopy (TEM) and infrared spectroscopy (FT-IR) measurements. XRD of the powders calcined at 550 °C for 2 h showed single-phase crystalline cubic ferrites with crystallite sizes in the range 17.2–21.6 nm. Both the lattice parameter and X-ray density are found to increase by the addition of rare earth ion. TEM image showed agglomerated nano-particles with irregular sizes and shapes. FT-IR spectra showed two absorption bands (ν_1 and ν_2) attributed to stretching vibration of tetrahedral and octahedral complex Fe³⁺–O²⁻, respectively. The shifting of the ν_2 band towards lower frequencies indicates the preference of lanthanum ions to occupy the octahedral sites. The effect of La-substitution on the magnetic properties was studied using vibrating sample magnetometry (VSM) and susceptibility measurements. The decrease in the saturation magnetization with increasing La content can be attributed to the decreasing of Fe³⁺–Fe³⁺ interactions in the octahedral sites. Coercivity shows size dependent behavior due to the combination of surface effect and surface anisotropy. The obvious decrease in the Curie temperature (T_C) with increasing La content indicates that the highly paramagnetic character of La³⁺ ions decreases the ferromagnetic region at the expense of the paramagnetic one.

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1. Introduction

Spinel ferrites are used in the fabrication of multilayer chip inductors (MLCIs) as surface mount devices for miniaturized electronic products such as cellularphones, notebook computers, video camera recorders and floppy drives [1]. NiCuZn ferrites are a soft magnetic material with a completely inverse spinel structure [2]. They have been widely used in multilayer chip inductors and correlative inductive devices due to their low-sintering temperature, high electrical resistivity and excellent magnetic properties [3].

The nanostructured magnetic particles have different properties from the corresponding bulk material due to their

reduced size and effect of magnetic interaction between particles [4]. Better magnetic properties of ferrite are essential for modern MLCIs to reduce the number of ferrite layer in the chip. The magnetic properties of the ferrite are highly sensitive to the amount of constituent metal oxides in their compositions [5]. Small amount of additives can also be used to modify microstructure and hence magnetic properties. In this category, rare earth oxides are becoming promising additives to improve the magnetic properties of ferrites [4,6–8].

In many investigations [9–13], a modification in the structural, magnetic and electrical properties is obtained due to the addition of rare earth ions however, in some cases conflicting results are obtained. For these reasons, further studies on rare earth-substituted ferrites are needed. Therefore, purpose of our investigation is to study the effect of La³⁺ substitutions for Fe³⁺ on the structural and magnetic properties of NiCuZn ferrite.

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