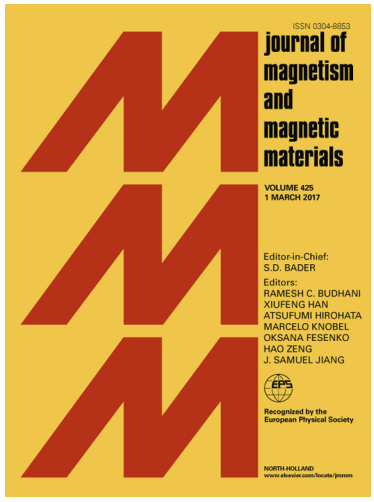

Research articles

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Design, Synthesis, and Testing of High Coercivity Cobalt Doped Nickel Ferrite Nanoparticles for Magnetic Applications

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Abstract

Spinel ferrite based magnetic materials are preferably used to prepare hard/soft magnets, magnetic data storage devices and recording media due to their excellent magnetic properties. Hence to study the magnetic behavior of nickel, cobalt based ferrites the cobalt doped (Co^{2+}) nickel ferrite nanoparticles with cubic spinel crystal structure are successfully designed via heat treatment method. The formation of single cubic spinel phase of Co^{2+} doped nickel ferrite nanoparticles is confirmed by X-ray diffraction analysis, and their structural properties, such as lattice parameter, average crystal size and X-ray density are investigated in detail. According to the microstructural study, the morphology of cobalt doped nickel ferrite nanoparticles is observed to be irregular in shape. Based on the thermal behavior carried out by the thermo-gravimetric analysis, it can be postulated that the complete formation of ferrite samples takes place at 600ºC. The hyperfine field parameters obtained by the Mossbauer spectroscopy indicates that on cobalt doping (x=0.4) additional sextet is obtained resulting into presence of unreacted Fe. The coercivity is increased from 263 to 1608 Oe with increasing Co^{2+} doping level in nickel ferrite. The Coercivity value is found to be the highest with good remnant magnetization, saturation magnetization and squareness ratio (M_r/M_s=0.49), indicating the capability of Co^{2+}-doping in improving the magnetic properties of nickel ferrite for magnetic applications such as permanent magnet, magnetic data storage devices and magnetic tapes.

Index Terms: Co^{2+} doping, Nanoparticles, Nickel ferrite, Permanent magnet

1. Introduction

Design of new materials to manufacture magnetic, electric, electronic, microwave and biomedical devices, have encouraged scientific and technological community to investigate structural and chemical properties of multi-component inorganic nanostructures. Various synthesis techniques are being used to alter physical and chemical properties of materials to obtain desired material characteristics suited to a particular application [1]. Among variety of materials, spinel ferrites are the most widely studied ceramic materials, since their characteristics can be enhanced using appropriate synthesis technique to achieve superior magnetic, electric, and chemical properties of the resultant material [2].

Ferrite materials based on nickel and cobalt are a subject of extensive research due to important magnetic properties like, good remnant magnetization, high coercivity, magnetic anisotropy and moderate saturation magnetization. They also exhibit high electrical resistivity good thermal and chemical stability [3, 4]. Based on these properties the ferrites are used in many diverse range important application such as magnetic data storage [5], permanent magnets [6], magnetic tape [7], hybrid electric vehicles [8], transformer core [9], radiofrequency circuits and