Magnetic Studies of Cobalt Doped Barium Hexaferrite Nanoparticles Prepared by Modified Sol-gel Method

M.Govindaraj Shalini, Subasa C. Sahoo*

Department of Physics, Central University of Kerala, Riverside Transit Campus, Padnekkad, Kasaragod, Kerala - 671314, India

**Corresponding author, Email: subasa@cukerala.ac.in*

Abstract. M-type barium hexaferrite ($BaFe_{12}O_{19}$) and cobalt doped barium hexaferrite ($BaFe_{11}CoO_{19}$) nanopowders were synthesized by modified sol-gel auto-combustion technique and were annealed at 900°C in air for 4 hours. The annealed powders were studied in the present work and X-ray diffraction studies showed pure phase formation after annealing. The average grain size in the nanopowder sample was decreased after doping. Magnetization value of 60 emu/g was observed at 300K for the barium hexaferrite and was reduced to 54 emu/g after doping. The coercivity of 5586 Oe was observed at 300K for the undoped sample and was found to be decreased in the doped sample. As the measurement temperature was decreased from 300K to 60K, magnetization value was increased in both the samples compared to those at 300K. The coercivity of the undoped sample was found to decrease whereas it was increased for the doped sample at 60K. The observed magnetic properties may be understood on the basis of modified exchange interaction and anisotropy in the doped sample compared to that of pure barium hexaferrite.

Keywords: M-type barium hexaferrite, sol-gel autocombustion, magnetic studies
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INTRODUCTION

Ferrites are used in permanent magnets, microwave devices, magnetic memories, telecommunication, electronic components, due to their attractive physical and chemical properties like reliable magnetization, high crystalline anisotropy, relatively high curie temperature, excellent mechanical hardness and corrosion resistivity[1,2]. Magnetic properties of the $BaFe_{12}O_{19}$ in nanosized form depend on the size, shape, and homogeneity of the material. For the synthesis of $BaFe_{12}O_{19}$ nanoparticles various synthesis techniques are adopted including, hydrothermal reaction[3], sol-gel[4], co-precipitation[5] and microemulsion technique[6]. In addition to the synthesis processes, calcining temperature, Ba:Fe ratio during synthesis, doping also influence the magnetic properties of $BaFe_{12}O_{19}$.[6] In the present study, we synthesized $BaFe_{12}O_{19}$ and $BaFe_{11}CoO_{19}$ by modified sol-gel auto combustion method and studied their magnetic properties after annealing at 900°C.

EXPERIMENTS

Nanocrystalline barium ferrite ($BaFe_{12}O_{19}$) and Co^{2+} doped barium ferrite ($BaFe_{11}CoO_{19}$) samples were synthesized by modified sol-gel auto-combustion method. Analytical grade Barium nitrate $Ba(NO3)_2$, Ferric nitrate $Fe(NO3)_3.9H_2O$ and cobalt nitrate $Co(NO_3)_2.6H_2O$ were used as starting salts and propylene glycol ($C_3H_8O_2$) was used as solvent. Stoichiometric amount of $Ba(NO3)_2$ and $Fe(NO3)_3.9H_2O$ were dissolved separately in distilled water and propylene glycol respectively, followed by continuous stirring by magnetic stirrer for 1 hr. The molar ratio of Ba^{2+}/Fe^{3+} was 1.2/12 in the present study. Generally an excess amount of barium salt is used due to its incomplete solubility in water during synthesis. The two solutions were mixed together and were under constant stirring for 1 hr at 60°C to obtain viscous gel. The temperature was further increased to 200°C to evaporate the

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