Magnetic Studies of $CuFe_2O_4$ Nanoparticles Prepared by Co-precipitation Method

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Abstract. Cu-ferrite nanoparticles were synthesized by co-precipitation method and were annealed at different temperatures ranging from 400 to 1000°C in air for 4 hours. The as-prepared sample and the sample annealed at 400°C showed small peaks of cubic Cu-ferrite in X-ray diffraction studies. For the intermediate temperature 600°C, some additional peaks of α-Fe_2O_3 were observed. As the annealing temperature increased further only tetragonal Cu-ferrite peaks were observed. In all the samples some traces of CuO was noted. Grain size was increased from 21nm for the as prepared sample to 42nm for the sample annealed at 1000°C. Spontaneous magnetization value was found to be very small for the as prepared sample and it was increased monotonically with the increase in annealing temperature. Maximum magnetization of 29.7emu/g was observed at 300K for the sample annealed at 1000°C. The remanent magnetization was increased with the increase in annealing temperature up to 900°C and then decreased whereas for the coercivity a peak was observed for the sample annealed at 800°C. The highest coercivity of 1402 Oe was observed at 300K for the sample annealed at 800°C. As the measurement temperature decreased from 300K to 60K, magnetization and coercivity values were increased. The observed magnetic behaviour may be understood on the basis of phase transformation, grain growth with the increase in annealing temperature and reduced thermal energy at low measurement temperature.

Keywords: $CuFe_2O_4$, Coprecipitation, Annealing, Magnetic properties
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INTRODUCTION

Ferrites are important magnetic materials, having properties such as high electrical resistivity, low eddy current losses, electro catalytic activity, high corrosion resistance and microwave properties [1]. Because of these unique properties they are widely used in telecommunication, permanent magnet, electronic devices and catalysis [1,2]. Spinel ferrites with chemical formula MFe_2O_4, where M is a divalent transition metal ion (like Mg^{2+},Co^{2+}, Ni^{2+} or Cu^{2+}), crystallize in normal or inverse spinel structure. Generally Cu-ferrite ($CuFe_2O_4$) has inverse spinel structure in which the tetrahedral sites are occupied by Fe^{3+} and octahedral sites are occupied by Fe^{3+} and Cu^{2+}. Due to Jahn-Teller distortion in the spinel lattice, modified magnetic behavior is observed in Cu-ferrite [3]. Synthesis route also plays a very important role in the formation of nanosized Cu-ferrite with different crystal structures and in its magnetic properties. Various synthesis methods such as ceramic method [4], sol-gel [5], hydrothermal [6], combustion synthesis [7], high energy ball milling [8] and chemical co-precipitation method have been adopted for the preparation of Cu-ferrite nanoparticles. In the present study, we have synthesized Cu-ferrite nanoparticles by co-precipitation method and studied the effect of annealing on its structural and magnetic properties.

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