Effect of Surface Coating on Magnetic Properties of Cobalt Ferrite Nanoparticles

M. Chithra, C. N. Anumol and Subasa C. Sahoo*

Department of Physics, Central University of Kerala, Riverside Transit Campus, Padnekkad, Kasaragod, Kerala - 671314, India
**Corresponding author: subasa@cukerala.ac.in*

Abstract. Cobalt ferrite nanoparticles were synthesized by coprecipitation method with and without surface coating. Oleic acid and citric acid were used as the surfactant during synthesis of nanoparticles. The sample prepared without coating and with (1M) oleic acid as surfactant showed crystalline nature whereas the sample prepared with (1M) citric acid was X-ray amorphous. The grain size was decreased with the addition of surfactant during synthesis. It was also observed that with the decrease in concentration of citric acid, grain size was increased. The sample prepared with (1M) citric acid was superparamagnetic and the other samples were ferrimagnetic in nature with magnetization value less than the bulk value of 80emu/g at 300K. Magnetization, remanence and coercivity values were decreased in the samples prepared with coating in comparison to the sample prepared without coating. As the temperature decreased from 300K to 60K all the magnetic properties mentioned above were enhanced. The observed magnetic properties of these nanoparticles can be attributed to the grain size, effect of surface coating and magnetic interactions in these nanoparticles.

Keywords: Co-ferrites, Coprecipitation method, Magnetic studies.
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INTRODUCTION

Co-ferrite ($CoFe_2O_4$) is one of the most investigating magnetic materials being studied in nano form due to its various applications in data storage [1], magneto optical devices [2], and biomedical diagnosis [3]. It has interesting physical properties like high chemical stability, coercivity, saturation magnetization, magnetostriction and Curie temperature [4]. There are several researches going on aiming at improving its physical properties for its use in suitable industrial applications. The properties of nanoparticles can be tuned by varying the size, shape, composition and surface morphology. These magnetic nanoparticles tend to agglomerate to form large clusters during synthesis because of their high surface energy and strong magnetic interactions [5]. The agglomeration of the nanoparticles may be controlled by proper surface coating. The surface coating can be done with organic, polymer, biocompatible materials, or with some inorganic materials such as silica, ferromagnetic and antiferromagnetic materials.

In this work, we synthesized Co-ferrite nanoparticles with coprecipitation method with and without surface coating by citric acid and oleic acid. The effect of these surfactants on structural and magnetic properties of Co-ferrite nanoparticles was investigated.

EXPERIMENTAL DETAILS

Co-ferrite nanoparticles were synthesized by coprecipitation method. In the synthesis process, 1M (25ml) solution of iron chloride ($FeCl_3.6H_2O$) and 0.5M (25ml) solution of cobalt chloride ($CoCl_2.6H_2O$) was prepared in separate beakers with double distilled deionized water. The salt solutions were mixed together under constant stirring at room temperature. 3M solution of NaOH was slowly added to the salt solution drop wise to reach a pH value of 12. The solution was under constant stirring at 80°C and a black color precipitate was formed uniformly in the solution. After 2 hrs, it was cooled down to room temperature. By centrifuging, the precipitate was collected from the supernatant liquid and was dried overnight at 150°C. This sample is named as CF in this study. For the coating of nanoparticles, the same procedure as mentioned above was followed with the addition of surfactant

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