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Magnetic Characterizations of $CoFe_2O_4$ Nano-Particles Prepared by Different Wet-Chemical Processing Techniques

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ABSTRACT

Nano-structured spinel ferrites are of great interest in fundamental as well as applied materials science. The ferrites have been extensively studied due to their wide technological applications. The materials synthesis technique is a decisive factor for its structural and physical properties. There are various techniques for preparation of spinel ferrites or ferro-spinels, such as high temperature dry ceramic method, co-precipitation method, sol-gel method, molecular precursor method, micro- emulsion method, microwave synthesis, sono-chemical synthesis, auto-combustion or flash combustion method, citrate precursor and polymeric precursor methods. The main objective of the present paper is to report comparative study of magnetic properties of nano-structured cobalt ferrite synthesized by various wet-chemical techniques.

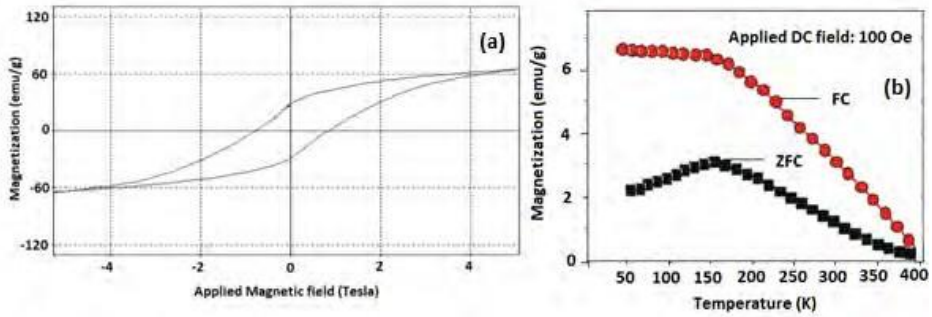

Fig. (a) M-H loop (b) ZFC-FC magnetization of CoFe2O4 prepared by auto combustion method

Cobalt ferrite (CoFe2O4) is a partially inverse spinel having degree of inversion sensitive to the thermal history of the specimen or material processing technique. Moreover, Co^{2+} ion introduces an uniaxial anisotropy in the material due to more spin-orbit coupling than the other 3d transition metal ions and the effect has been found to be more pronounced when it occupies the octahedral sites. The strong binding of the magnetization vector to the crystal axis produces low permeabilities and high coercive force. The method of synthesis of nano-ferrite material plays an important role with regard to microstructural and magnetic properties. The present study aims to discuss the properties Cobalt Ferrite nano-particles prepared by different wet-chemical methods namely, co-precipitation, citrate pre-cursor, auto-combustion, flash combustion, sol-gel and polymeric pre-cursor methods. The chemistry of each of the above methods is covered. All the ferrite products of different methods are characterized by X-ray diffraction, FTIR, M-H loop, susceptibility and SEM measurements. The comparative study of properties of cobalt ferrite prepared by various methods is presented. The highest saturation magnetization (72 emu/g) is observed for the sample prepared by co-precipitation technique while the samples prepared by citrate gel and polymeric precursor methods exhibit lower magnetization (~ 50 emu/g). The observed lower value of magnetization is attributed to the presence of acicular nano-particles with large surface area in case of synthesis by both the precursor methods. The Curie temperatures determined through thermal variation of AC susceptibility varies between 820K–850K. The ZFC-FC magnetization for the sample of auto-combustion method shows thermo- magnetic irreversibility at 400 K.

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