Zn-Cr Co-Substitution Effect on Structural and Electromagnetic Properties of $CuFe_2O_4$ via Oxalate Decomposition Route

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Zn-Cr-co-substituted $Cu_{1-x}Zn_xFe_{2-2x}Cr_{2x}O_4$ ferrites (where x = 0.0–0.5) were prepared via thermal decomposition of oxalate precursors. The thermal decomposition up to ferrites formation was followed by differential thermal analysis–thermogravimetry measurements. M€ossbauer technique was used to predict the possible cation distribution of the entire system, and X-ray diffraction, Fourier transform infrared, and electromagnetic measurements were used for confirmation. The superparamagnetic characteristics estimated via M€ossbauer studies, for samples with higher substitution, agreed well with vibrating sample magnetometer, magnetic susceptibility, and conductivity results. All the samples showed semiconducting properties in which conductivity decreases by increasing substitution. The effect of cationic substitution on the entire system was investigated and discussed.

Keywords: conductivity; electromagnetic properties; thermal decomposition; ferrites

Introduction

Recently, much interest has been focused on noncollinear magnetic structures appeared in ferrimagnetic materials, in which the magnetic ions are partially substituted by diamagnetic or paramagnetic ions, due to the presence of unsatisfied superexchange bonds as well as exchange interactions.[1]

Ferrites are interesting systems in which the gradual changes in their composition could result in clear variations in their physical and chemical properties. $CuFe_2O_4$ has been received a considerable attention due to its high conductivity, thermal stability, and catalytic activity.[2,3] It can be crystallized either in tetragonal or in cubic symmetry according to the distribution of cations in its structure.

Very few works are reported on the Cr-substituted copper ferrites.[4–8] Generally, the substitution with magnetic Cr ion can produce magnetic dilution, which may induce amazing magnetic properties. On the other hand, the substitution with nonmagnetic ions such as zinc may cause changes in the cation distribution of ferrite systems and consequently drastically affects structural and magnetic properties.[9–11]

The different properties of ferrites are sensitive, in addition to their composition and their synthesis route. Some of the used methods reported in the literature are cited in[12–17]