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Comparative study of enhanced magnetic properties of Cr and Al doped Y and Z type Hexaferrites: AReview

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Abstract:

The Comparative study is based basically on the results obtained from vibrating sample magnetometer taking coercivity, retentivity and magnetic saturation of different materials $Ba_3Cu_2Cr_{x/2}Al_{x/2}Fe_{24-x}O_{41}$*and* $Ba_2Mg_2Al_{x/2}Cr_{x/2}Fe_{12-x}O_{22}$*,(where,* $x = 0, 0.5$ *and 1.0). The sol gel technique was employed for the preparation of samples and further XRD, VSM, FTIR and VNA was used for characterization.The samples* $Ba_3Cu_2Al_{0.25}Cr_{0.25}Fe_{23.5}O_{41}$ *and* $Ba_2Mg_2Fe_{11.5}O_{22}$ *shows less magnetic losses, comparatively lower coercivity, retentivity and magnetic saturation which enable these samples the best candidate for antenna miniaturization and microwave absorber applications.*

Keywords: *vibrating sample magnetometer, coercivity, retentivity and magnetic saturation*

Introduction

Hexaferrites are gaining admiration due to its numerous applications in latest technologies including miniaturization devices and also in Health care innovations. Their elixir properties such as high permittivity, permeability and resistivity, less dielectric losses, enhanced power competency and various other mechanical characteristics make it best suitable applicant of above-mentioned applications.The Quantity of dopants, chemical conformation and amalgamation process are imperative factors that enhanced the properties of ferrite. So diverse amalgamation processes as well as various kind of dopants are cast-off by scientist and researchers to synthesis hexaferrite. The most common synthesize methods includes combustion, hydrothermal, pyrolysis, sol-gel and coprecipitation etc.Among these methods, Sol gel (SG) is one of the best method due to its easiness, limpidness, environmentally friendly and low processing time. Keeping in mind this, SG based Al and Cr doped Y-type ferrites ($Ba_2Me_2Fe_{12}O_{22}$) and Z-type ferrites ($Ba_3Me_2Fe_{24}O_{41}$) has been chosen for comparison of magnetic properties.[1-2]

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Synthesis & Characterization Techniques: The Chemical composition for Y-type was $Ba_2Mg_2Al_{x/2}Cr_{x/2}Fe_{12-x}O_{22}$ (x = 0, 0.5 and 1.0) and Z-type was $Ba_3Cu_2Cr_{x/2}Al_{x/2}Fe_{24-x}O_{41}$(where, x = 0.0, 0.5, 1.0). The synthesis along with Characterization Techniquesmethod is already reported in previous work.[1-2] The present work compared their magnetic properties.

Result and Discussion: From the graph**1(a)-1(c)**, With the increase in crystalline size in Z-type hexaferrite, coercivity also increases but opposite behavior is reported in the case of y-type hexaferrite. In y- type with increase in dopant concentration, the crystalline size decreases but coercivity and saturation magnetization increases. This anomalous behavior can be explained on the basis of Gorter Model.[3]According to this model, in ferrites there are four parallel and eight anti parallel spins along with its STSTST unit cell.In T block, there are three $6c_{v1}$ octahedral ionsand $3b_{v1}$sublattices. Such arrangement is attributed for high potential energy because of high electrostatic repulsion amongst cations. The addition of any non-magnetic ionat such octahedral coordination give rise to the cancellation of the antiferromagnetic interaction which is the strongest one in the Y-structure.Hence, anomalous behavior is there.

More is the value of saturation magnetization and coercivity lesser will be reflection losses. The highest reflection losses were observed for $Ba_3Cu_2Al_{0.25}Cr_{0.25}Fe_{23.5}O_{41}$ (−31.19 dB) and$Ba_2Mg_2Fe_{11.5}O_{22}$ (−37.25 dB) both the sample have lesser value of saturation magnetization and coercivity amongst another samples. [1-2]All the samples are single domain because SR for all samples is greater than 0.5. The domain motion can also be understood on basis of magnetic permeability, more the permeability means increase in grain boundaries which offers high reluctance to magnetic domain motion. The samples $Ba_3Cu_2Al_{0.25}Cr_{0.25}Fe_{23.5}O_{41}$ and $Ba_2Mg_2Fe_{11.5}O_{22}$ also shows less magnetic losses which suggest high energy dissipation. So, these samples are very beneficial for microwave absorption-based devices or applications.

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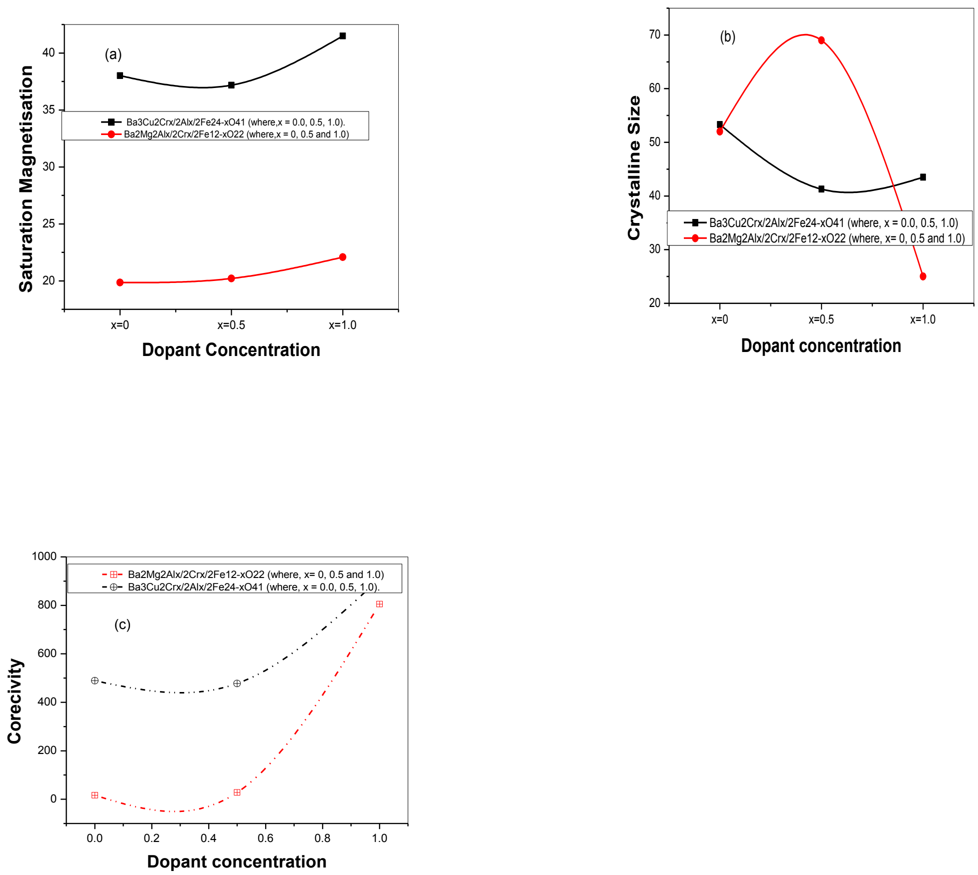

Figure 1: Figure 1(a), (b) and (c) represents the comparisons of Saturation magnetization, Crystalline size and Coercivity, respectively with dopant concentration for $Ba_2Mg_2Al_{x/2}Cr_{x/2}Fe_{12-x}O_{22}$ (x = 0, 0.5 and 1.0) and Z-type was $Ba_3Cu_2Cr_{x/2}Al_{x/2}Fe_{24-x}O_{41}$(x = 0.0, 0.5, 1.0).

Conclusion: The magnetic and electric properties such as permeability and permittivity which is greater than one and dielectric losses which is less than one made hexaferrites best appropriate

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material for numerous applications such as magnetic storage devices, microwave absorber and miniaturization applications. Moreover, crystalline size has greatest impact on magnetic properties. The composition $Ba_3Cu_2Al_{0.25}Cr_{0.25}Fe_{23.5}O_{41}$ (−31.19 dB) and $Ba_2Mg_2Fe_{11.5}O_{22}$ (−37.25 dB) showed highest reflection losses amongst rest compositions because of their multifaceted magnetic properties.

References

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