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B.V. Rao, A.D.P. Rao

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Influence of Mo^{6+} on Magnetic and Micro-Structural properties of Copper Ferrite

B.V.Rao and A.D.P.Rao*
Department of Nuclear Physics, Andhra University, Visakhapatnm-530003, A.P., India
*Corresponding author, email: research.angalakuduru@yahoo.com

Highlights

- The Mo^{6+} substitution has promoted the hardness of thermal stability increasing curie temperature
- Presence of Neel's two sub-lattice model and Yafet – Kittel angle are caused to vary magnetization
- All the materials showed initial permeability dispersion below 1 kHz, followed by relaxation
- Grains are faceted type in liquid phase having precipitation with white color spots at grain boundary

Abstract

Two series of copper ferrites are prepared using the chemical compositional formula $Cu_{1.0}Fe_{2.0-2x}Mo_xO_{4.0}$ and $Cu_{1.0-3x}Fe_{2.0}Mo_xO_{4.0}$. They are calcinated at 750 C and sintered at 950C. The grain size initially decreases with Mo^{6+} concentration. while it found to increase from x=y=0.06 (Mo^{6+}) onwards. The monotonic increase of Tc is found in C series materials while in F series it observed to decrease at intermediate values of x. Variation of magnetization has been explained on the basis of Neel's model of magnetic interactions and Yafet-Kittel angle existence. The initial permeability (μ_i) increases at room temperature followed by its fall with the increase of F as well as C series. The observed deviation between experimental and theoretical magnetic moment values is explained in terms of Y-K angle occurrence.

Keywords: Copper ferrite; Molybdenum; Magnetization; Exchange interaction; Curie temperature; Permeability; Grain size

1. Introduction

Copper ferrite spinel lattice is highly distorted ($c/a \sim 1.06$) because of Cu^{2+} ion, as it is a Jahn-Teller(JT) ion arising from the octahedral cupric ions and also shows the inability to have a cation/oxygen ratio higher than 3/4 [1]. The JT transition is argued to be order – disorder in character but the exact nature is not yet fully understood. On the other hand, research work so far reported on copper ferrites is emphasized about the $\leq$ 5+ valence cation(s) influence on their physical properties. Almost no investigations by substituting high valence ions like Mo^{6+} in copper ferrite are available. Earlier substitution of Mo^{6+} in Mg-Mn ferrites led to improve some of the physical properties at 0.10 concentration of molybdenum [2]. On the basis of this, in the present work it is proposed to understand the impact of high valence cation by substituting molybdenum in copper ferrite. The proposed studies might throw a light on possibility of developing a new material for device development or up gradation of existing devices. The main aim of the present investigations is to study influence of Mo^{6+} on magnetic and micro structural properties of copper ferrite, which might be useful for the above said purpose.

2. Preparations of Samples

Copper ferrite samples are prepared with the chemical compositional formula $Cu_{1.0}Fe_{2.0-2x}Mo_xO_4$. Substitution of Mo^{6+} at the expense of Fe^{3+} varying x in steps of 0.02 for x=0.00 to x=0.08 and in steps of 0.10 from 0.00 to 0.40, (F series) is performed. Mo^{6+} is substituted at the expense of Cu^{2+} also having compositional formula $Cu_{1.0-3x}Fe_{2.0}Mo_xO_4$ varying x in steps of 0.02 for x=0.00 to 0.08 and in steps of 0.10 for 0.00 to 0.20, (C series). Both the series materials are calcinated at 1023 K and sintered at 1223 K. These are characterized with XRD spectra that emphasized the single phase formation of copper ferrite