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Frequency and temperature dependence of conductance, impedance and electrical modulus studies of $Ni_{0.6}Cu_{0.4}Fe_2O_4$ spinel ferrite

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Abstract

Ferrite with nominal composition $Ni_{0.6}Cu_{0.4}Fe_2O_4$ was synthesized using Pechini sol-gel method. The X-ray diffraction results indicate that the ferrite sample has a cubic spinel type structure with $Fd\bar{3}m$ space group without any impurity phase. The electrical properties of this ferrite using complex impedance spectroscopy technique have been carried out as a function of frequency at different temperatures. The total conductance curves for the sample are found to obey *Jonscher* power law ($G(\omega) = G_{DC} + A\omega^n$) with an increase of frequency exponent (n) as temperature increases. Frequency dependence of imaginary part of impedance (Z'') shows the existence of relaxation phenomenon in our sample. The impedance study using Nyquist representation revealed the appearance of semicircle arcs and an equivalent circuit of the type of ($R_g+R_{gb}//Z_{CPE}$) has been proposed to explain the impedance results. Likewise, the analysis of the temperature variation of the imaginary part of modulus (M'') spectra confirms the existence of relaxation phenomena. Activation energies calculated from *DC* conductance, impedance and modulus spectra are in close agreement. This indicates that the relaxation process and electrical conductivity are attributed to the same defect.

Keywords: Spinel ferrite; Conductance; Impedance spectroscopy; Electric modulus; Relaxation time.