Enhanced Inductivity, Redox Potential, and Magneto-Dielectric Properties of $SrFe_{12}O_{19}$ Nano-Hexaferrite due to Cu and Gd Co-Substitution

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Abstract

The M-Type hexaferrites of composition $SrFe_{12}O_{19}$, $Sr_{0.95}Gd_{0.05}Fe_{11.7}Cu_{0.3}O_{19}$, $Sr_{0.95}Gd_{0.05}Fe_{11.4}Cu_{0.6}O_{19}$, and $Sr_{0.95}Gd_{0.05}Fe_{11.1}Cu_{0.9}O_{19}$ have been synthesized through the conventional sol-gel method. The X-ray diffraction (XRD) patterns of the synthesized compositions confirm the hexagonal structure associated with the P63/mmc space group. The microstructure of these samples has been evaluated by transmission electron microscopy (TEM). In addition, the contribution of ferroelectric dipoles for all samples has been analyzed from the frequency-dependent dielectric constants (ε' and ε'') using the Cole-Cole relaxation and Jonscher power law model. The AC conductivity (σ_{ac}) was measured for all studied samples in the frequency range of 100 Hz to 100 MHz. Additionally, optical absorbance spectra have been employed to estimate the band gap and redox potential of all samples. Notably, the phase angle (θ) predicts the exceptional inductive nature of $Sr_{0.95}Gd_{0.05}Fe_{11.1}Cu_{0.9}O_{19}$ between 100 Hz to 100 MHz whereas the $Sr_{0.95}Gd_{0.05}Fe_{11.7}Cu_{0.3}O_{19}$ functions as an inductor or capacitor, depending on the frequency.

Keywords: Hexagonal structure, Redox potential, Magnetization, Ferroelectric dipoles, Phase angle.