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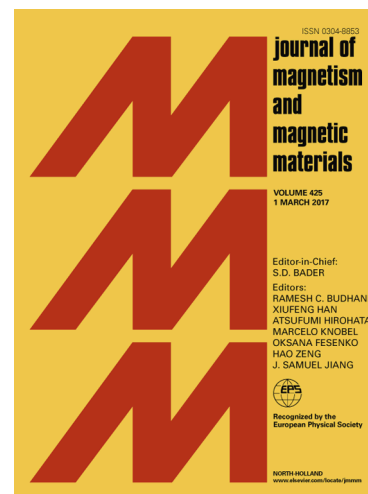
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## Structural, optical, dielectric and magnetic studies of Gadolinium-added Mn–Cu nanoferrites

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### Abstract

Spinel ferrite with the general formula  $\text{Mn}_{1-x}\text{Cu}_x\text{Fe}_{1.85}\text{Gd}_{0.15}\text{O}_4$  ( $x = 0.2, 0.4, 0.6$  and  $0.8$ ) was synthesized using the standard sonochemical method. The structure, optical, morphology, dielectric and magnetic properties of the prepared  $\text{Mn}_{1-x}\text{Cu}_x\text{Fe}_{1.85}\text{Gd}_{0.15}\text{O}_4$  nanoferrites were exhaustively investigated using various characterization techniques. The phase purity, secondary phase and crystallite parameters were studied from X-ray diffraction patterns. Fourier transform infrared spectra showed two absorption bands of transition metal oxides in the frequency range from  $400$  to  $650\text{ cm}^{-1}$ , which are related to asymmetric stretching modes of the spinel ferrites ( $\text{AB}_2\text{O}_4$ ). Raman spectra have five active modes illustrating the vibration of  $\text{O}^{2-}$  ions at both tetrahedral (A) site and octahedral (B) site ions. The wide and narrow scan spectrum from X-ray photoelectron spectroscopy results confirmed the presence of Mn, Cu, Gd, Fe, C and O elements in the composition. The oxidation state and core level of the photo electron peaks of Mn 2p, Cu 2p, Gd 3d, Fe 2p and O 1s were analyzed. The influence of the  $\text{Cu}^{2+}$  concentration in  $\text{Mn}_{1-x}\text{Cu}_x\text{Fe}_{1.85}\text{Gd}_{0.15}\text{O}_4$  on the morphology, varying from nanorods, nanoflakes to spherical, was explored on the basis of scanning electron microscopy images. Ultraviolet diffuse reflectance spectroscopy studies indicated that the optical bandgap ( $5.12$ – $5.32\text{ eV}$ ) of the nanoferrites showed an insulating behavior. The dielectric constant, loss tangent and complex dielectric

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