Paper No: PU-SOE- Physics - 13

Synthesis and characterization of multi functional nickel ferrite nano-particles for X-ray/gamma radiation shielding, display and antimicrobial applications

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Abstract

In the present communication, $NiFe_2O_4$ (NFO) nanoparticles (NPs) are synthesized by using solution combustion method. To know the phase purity, functional group, surface morphology, structural analysis and energy band gap, the synthesized sample was characterized by using the techniques such as powder X-ray diffraction (PXRD), Scanning electron microscopy (SEM), Fourier transmission infrared spectroscopy (FTIR) and UV–Visible spectrophotometer. The Bragg's reflection of PXRD confirms the formation of cubic NFO NPs with $Fd-3m$ space group. The SEM morphology shows the distribution of irregular shaped agglomerated NFO NPs and EDAX confirms the presence of Ni, Fe and O elements and absence of other impurities. The concentric circles observed in SAED pattern confirms the high crystallinity nature and the estimated crystallite size matches well with that of the crystallite size calculated from Scherrer's equation. The direct energy band gap calculated using Tauc's relation is found to be 5.2 eV. Further, the X-ray/gamma ray shielding properties of NFO NPs in the energy range 0.081–1.332 MeV using NaI (Tl) detector and multi channel analyzer (MCA) were measured. The measured shielding parameters are compared with the theory. Above 356 keV energy of X-ray/gamma ray, the measured shielding parameters agrees well with the theory, whereas slight deviation is observed below 356 keV. This deviation is mainly due to the influence of atomic size of the target medium. Hence, we can conclude that an accurate theory is necessary to explain the interaction of X-ray/gamma with the nano size atoms. The photoluminescence emission spectra consists of peaks at 448, 540 and 628 nm. The CIE and CCT coordinates clearly confirms that the present nanophosphor might find applications in display/cool white light LEDs. Furthermore, antimicrobial activity of synthesized NFO NPs are also studied. Viability test was conducted on two food borne pathogens such as *Bacilluscereus* and *Pseudomonasaeruginosa*. The material showed fairly good antimicrobial activity compared to streptomycin which was used treat a number of bacterial infections. Thus NFO material may unfold new prospects in the fields like shielding of X-ray/gamma ray, display and biomedical applications.

Keywords:
X-ray diffraction, Humidity sensors, Saturation magnetization, Hysteresis, Anisotropy,

Publication Details:

Journal Name	Vol.	Month & Year	Page No.	Publisher	Scimago Ranking
Journal of Physics and Chemistry of Solids	159	Dec, 2021	NA	Elsevier	Q2