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BiFeO3-CoFe2O4-PbTiO3 Composites: Structural, Multiferroic and Optical Characteristics

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Abstract : Three phase magnetoelectric (ME) composites (1-x)(0.7BiFeO3-0.3CoFe2O4)-xPbTiO3 (or equivalently written as (1-x)(0.7BFO-0.3CFO)-xPT) with x variations 0, 0.30, 0.35, 0.40, 0.45 and 1.0 were synthesized using hybrid processing route. The effects of PT addition on structural, multiferroic and optical properties have been subsequently investigated. A detailed Rietveld refinement analysis of X-ray diffraction patterns has been performed, which confirms the presence of structural phases of individual constituents in the composites. Field emission scanning electron microscopy (FESEM) images are taken for microstructural analysis and grain size determination. Transmission electron microscopy (TEM) analysis of 0.3CFO-0.7BFO reveals the average particle size to be lying in the window of 8-10 nm. The temperature dependent dielectric constant at various frequencies (1 kHz, 10 kHz, 50 kHz, 100 kHz and 500 kHz) has been studied and the dielectric study reveals that the increase of dielectric constant and decrease of average dielectric loss of composites with incorporation of PT content. The room temperature ferromagnetic behavior of composites is confirmed through the observation of Magnetization vs. Magnetic field (M-H) hysteresis loops. The variation of magnetization with temperature indicates the presence of spin glass behavior in composites. Magnetoelectric coupling is evidenced in the composites through the observation of the dependence of the dielectric constant on the magnetic field, and magnetodielectric response of 2.05 % is observed for 45 mol% addition of PT content. The fractional change of magnetic field induced dielectric constant can also be expressed as $\Delta\varepsilon_r \sim \gamma M^2$ and the value of γ is found to be ~1.08×10-2 (emu/g)-2 for composite with x=0.40. Fourier transformed infrared (FTIR) spectroscopy of samples is carried out to analyze various bonds formation in the composites.

Keywords : composite, X-ray diffraction, dielectric properties, optical properties
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