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Investigation of magnetoelectric response in lead-free $K_{0.5}Na_{0.5}NbO_3$–$SrFe_{12}O_{19}$ novel composite system

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Abstract

Lead free multiferroic composites have drawn the interest of research fraternity due to their potential applications in memory devices, magnetic probes, transducers, phase shifters etc. In this work, lead free KNN–SFO composites viz: (1-x) $K_{0.5}Na_{0.5}NbO_3$–(x) $SrFe_{12}O_{19}$ with x = 30, 40 and 50 wt.% were prepared via the solid-state reaction route. XRD patterns confirmed the formation of diphase composites with KNN and SFO having perovskite monoclinic and hexagonal structure respectively. Scanning Electron Microscope (SEM) and Energy Dispersive X-ray Spectroscopy (EDAX) were employed to study the morphological and compositional analysis. The electrical properties of the samples were studied in the frequency range of 100 Hz to 1 MHz at temperatures of 50°C, 100°C, 150°C, and 200°C. Dielectric measurements showed a typical frequency dispersion behaviour with the value of dielectric constant increases with the addition of SFO. The AC conductivity analysis of the samples were found to follow Jonscher's Power Law (JPL). Nyquist plot analysis confirmed the evidence of thermally activated semi-conducting behaviour. Room temperature magnetisation is found to increase; however, polarisation decreases with ferrite concentration. The composite with 30 wt.% SFO has shown maximum room temperature magnetoelectric (ME) coefficient of $\alpha_{ME} \approx 47$ mV·cm^{-1}·Oe^{-1}. This features in KNN–SFO composites underscores their potential for multifunctional device applications.

Keywords: KNN-SFO, XRD, dielectric, conductivity, magnetoelectric, Nyquist plot

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