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Structural, magnetic, dielectric, vibrational and optical properties of Zr substituted $Bi_{0.90}Gd_{0.10}FeO_3$ multiferroics

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Abstract

We report the evolution of structural, physical and magnetic properties of Zr doped $Bi_{0.90}Gd_{0.10}Fe_{1-x}Zr_xO_3$, (x=0.0, 0.03, 0.07 and 0.10) nanoparticles prepared by tartaric acid based sol gel route. Rietveld refinement of X-ray diffraction patterns shows the coexistence of rhombohedral (*R3c*) and orthorhombic (*Pbnm*) phase in all the samples. Morphological studies confirm the compositional driven reduction in particle size with increasing Zr concentration due to filling of oxygen vacancies and hence lower grain growth. The magnetic measurements at room temperature indicate that Zr substitution induces weak ferromagnetism and discerns large and non-zero remanant magnetization. Both dielectric constant (ε') and loss factor (tan δ) of these samples decrease with increasing Zr concentration, indicating improved dielectric properties due to the suppression of oxygen vacancies in co-doped compositions. An anomaly in dielectric constant and dielectric loss is observed in the vicinity of antiferromagnetic Neel temperature. Fourier transform infrared spectra show that the Fe–O bond length decreases with increasing Zr concentration which is consistent with the Rietveld analysis. The UV-visible diffuse reflectance spectroscopy measurements show a significant reduction in the optical band gap value from 2.35 eV to 2.05 eV for $Bi_{0.90}Gd_{0.10}Fe_{1-x}Zr_xO_3$ samples.