Effects of HoMnO3 nanoparticles addition on microstructural, superconducting and dielectric properties of YBa2Cu3O7–δ

ABSTRACT

(YBa2Cu3O7–δ)1-x(HoMnO3)x ($x = 0.0$, 0.0025, 0.005, 0.01, 0.03 and 0.05) ceramics were fabricated by introducing co-precipitation synthesized HoMnO3 (HMO) nanoparticles during solid state reaction process of YBa2Cu3O7–δ (Y-123) superconductors. (Y-123)1-x(HMO)x samples were characterized using X-ray diffraction (XRD), field emission scanning electron microscope (FESEM) attached with energy Dispersive X-ray spectrometer (EDX), four-point probe measurement, AC susceptometer and impedance analyzer. Majority of XRD patterns were indexed to orthorhombic Y-123 phase. Besides, YBaMn2O5 (1.5–3.6%) and YBaMn2O6 (2.4–7.4%) phases were detected. FESEM images and EDX analysis showed the presence of agglomerated particulates related to Mn and Ho based phases residing in between the Y-123 grains. The superconducting behavior was significantly enhanced at $x = 0.0025$ while there was no major depression noticed in critical temperature (Tc-R=0) as the addition increased till $x = 0.03$ (Tc-R=0 = 88 K). AC susceptibility curves of composites samples manifested sharp transitions for samples with $x = 0.0025$ and 0.005. Dielectric parameters $\varepsilon r'$ and $\varepsilon r''$ decreased as the frequency increased for all samples. The εr versus frequency measurements showed increment in $\varepsilon r'$ and $\varepsilon r''$ values for all added samples as compared to Y-123 sample. The highest values for $\varepsilon r'$ and $\varepsilon r''$ were obtained for sample $x = 0.05$ with the highest loss at lower frequency. The Nyquist plots of complex impedance were analyzed where two semi-arc circulars represent grain and grain boundary effect were deduced.

Keyword: Y-123; HoMnO3; Critical temperature; Solid state reaction; Co-precipitation; Impedance