Effect of NiO nanoparticle addition on the structural, microstructural, magnetic, electrical, and magneto-transport properties of $La_{0.67}Ca_{0.33}MnO_3$ nanocomposites

ABSTRACT

Incorporation of the secondary oxide phase into the manganite composite capable of enhancing low-field magnetoresistance (LFMR) for viability in high-performance spintronic applications. Polycrystalline $La_{0.67}Ca_{0.33}MnO_3$ (LCMO) was prepared via the sol–gel route in this study. The structural, microstructural, magnetic, electrical, and magneto-transport properties of (1−x) LCMO: x NiO, x = 0.00, 0.05, 0.10, 0.15 and 0.20 were investigated in detail. The X-ray diffraction (XRD) patterns showed the coexistence of LCMO and NiO in the composites. The microstructural analysis indicated the amount of NiO nanoparticles segregated at the grain boundaries or on the surface of LCMO grains increased with the increasing secondary phase content. LCMO and NiO still retained their individual magnetic phase as observed from AC susceptibility (ACS) measurement. This further confirmed that there is no interfacial diffusion reaction between these two compounds. The NiO nanoparticle acted as a barrier to charge transport and caused an increase in resistivity for composite samples. The residual resistivity due to the grain/domain boundary is responsible for the scattering mechanism in the metallic region as suggested by the theoretical model fitting, $\rho(T)=\rho_0+\rho_2T^2+\rho_{4.5}T^{4.5}$. The magnetoresistance values of LCMO and its composites were found to increase monotonically with the decrease in temperature. Hence, the LFMR was observed. Nonetheless, the slight reduction of LFMR in composites was attributed to the thick boundary layer created by NiO and impaired the spin polarised tunnelling process.

Keyword: Fitting; Grain boundary; LFMR; Sol–gel