Revival of ferromagnetic behavior in charge-ordered $Pr_{0.75}Na_{0.25}MnO_3$ manganite by ruthenium doping at Mn site and its MR effect

ABSTRACT

Ru doping in charge-ordered Pr0.75Na0.25Mn1-xRuxO3 (x = 0–0.1) manganites was studied to investigate its effect on structure, electrical transport, magnetic properties, and magnetotransport properties. DC electrical resistivity (ρ), magnetic susceptibility, and χ' measurements showed that sample x = 0 exhibits insulating behavior within the entire temperature range and antiferromagnetic (AFM) behavior below the charge-ordering (CO) transition temperature TCO of 221 K. Ru4+ substitution (x>0.01) suppressed the CO state, which resulted in the revival of paramagnetic to ferromagnetic (FM) transition at the Curie temperature Tc, increasing from 120 K (x = 0.01) to 193 K (x = 0.1). Deviation from the Curie–Weiss law above Tc in the 1/χ' versus T plot for x = 0.01 doped samples indicated the existence of Griffiths phase with Griffith temperature at 169 K. Electrical resistivity measurements showed that Ru4+ substitution increased the metallic-to-insulating transition temperature TMI from 144 K (x = 0.01) to 192 K (x = 0.05) due to enhanced double-exchange mechanism, but TMI decreased to 176 K (x = 0.1) probably due to the existence of AFM clusters within the FM domain. The present work also discussed the possible theoretical models at the resistivity curve of Pr0.75Na0.25Mn1-xRuxO3 (x = 0–0.1) for the entire temperature range.

Keyword: Ru doping; Charge ordering; Double-exchange mechanism; Jahn–Teller effect; Perovskite manganite