ABSTRACT

Exchange bias effect, magnetic entropy changes, Griffiths phase formation, magnetization behaviour, electronic- and magneto-transport properties of several Sm and La based perovskite manganites with the variation of grain/particle size down to the nanometric regime have been investigated. The systems are taken $Sm_{0.5}Ca_{0.5}MnO_3$, $Sm_{0.09}Ca_{0.91}MnO_3$, $Sm_{0.55}Sr_{0.45}MnO_3$, $Sm_{0.35}Sr_{0.15}Pr_{0.5}MnO_3$ and thin films of $Sm_{0.55}Sr_{0.45}MnO_3$, $La_{0.7}Ca_{0.3}MnO_3$ and $La_{0.67}Sr_{0.33}MnO_3$ manganites. Various physical properties have been investigated through x-ray diffraction, FESEM, HRTEM, XPS, magnetization, thermoelectric power and electrical resistivity measurements. The experimental investigations of the exchange bias effect have been made for $Sm_{0.5}Ca_{0.5}MnO_3$, $Sm_{0.09}Ca_{0.91}MnO_3$ and $Sm_{0.35}Sr_{0.15}Pr_{0.5}MnO_3$ systems. The exchange bias phenomenon of these manganites has been discussed based on macroscopic experimental tools such as magnetization and magnetoresistance measurements. A phenomenological antiferromagnetic-ferromagnetic core-shell type model has been proposed to describe the observed exchange bias effect. The influence of first and second order magnetic phase transition on the magnetocaloric effect and relative cooling power has been investigated in $Sm_{0.55}Sr_{0.45}MnO_3$, $Sm_{0.09}Ca_{0.91}MnO_3$, and $Sm_{0.35}Sr_{0.15}Pr_{0.5}MnO_3$ manganites. $Sm_{0.55}Sr_{0.45}MnO_3$ and $Sm_{0.35}Sr_{0.15}Pr_{0.5}MnO_3$ bulk manganites exhibit first order magnetic phase transition at low field and show large entropy change around T_C. $Sm_{0.09}Ca_{0.91}MnO_3$ nanomanganite with second order phase transition show large entropy change around T_C. The anomalous behavior of the low field temperature dependent inverse magnetic susceptibility above T_C proves the existence of Griffiths phase in $Sm_{0.5}Ca_{0.5}MnO_3$ and $Sm_{0.09}Ca_{0.91}MnO_3$ nanomanganites. We have also investigated the Griffiths phase phenomenon through non-linear ac magnetic susceptibility. We have observed the interesting effect of field-temperature history dependence of resistivity in $Sm_{0.55}Sr_{0.45}MnO_3$ and $Sm_{0.35}Sr_{0.15}Pr_{0.5}MnO_3$ bulk manganites. The electronic-transport property clearly confirms that the electronic phase of the sample gets arrested to a low resistive state during field cooling and cannot return to its original state even after the magnetic field is removed (kinetic arrest). The magnetoresistance of the sample also shows a strong irreversibility with respect to the sweeping of the magnetic field between its highest positive and negative values. To integrate manganites with Si for technological application we have fabricated a p-$La_{0.7}Ca_{0.3}MnO_3/SiO_2$/n-Si heterostructure to study the spin injection properties, the junction magnetoresistance (JMR) etc. To examine the effect of strain on magnetic phase transition and electrical resistivity behaviour, epitaxial $Sm_{0.55}Sr_{0.45}MnO_3$ thin films (thickness ~ 70 nm) have been grown on LAO (001), STO (001) and LSAT (001) single crystalline substrates by pulsed laser deposition technique. Effects of drastic change of 3-dimensional film lattice strain by substrate structural transformations on the electronic-transport and magnetic properties of tensile strained rf-sputtered 500 Å epitaxial $La_{0.67}Sr_{0.33}MnO_3$ thin films have been studied using (001) $BaTiO_3$ as the templates.

Keywords: Exchange bias, Magnetocaloric effect, Griffiths phase, Manganite, Nanoparticle, Spin glass, Ferromagnetism, Antiferromagnetism, Magnetoresistance, Kinetic arrest, Surface disorder, Magnetic relaxation, Biaxial strain, Jahn-Teller strain.