ABSTRACT

In the present work, we have studied the magnetic and magnetotransport properties of single crystalline and polycrystalline thin films of some half- and over-doped manganites, prepared by DC magnetron sputtering and nebulized spray pyrolysis techniques, respectively. In DC sputtered Nd$_{0.51}$Sr$_{0.49}$MnO$_3$ polycrystalline films on Y-stabilized ZrO$_2$ (YSZ), strong phase coexistence caused by the occurrence of ferromagnetic metal (FM-M), A-type antiferromagnetic (A-AF) and charge ordered insulating (COI) phases is observed. The electrical transport in these films is dominated by the grain boundary disorder and hence these films also show a large magnetoresistance at low as well as high magnetic fields. We have also carried out a comparative study of the out-of-plane anisotropic magnetoresistance (AMR) in single crystalline and polycrystalline thin films of this phase separated manganite. The in-plane and out-of-plane magnetotransport properties of these films differ significantly. A large low field AMR is observed in all the films. AMR shows a peak below the insulator–metal transition (IMT) temperature in the single crystalline films, while the same increases monotonically in the polycrystalline film. Relatively larger low field AMR ($\sim$ 20% at T = 78 K and H = 1.7 kOe) in the polycrystalline films suggests the dominance of the shape anisotropy. The occurrence of an anomalous weak FM behaviour and presence of metallic state has been shown in nanostructured thin films of Nd$_{1-x}$Sr$_x$MnO$_3$ (0.50 $\leq$ x $\leq$ 0.62). These films also show phase coexistence due to the competing FM, COI and A-AF clusters. This is also evidenced by the presence of a weak exchange bias effect in these films. The observed phenomena have been explained in terms of the combined effect of spin reorganization and enhanced orbital disordering in nano manganites. We have also studied the coexistence of magnetic-electronic phases and hence phase separation in polycrystalline thin films of La$_{1-x}$Ca$_x$MnO$_3$ (0.45 $\leq$ x $\leq$ 0.60). The observed phase separation is due to the presence of multiple magneto-electric phases. We have shown that even at x = 0.55 the fraction of the metallic clusters are dominant so much, so that an IMT is observed. We have also explored the thickness dependent properties of Nd$_{0.50}$Sr$_{0.50}$MnO$_3$ single crystalline thin films and have shown that at half doping the COI state is quite robust at lower film thickness (~10 nm). However, at much higher thickness (~300 nm) disordered induced zero field IMT is observed. The current works demonstrates that magnetic and magnetotransport properties of the same material could be drastically different in polycrystalline and single crystalline forms.