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Properties of mixed $\text{Pr}_{0.65}\text{Ca}_{0.35}\text{MnO}_3/\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3$ films

S. F. Li, 배혜련, 현영훈, 이영백, V. G. Prokhorov*
q-Psi & 한양대학교 물리학과, *Institute for Metal Physics, Kiev, Ukraine

A wide range of investigations of the perovskite manganese oxides have been accomplished not only because of their interesting fundamental science but because of the potential device applications such as magnetic-reading heads, field sensors and memories. These materials exhibit a paramagnetic-to-ferromagnetic transition upon cooling, which is accompanied by a sharp drop of resistivity. The colossal magnetoresistance (CMR) results from a rapid shift of the ferromagnetic transition temperature to a higher temperature range in the presence of an applied magnetic field. It is well known that the lattice strain has strong effect on the charge, spin, and orbital states in epitaxially-grown CMR films.

In this study, mixed $\text{Pr}_{0.65}\text{Ca}_{0.35}\text{MnO}_3/\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3$ films were prepared by pulsed-laser ablation on LaAlO_3 substrate using two different targets. Different substrate temperatures (T_{sub}) and annealing temperatures (T_{ann}) were adopted in order to study the effect of strain and microstructures on the physical properties of the films. The transport properties were measured in a temperature range from 5 to 300 K by employing a four-probe method. Temperature dependence of the magnetic properties was investigated by using VSM and SQUID magnetometers in the 5 - 300 K temperature range. It was found that the films deposited at 300°C did not exhibit CMR. However, after the film was annealed at 750°C, a magnetoresistance ratio of 1600% was achieved around 130 K under a magnetic field of 5 T. A great enhancement of the metal-insulator transition temperature from 130 K to 250 K was also observed by increasing the T_{sub} and T_{ann} to 740°C and 900°C, respectively. While the films deposited at 740°C contain two distinct structural phases, the annealing at 900°C leads to single structural phase. The mixed $\text{Pr}_{0.65}\text{Ca}_{0.35}\text{MnO}_3/\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3$ films showed a Curie temperature of 220 K which is lower than that of the $\text{La}_{0.7}\text{Sr}_{0.3}\text{MnO}_3$ film, but higher than the $\text{Pr}_{0.65}\text{Ca}_{0.35}\text{MnO}_3$ film.