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Low temperature magnetoresistance in $La_{1.32}Sr_{1.68}Mn_2O_7$ layered manganite under hydrostatic pressure

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Abstract – We have synthesized a bilayer manganite $La_{1.32}Sr_{1.68}Mn_2O_7$ by the standard solid-state reaction method. Low temperature magnetoresistance has been studied under pressure up to 25 kbar. We have observed a large negative magnetoresistance at the transition temperature, upon 5 T field. The increasing pressure reduces magnetoresistance ratio significantly. The reduction of magnetoresistance ratio is explained by the changes in the coupling between the ferromagnetic bilayers by pressure.

The bilayer manganites are manganese oxides with layered perovskite structure, where the Mn atom is surrounded by six oxygen ions and form MnO_6 octahedra. Since, bilayer manganite consists of the ferromagnetic metallic MnO_2 bilayers separated by nonmagnetic $(La,Sr)_2O_2$ insulating layer stacked along the c-axis, these are also recognized as an intrinsic ferromagnetic metal(FMM) – insulator (I) – FMM multilayered system. The $La_{1.32}Sr_{1.68}Mn_2O_7$ polycrystalline sample was prepared by standard high temperature solid-state reaction method. The room temperature powder XRD patterns were analyzed with Rietveld method using GSAS program and plotted in figure1. The compound was found to be monophasic and the calculated unit cell parameters a = 3.8661 Å and c = 20.1759 Å are well agreed with the reported earlier [1]. The magnetic phases have been verified by temperature dependence of hysteresis curves, result a ferromagnetic state at 5 K and a paramagnetic state at room temperature.

The electrical resistivity was measured by the four probe method. We have used a self clamp type hydrostatic pressure cell, made of non magnetic Be-Cu alloy to measure the electrical resistance under magnetic field up to 5 T. The pure Pb and Manganin were used as pressure monometers at low temperature and at room temperature, respectively. In Fig.2 temperature dependence of the resistivity with the external field is shown, which results a metal to insulator transition (T_{MI}) at 118K. On the application of field, we have observed a large negative magnetoresistance (MR) of about 300 % at T_{MI}. The observed MR at T_{MI} is much larger than observed at 4.2 K. Figure 3 shows the field dependence of resistivity at different pressures. The MR ratio at ambient pressure is about 128 %, decreases to 95 % when the pressure reaches to 25 kbar. The increasing pressure reduces the MRR significantly by about 33% for 25 kbar.

Since, the bilayer manganite consists of FMM-I-FMM junction, the large negative MR is explained in terms of the inter bilayer tunneling magnetoresistance (TMR). This TMR is depending on the spin polarization of conduction electrons in each FM layer [2]. The structural studies on manganites reported that the applied pressure changes the Mn-O bond length and Mn-O bond angle significantly, which will modify the spin ordering in the MnO_2 layers [3]. Hence, the pressure tilted the MnO_6 octahedra that lead to a change in the MnO_2 coupling. Due to the pressure induced changes in the MnO_2 layers, the MR ratio is decreased with increasing pressure. From our experimental results, we conclude that the hydrostatic pressure weakens the inter bilayer coupling and reduces the TMR effect in $La_{1.32}Sr_{1.68}Mn_2O_7$ layered manganite.

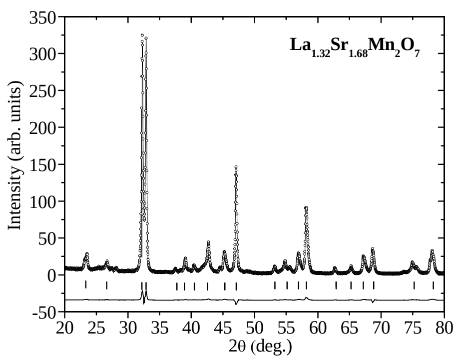

Figure 1: Room temperature powder XRD pattern of $La_{1.32}Sr_{1.68}Mn_2O_7$ and processed by the Rietveld method

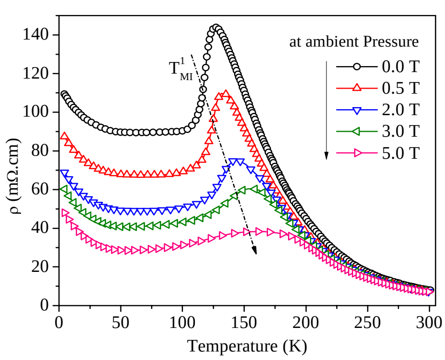

Figure 2: Temperature dependence of the resistivity curves at different magnetic field

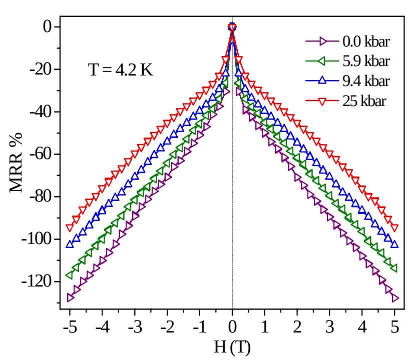

Figure 3: Temperature dependence of the magnetoresistance ratio under hydrostatic pressure at 4.2 K

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