UGC Minor Research Project

Preparation of Rare Earth Based Magneto-Resistive Materials

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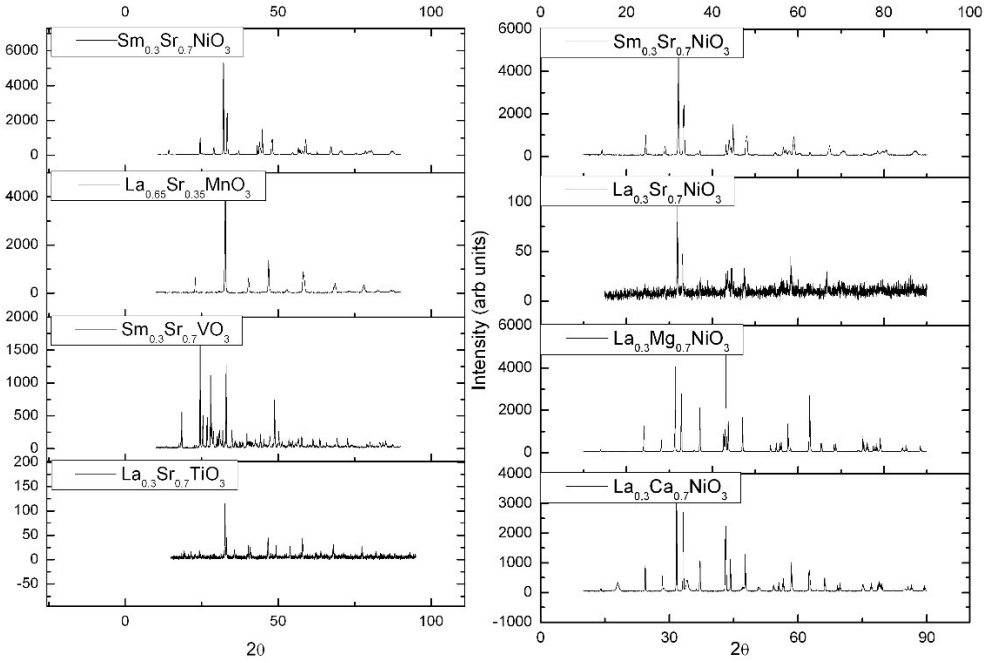
Status: Completed

Executive Summary of the Findings

28 samples which bear the formula $Ln_{(1-x)}\ A_xRO_3$, (Ln – Lanthanides, A - Alkaline earth Metals, R - 3d Transition Metals and x - Stoichiometeric composition of the compound) were prepared and 19 samples are found crystallizing in well-defined crystal systems. Single phased compounds are obtained only for rare-earth doped manganites and nickelates. The standard preparation procedure for manganites was refined from 1400 ^{O}C and 24 hrs to 1150 ^{O}C and 20 hrs steps. The sintering temperature and time was reduced from 1700 ^{O}C to 1300 ^{O}C and 10 hrs. Conventional solid state reaction technique is not applicable for the preparation of Vandates or Titanates. They could be prepared only by using constraints in physical conditions like pressure, oxidation atmosphere etc in the solid state reaction method.



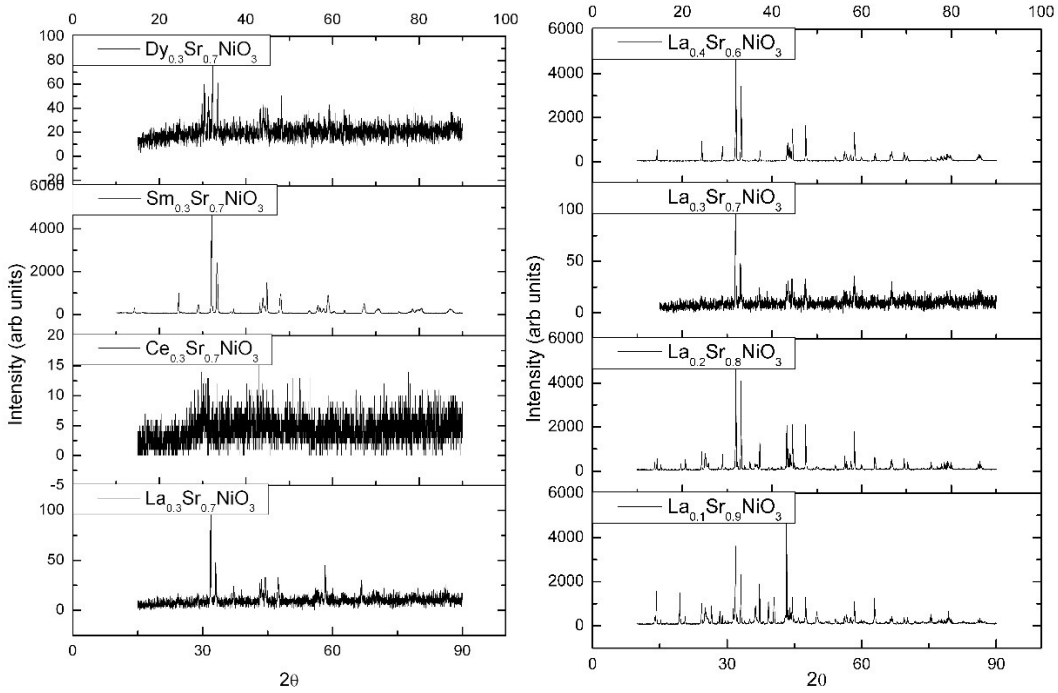


Fig.1: Rietveld XRD refined patterns of selected samples

From the conductivity studies of SmSrNiO3 for four stoichiometric ratios, it was observed that both insulating and metallic behavior were present in the prepared samples except in $Sm_{0.4}Sr_{0.6}NiO_3$. All these samples show insulating behavior at high temperature and metallic behaviour at high temperatures.

Magnetization studies of $Sm_xSr_{1-x}NiO_3$ with temperature showed that the samples exhibit paramagnetic behavior all through the temperature. Any predominant magnetic transition or ordering is absent in the prepared samples. Magnetization in the samples is highly influenced by the anti-ferromagnetic behavior of NiO layers which hinder the exchange interaction between the neighboring atoms. This is also well evident from the magnetoresistance property of the samples.

Magnetization studies with temperature for $La_{0.67-x}Sm_xCa_{0.33}Mn_{0.95}Ni_{0.05}O_3$ with x = 0 and 0.1 revealed that magnetization is much higher than rare-earth nickelates which is due to the presence of Jahn-Teller effect in the material which enhances magnetic ordering of the material. The transition temperature of the $La_{0.67}Ca_{0.33}Mn_{0.95}Ni_{0.05}O_3$ is much smaller than $La_{0.67}Ca_{0.33}MnO_3$ which suggests that the anti-ferromagnetic ordering of Ni hinders the ferromagnetic ordering there by decreasing the transition temperature.

MR values of three manganate samples sintered at different temperatures were calculated. The change in MR with change in temperature for the samples are evaluated. The study showed that

MR values increases slightly with increasing sintering temperature at the metal insulator transition temperature

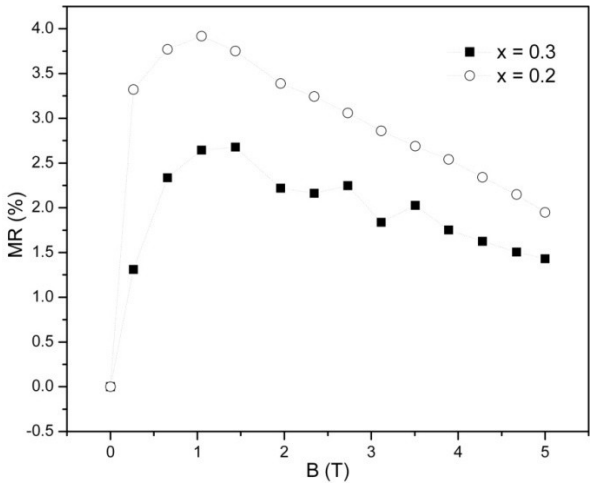


Fig. 2: The variation of magnetic resistance on the applied magnetic field at a temperature of 5 K.

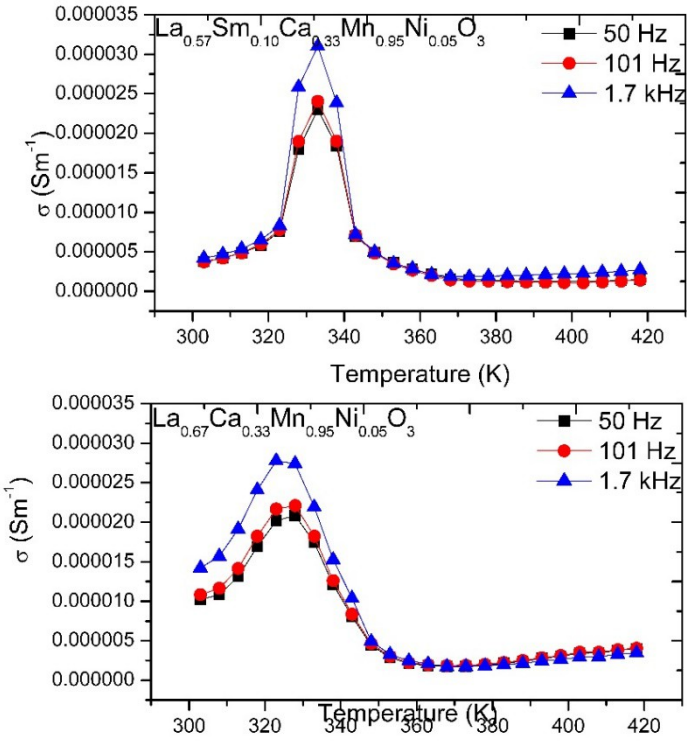


Fig. 3: The variation of electrical conductivity with temperature for $La_{0.67-x}Sm_xCa_{0.33}Mn_{0.95}Ni_{0.05}O_3$ with x = 0 and 0.1.

Fig. 3 shows the variation of conductivity with temperature for $La_{0.67-x}Sm_xCa_{0.33}Mn_{0.95}Ni_{0.05}O_3$ with x = 0 and 0.1. It was observed that as the temperature increase the behavior of conduction changes and shows metal-insulator transitions. The temperature corresponding to metal-insulator transition changes with addition of Sm from 323 K to 333K. Thus the metal-insulator transition temperature can be tuned with rare-earth substitution.

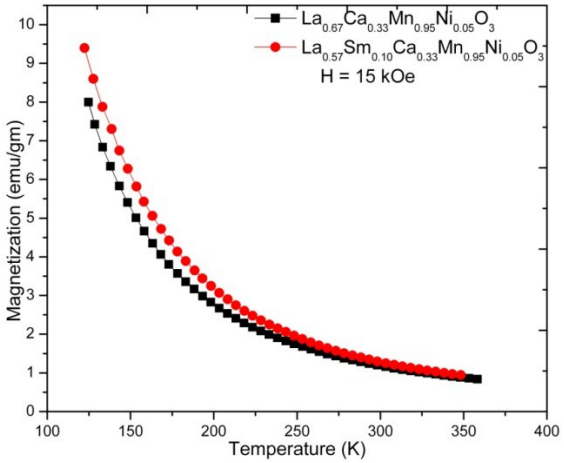


Fig. 4: Variation of Magnetization with temperature for $La_{0.67-x}Sm_xCa_{0.33}Mn_{0.95}Ni_{0.05}O_3$ with x = 0 and 0.1 at a magnetic field of 15 kOe.

The variation of Magnetization with temperature for $La_{0.67-x}Sm_xCa_{0.33}Mn_{0.95}Ni_{0.05}O_3$ with x = 0 and 0.1 is shown in Fig. 4. It is observed that magnetization is much higher than rare-earth nickelates which is due to the presence of Jahn-Teller effect in the material which enhances magnetic ordering of the material. The transition temperature of the $La_{0.67}Ca_{0.33}Mn_{0.95}Ni_{0.05}O_3$ is much smaller than $La_{0.67}Ca_{0.33}MnO_3$ which suggests that the anti-ferromagnetic ordering of Ni hinders the ferromagnetic ordering there by decreasing the transition temperature.

MR values of three manganate samples sintered at different temperatures were calculated. The change in MR with change in temperature for the samples are represented by Figs. 5- 7. The study showed that MR values increases slightly with increasing sintering temperature at the metal insulator transition temperature.

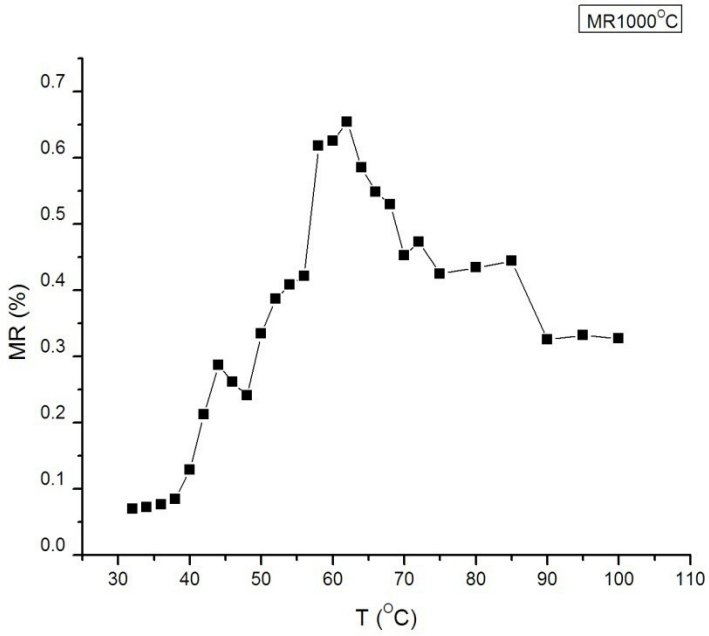


Fig. 5: MR variation with temperature for $La_{0.67-x}Sm_xCa_{0.33}Mn_{0.95}Ni_{0.05}O_3$ sintered at 1000oC.

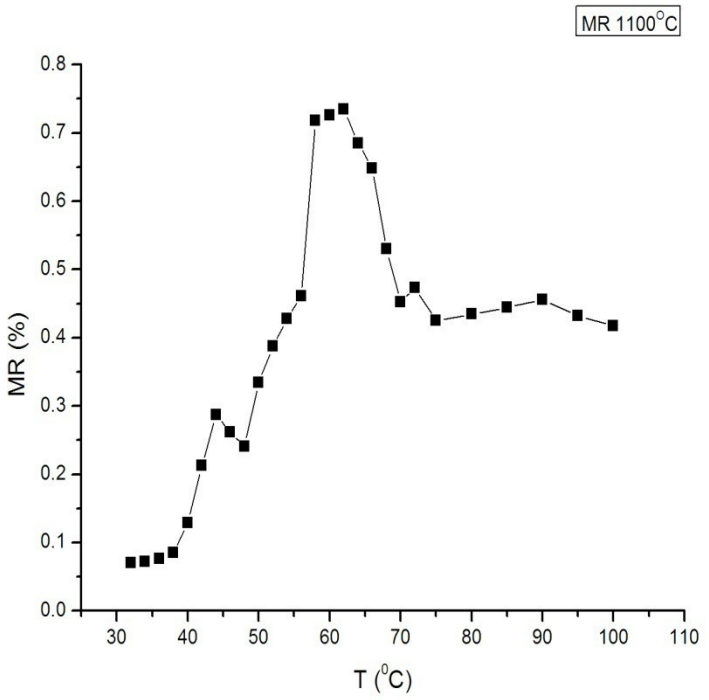


Fig. 6: MR variation with temperature for $La_{0.67-x}Sm_xCa_{0.33}Mn_{0.95}Ni_{0.05}O_3$ sintered at 1100oC.

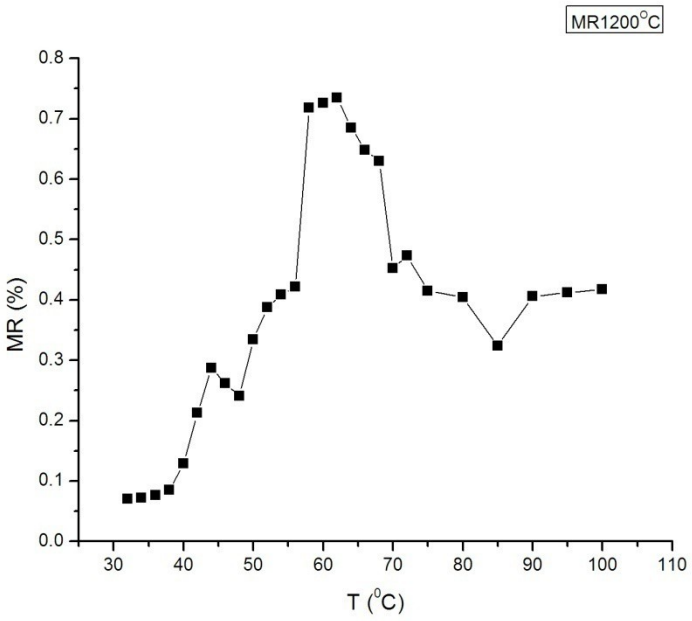


Fig. 7: MR variation with temperature for $La_{0.67-x}Sm_xCa_{0.33}Mn_{0.95}Ni_{0.05}O_3$ sintered at 1200oC.

The study showed that increase in sintering temperature leads to an increase in MR value around metal- insulator transition temperature.