

## X-ray absorption fine structure studies on $\text{La}_{1-x}\text{Sr}_x\text{CoO}_3$

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### Introduction

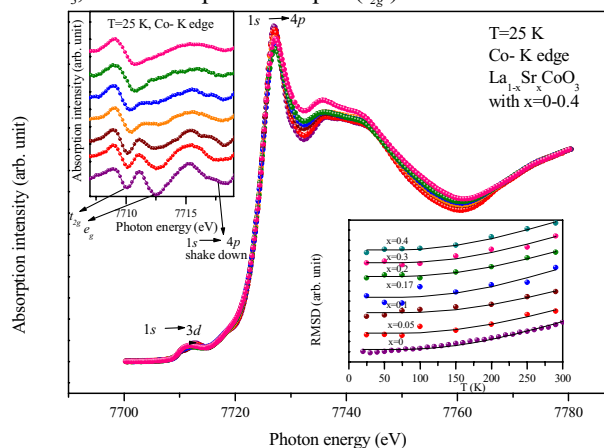
Metal insulator transitions (MIT) in transition metal oxides is a widely studied problem in condensed matter physics, but is still not completely understood. It is not surprising that when we dope charge carriers into a system, it undergoes a transition from an insulating to a metallic state, for example as exhibited by  $\text{La}_{1-x}\text{Sr}_x\text{CoO}_3$  [1] and  $\text{La}_{1-x}\text{Sr}_x\text{TiO}_3$  [2]. But the extent of doping required to bring about MIT is different for different systems. Also it is surprising to note that certain family of compounds like  $\text{La}_{1-x}\text{Sr}_x\text{FeO}_3$  [3] and  $\text{La}_{1-x}\text{Sr}_x\text{CrO}_3$  [4] remain insulating for all values of  $x$ . To understand the role of local distortions in bringing out such differences, we have proposed to perform x-ray absorption fine structure studies on some representative samples for different concentrations and different temperatures. Here we have taken  $\text{LaCoO}_3$  which is a nonmagnetic insulator. On substitution of  $\text{La}^{3+}$  by  $\text{Sr}^{2+}$ , the system undergoes a transition to a metallic state at  $x \sim 0.15$  [1].

### Experiment

Polycrystalline samples of  $\text{La}_{1-x}\text{Sr}_x\text{CoO}_3$  with  $x = 0, 0.05, 0.1, 0.17, 0.2, 0.3$  and  $0.4$  were prepared by solid state synthesis using the starting materials  $\text{La}_2\text{O}_3$ ,  $\text{SrCO}_3$  and  $\text{Co}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$ . X-ray absorption measurements were carried out at the beam line BL-10B and BL-9A to cover the Co K, Sr K and La  $L_3$  absorption edges. Experiments were performed at temperatures ranging from 25 K to 300 K.

### Results and discussion

Figure 1 shows the Co K-edge XANES spectra of  $\text{La}_{1-x}\text{Sr}_x\text{CoO}_3$  collected at 25 K, exhibiting no drastic change with hole doping. Thus, the Co valency remains essentially the same across the series. Thus this system belongs to the charge-transfer insulator regime. The  $t_{2g}$  and  $e_g$  features and the  $1s$  to  $4p$  shake down processes are marked in the figure. These clearly show that  $\text{Co}^{3+}$  in  $\text{LaCoO}_3$  is not in a pure low spin ( $t_{2g}^6$ ) state.



Preliminary analysis of the Co K EXAFS region was carried out using the nearest neighbour shell. It is seen that the Co-O distance remains essentially the same within a range of  $0.005 \text{ \AA}$  even after hole doping the system. Inset of figure 1 shows the relative mean square displacement (RMSD) of bond lengths with respect to temperature for various compositions. In the figure, individual plots are shifted by 0.05 units for help of view. We observed that the RMSD increases initially with the Sr doping, but saturates after a critical composition.

Fitting the data using correlated Einstein model, Einstein frequency and relative static mean square displacement are extracted for each  $x$  value. It is observed that the Einstein frequency in the insulating region is higher than that in the metallic region. The static disorder increases steadily with Sr concentration in the insulating regime where as there is no change in the static disorder within the metallic phase.

### Conclusions

We probed the role of local distortions in bringing out metal insulator transitions in  $\text{La}_{1-x}\text{Sr}_x\text{CoO}_3$  system using x-ray absorption fine structure studies. Preliminary analysis shows that there is an increase in the static disorder in the insulating regime and after entering the metallic regime, it saturates which possibly bring out a strong influence in driving MIT in the system. Further investigations and thorough analysis is required to come to a conclusion.

### References

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