

Title: Impact of Gd-site Doping on Magnetic, Transport and Specific Heat Behavior of Multi-Ferroic Gd₂CuO₄

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Abstract: The magnetic properties of ceramic samples of Gd_{1.98}R_{0.02}CuO₄ R= Ca Sr Th were studied and compared with Gd₂CuO₄. The results showed weak ferromagnetic ordering in all samples. We observed two magnetic ordering temperatures in the heat capacity measurement a sharp peak at TN(Gd) 6.5 K that can be attributed to the Neel temperature of Gd³⁺ ions and the second transition temperature at about 20 K that suggested to the magnetic interactions of Gd-Cu. The third anomaly was seen at TN(Cu)=280 K in susceptibility measurements. Investigations indicated that 0.02% mole substitution for Gd was not much effective on the transition temperature of compounds although we observed significant change in the magnitude of heat Capacity susceptibility and magnetization of samples as well as their conductivities.

Impact of Gd-site doping on magnetic, transport and specific heat behavior of multiferroic Gd_2CuO_4

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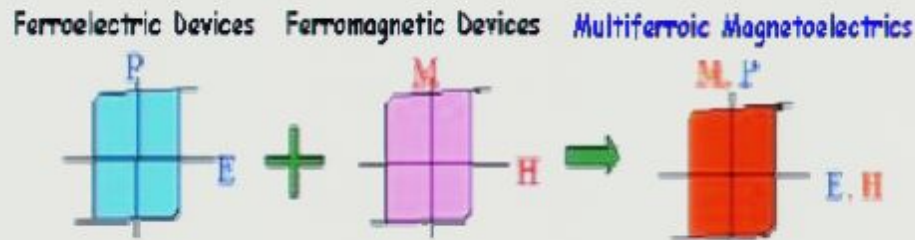
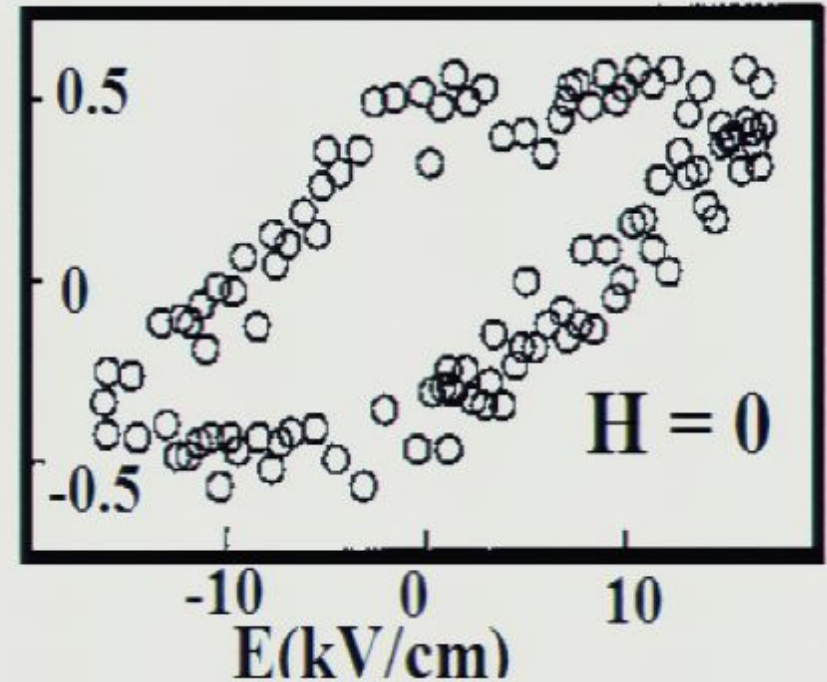
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Motivation

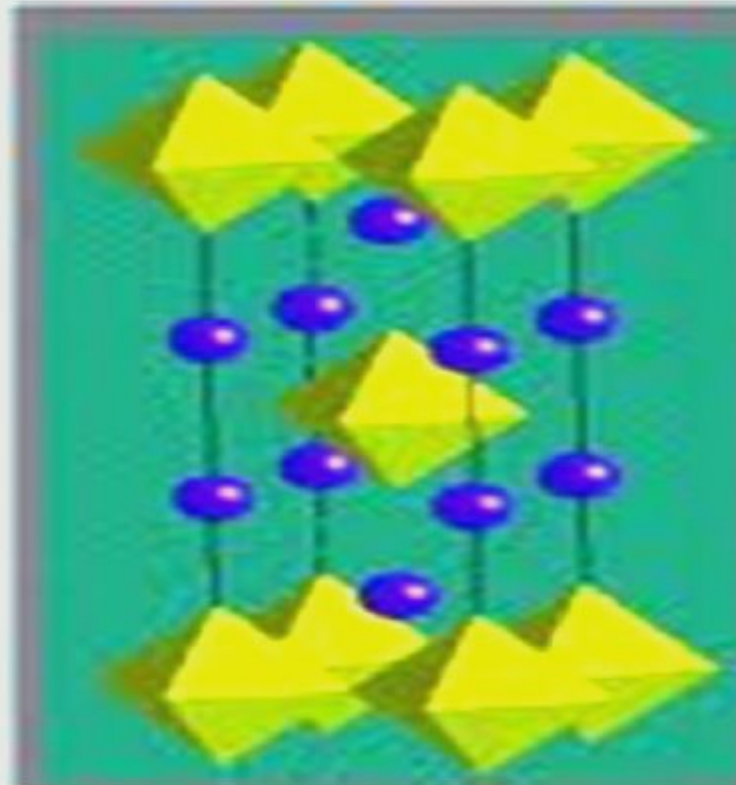
- Multiferroics are materials that have two or more ferroic properties namely, ferromagnetism, ferroelectricity and ferroelasticity in the same phase.
- Gd_2CuO_4 exhibits an antiferromagnetic property with two Neel temperatures at 7K and 280K.
- A large magneto-electric and magneto-elastic coupling below 50 K are recently demonstrated.

-6
M.10
(emu)



A. I. Smirnov, I. N. Khlyustikov, JETP Lett., 59, 11, 1994.
H. Martinho, A.A. Martina, Physica B, 305, 2001.
A. I. Smirnov, I. N. Khlyustikov, J. Magn. Magn. Mater., 157, 1996.

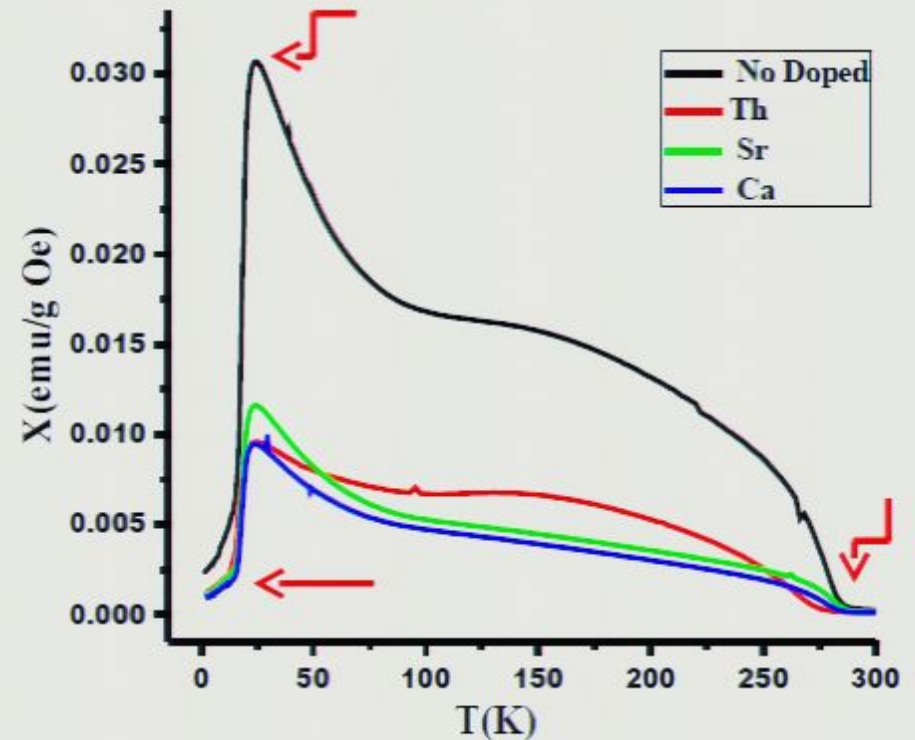
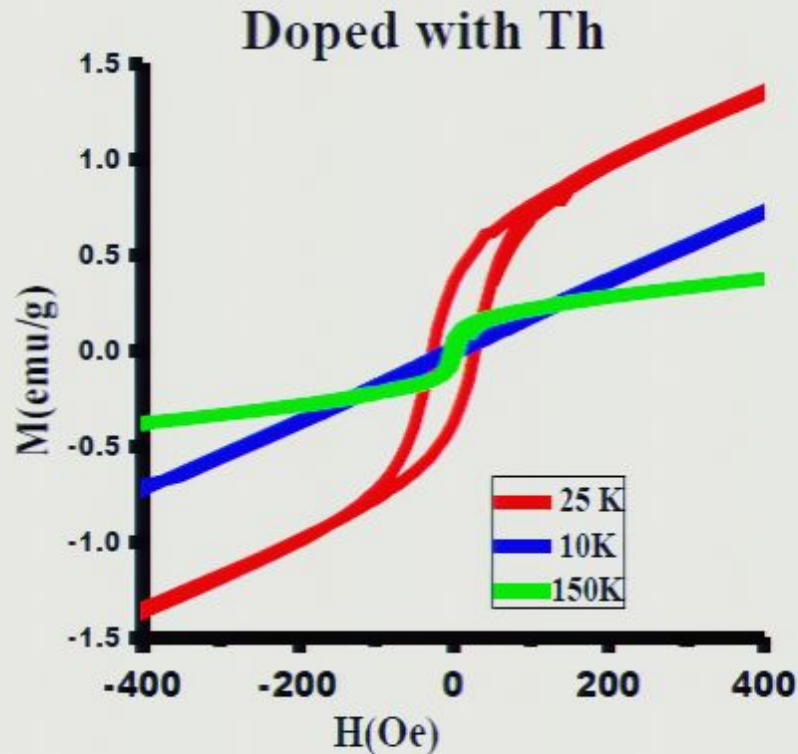
Tetragonal T' structure
 $a = 3.89 \text{ \AA}$
 $c = 11.86 \text{ \AA}$



Our project

We studied the magnetic, transport and specific heat properties of polycrystalline $\text{Gd}_{1.98}\text{R}_{0.02}\text{CuO}_4$ wherein $\text{R} = \text{Ca}, \text{Sr}, \text{or Th}$ by

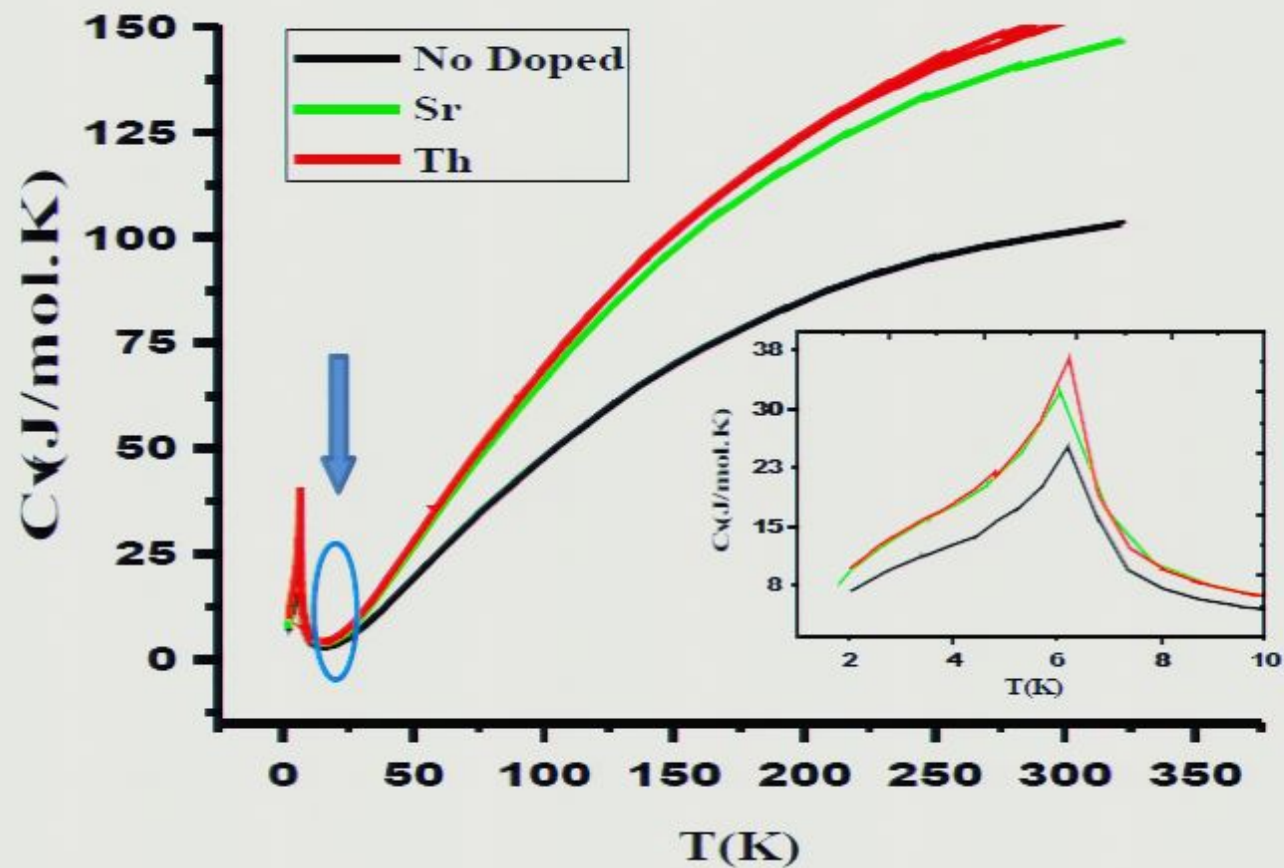
Magnetic Measurement



- Weak ferromagnetism at 25K
- $M_s = 1.34 \text{ emu/g}$ at $H = 400 \text{ Oe}$ & 25 K

- TN at 280K, 25K, and 7 K
- Doped samples exhibit a similar χ -T behavior
- Susceptibility decreased by doping
- Small shift in χ -T graph by doping Th

Heat Capacity Measurement

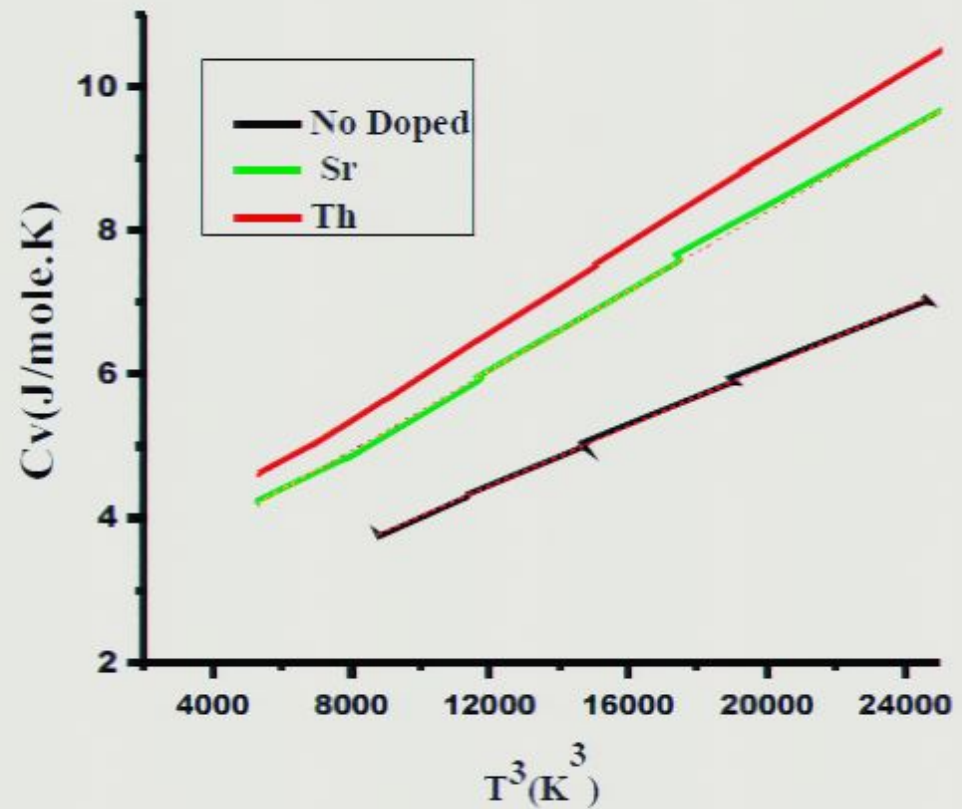


- No significant change in Neel Temperature at 7 K
- Enhanced phonon scattering by doping at high temperature

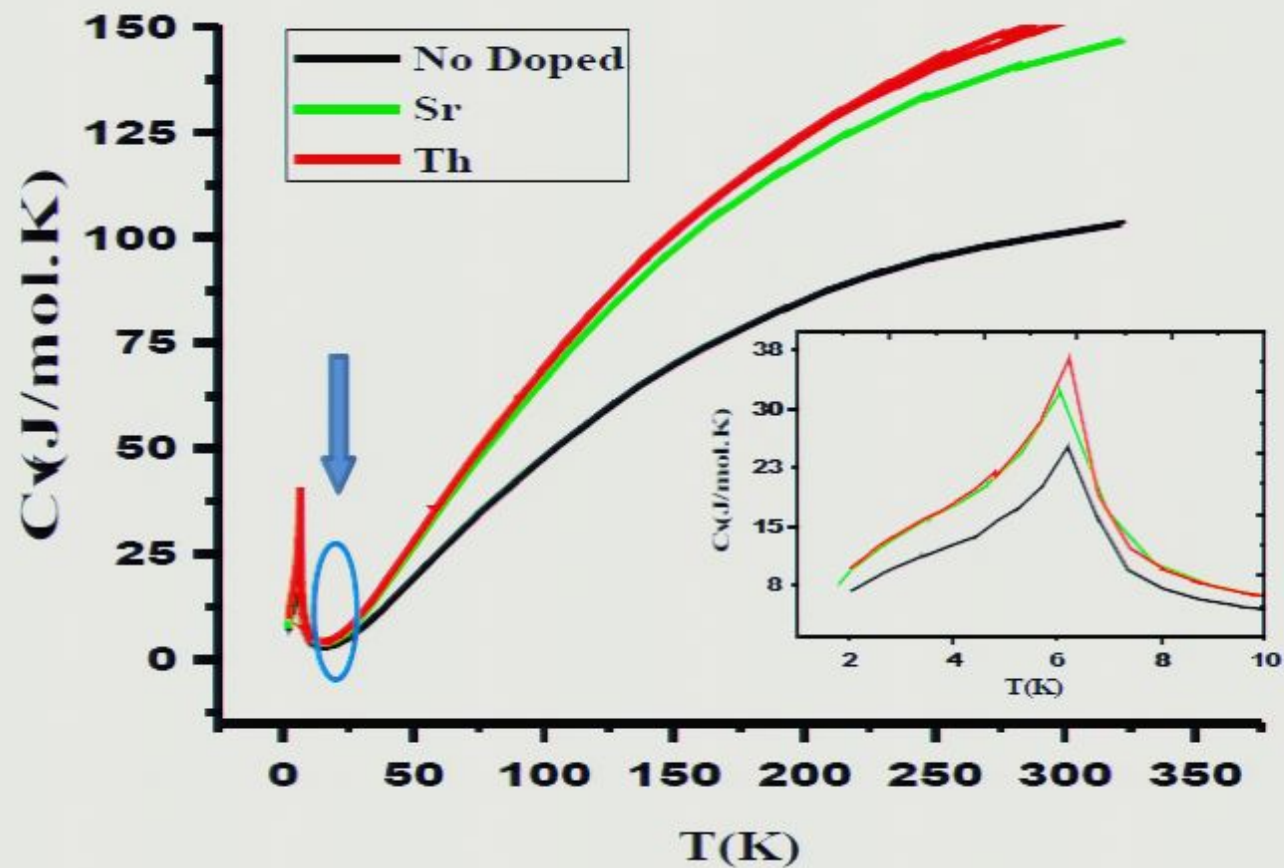
Heat Capacity Measurement

Sample	β (J/mole.K ⁴)
No Doped	2.07
Sr	2.77
Th	3.02

$$C_v = \beta T^3$$



Heat Capacity Measurement

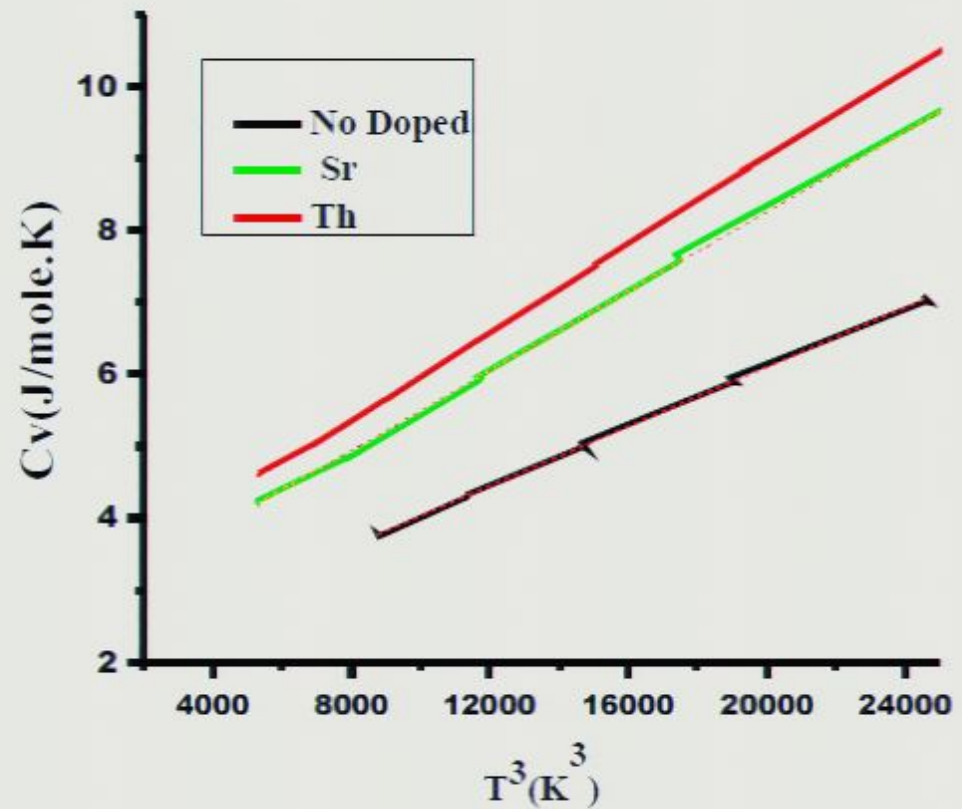


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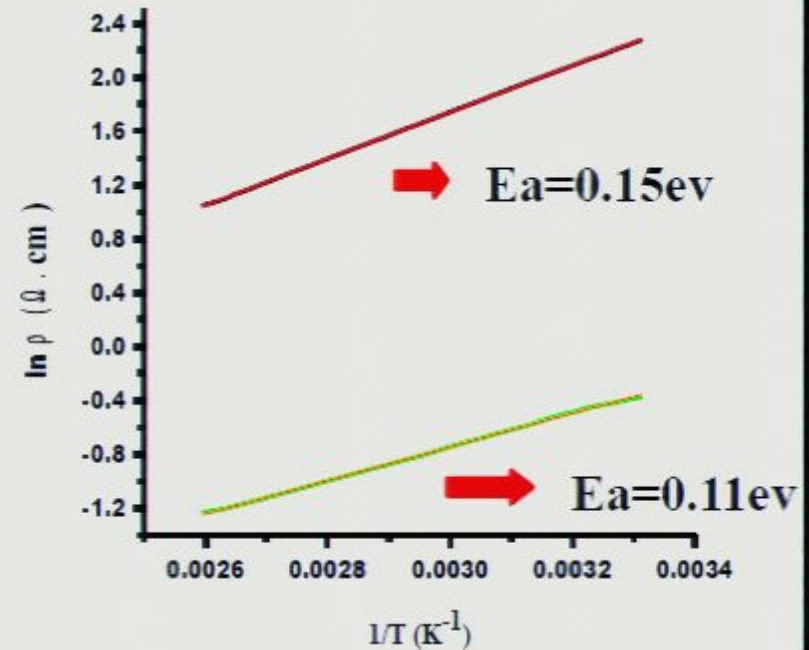
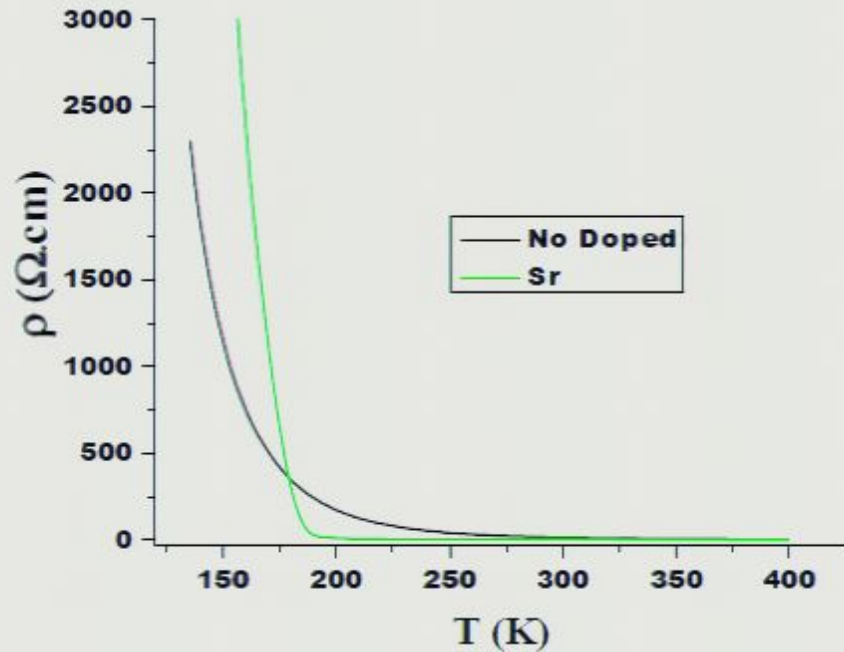
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Resistivity Measurement



- Insulator behavior
- Thermally activated conduction process $\rho = \rho_0 \exp (E_a/K_B T)$
- Decreasing conductivity below room temperature by doping Sr

Concluding remarks

- Superexchange interaction between CuO_2 planes \longrightarrow antiferromagnetic ordering in of 260-290K.
- Superexchange interaction of Gd^{3+} moments \longrightarrow antiferromagnetic ordering at ~ 7 K.
- The small distortion of the CuO_2 planes \longrightarrow weak ferromagnetism in 25K

Acknowledgement



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Thanks for your kind attention