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Transport and thermoelectric properties of multi-phase LSCuO samples grown by citrate sol-gel method

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Abstract – We have studied the thermoelectric properties of $La_{2-x}Sr_xCuO_{4-\delta}$ /La_2CuO_4 (x=0.05, 0.10 and 0.15) samples grown by using the citrate sol-gel method followed by high temperature sintering. Transport properties were studied from electrical resistivity $\rho(T)$ and Seebeck coefficient S(T) measurements in the temperature range between 100 and 290K. The magnitude of Seebeck coefficient S(T) and electrical resistivity $\rho(T)$ decreases with the Sr content from 230 μV/K to 20 μV/K and from 20 mΩ-cm to 1 mΩ-cm, respectively. The temperature behavior of S(T) and $\rho(T)$ was interpreted in terms of small-polaron hopping mechanism. From S(T) and $\rho(T)$ data it was possible to calculate the thermoelectric power factor PF, which reaches maximum values close to 18 $\mu W/K^2$-cm.

The discovery of large positive Seebeck coefficient in the metallic oxide Na_xCoO_2 has shown the great potenciality of oxides as thermoelectric materials for a wide range of temperature applications. Since then, numerous studies have been devoted to the research of thermoelectric properties of different families of oxides[1]. $La_{2-x}Sr_xCuO_{4-\delta}$ (LSCuO) compounds are members of perovskites-family, they adopt tetragonal symmetry and K_2NiF_4-type structure. The majority of its transport phenomena take place throughout the CuO_2 planes, which causes a marked asymmetry of their transport properties and a metallic or semiconducting behavior, which depend on the Sr content and critically on the oxygen stoichiometry.

Polycrystalline samples were prepared using citrate sol-gel method followed by high temperature sintering. The x-ray diffraction analysis shows the presence of tetragonal $La_{2-x}Sr_xCuO_{4-\delta}$ and orthorhombic La_2CuO_4 as majority phases. On the other hand, it was clearly seen that with increasing the Sr level the grain size decreases from 0.8 μm to 0.4 μm, which have important effects on the transport properties and specially on the heat flow across the samples.

So long as, the electrical resistivity shows a weak semiconducting dependence whose magnitude decreases with the Sr content, the Seebeck coefficient is positive over the measured temperature range, suggesting a hole-type conduction.

In the temperature behavior of Seebeck coefficient two contributions were identified; the first one is given by carrier diffusion, which according to the Mott-Jones model is proportional to temperature and the second one is proportional to 1/T, which in these correlated compounds is ascribed to hopping of small pollarons. Therefore, S(T) can be described by an expression of the form: $S(T)=\alpha T+\beta/T$.

The power factor for thermoelectric conversion was calculated for these perovskite-ceramics. Which reaches maximum values close to 18 $\mu V/K^2$-cm. These values can be compared with the state-of-the-art of conventional semiconducting thermoelectric materials. This behavior could be a result of the presence of semiconducting La_2CuO_4, which improve the thermoelectric properties of metallic $La_{2-x}Sr_xCuO_{4-\delta}$, becoming these compounds promising thermoelectric material for low temperature thermoelectric applications.

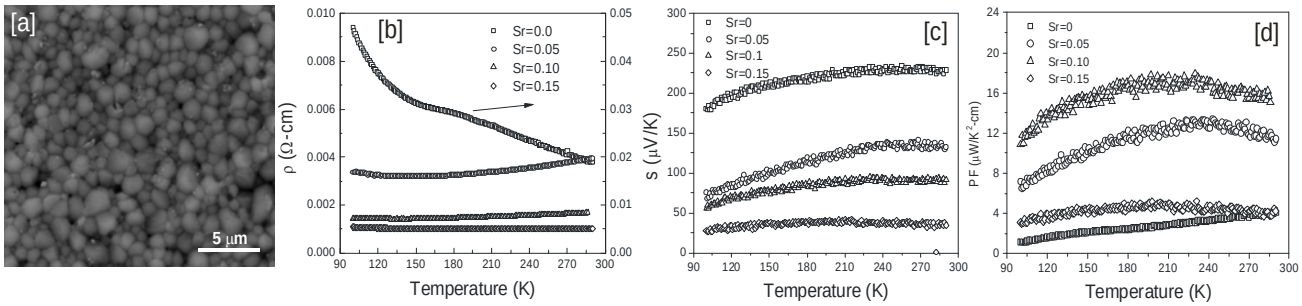

Figure 1. Morphological structure, electrical resistivity, Seebeck coefficient and thermoelectric power factor of LSCuO/LCuO samples grown by citrate sol-gel method followed by sintering processes.

References

[1] I. Terasaki, Y. Sasago and K. Uchinokura, *Phys. Rev.B* ,**56**,12684-12689(1997); Y. Yakabe, K. Kikuchi, I. Terasaki, Y. Sasago and K. Uchinokura,*Proc. 16th Int. Conf. on Thermoelectrics*, 523-527(1997).