Dependence of Activation Energy on Temperature and Structure in Lanthanum Gallates

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The parent phase of the Lanthanum Gallate series of electrolytes, LaGaO3, is orthorhombic at room temperature and rhombohedral between 250-1000°C[1-3].

Our High Resolution Neutron Powder studies on the doped phase, $La_{0.9}Sr_{0.1}Ga_{0.8}Mg_{0.2}O_3$, show significant structural differences from the parent phase that have direct bearing on the ionic conduction process, which can easily be understood in terms of the degree of tilting of the GaO_6 octahdra **Figure1**.

The monoclinic form at room temperature has a higher degree of distortion associated with the octahedra and undergoes two phase transitions at elevated temperatures that relate to the change in activation energy for the ionic conduction obtained from AC Impedance Spectroscopy data **Figure2**.

In particular the gradual alignment of the octahedra above 750°C, as the cell heads towards cubic symmetry, produces a slow temperature dependent decrease in Ea for ionic conduction as the constriction caused by tilting of the GaO_6 is reduced, thereby opening the path of migration for the oxide ion.

AC impedance studies of other doped Lanthanum Gallates reveal a similar activation energy dependence for the Barium doped analogue at high temperature, while the low temperature transition from electronic to dominant ionic conduction process in the Cobalt doped sample has also been extracted **Figure3**.

References:

1. T. Moeller and G.L. King, *J. Am. Chem. Soc.* **75**, 6060, 1953.
2. M. Sundberg, P-E. Werner, M. Westdahl, and K. Mazur, *Mater. Sci. For*. **166**, 795 (1994)
3. W. Marti, P. Fischer, F. Altorfer, H.J. Scheel and M. Tadin, *J. Phys. Condens. Matter* **6**,127 (1994).

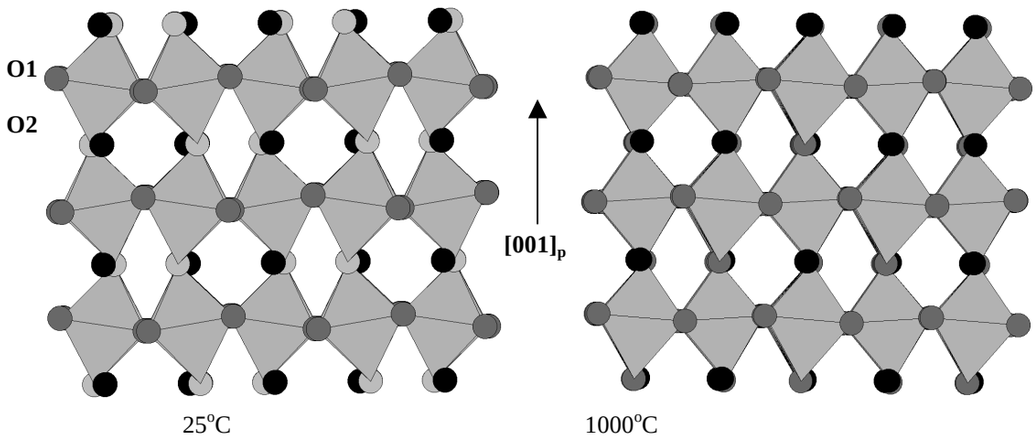

Figure 1 Views down $[110]_p$, La atoms in black, O atoms and MO_6 octahedra shown.

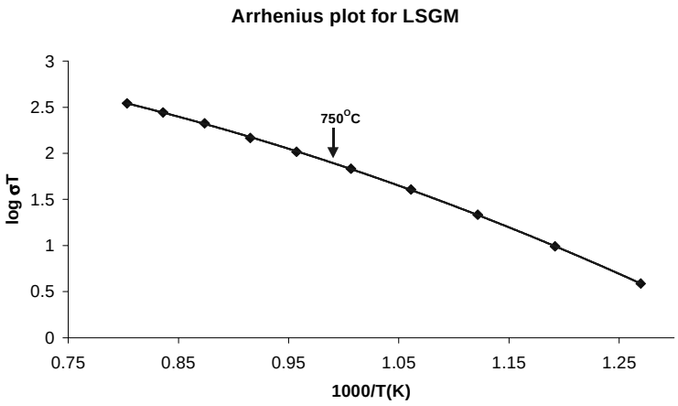

Figure 2 Arrhenius plot for $La_{0.9}Sr_{0.1}Ga_{0.8}Mg_{0.2}O_3$

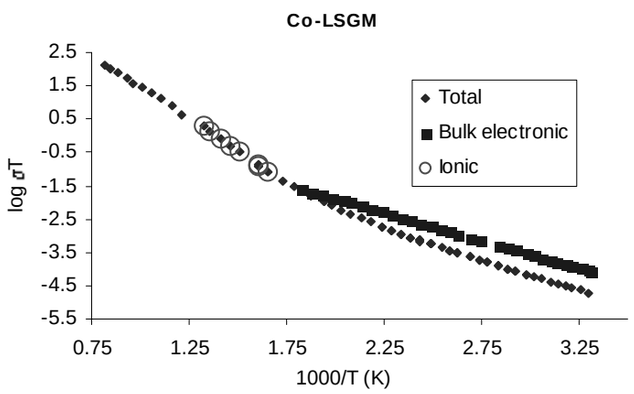

Figure 3 Arrhenius plot for $La_{0.8}Sr_{0.2}Ga_{0.8}Mg_{0.115}Co_{0.085}O_3$