Grain growth and impedance spectroscopy of $Ce_{0.9}Gd_{0.1}O_{2-\delta}$ solid electrolyte

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Abstract – The solid electrolyte $Ce_{0.9}Gd_{0.1}O_{2-\delta}$ prepared by chemical route was sintered at several temperature and time to study the densification and the kinetics of grain growth in this material. Impedance spectroscopy measurements were carried out in sintered specimens revealing the role of the sintering profile on grain and grain boundary conductivities.

Oxygen-ion conductors are a class of engineering ceramics with technological applications in several areas including gas sensors, oxygen pumps, oxygen semipermeable membranes and fuel cells for environmentally clean energy production[1,2]. To date, the most studied and developed oxygen-ion conductors for these applications are based on zirconia and ceria solid electrolytes. In this context, the electrical conductivity of these materials is of primary importance. In this study the densification and grain growth phenomena were focused with emphasis on the relationship between the microstructure of sintered compacts and the electrical conductivity.

Nanosized powders of $Ce_{0.9}Gd_{0.1}O_{2-\delta}$ were synthesized by the coprecipitation method[3,4]. Cylindrical pellets were prepared by uniaxial pressing. The sintering of green compacts was carried out in air with heating and cooling rates of 8 and 10 $^{o}C.min^{-1}$, respectively, at several temperature and time.

Fig. 1 shows the grain growth behavior with increasing soaking time. The best fitting of experimental data resulted in an exponent m = 3, which means that the mechanism operating should be either boundary control by impurity drag or pore drag control.

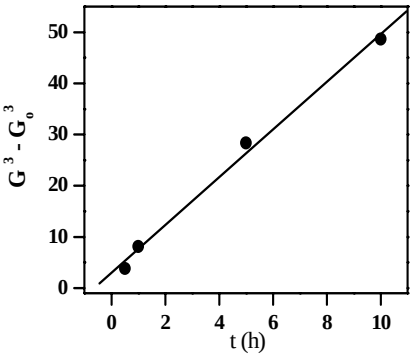

Fig. 1. Grain growth kinetics of GDC sintered pellets.

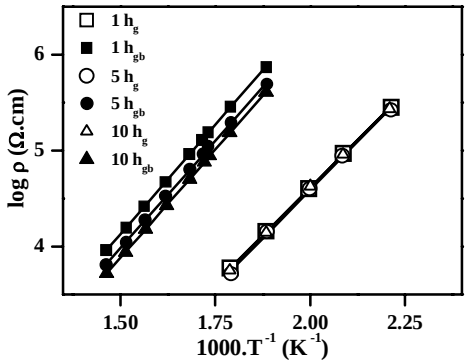

Fig. 2. Arrhenius plots of grain (open symbols) and grain boundary (full symbols) resistivity.

Fig. 2 shows the Arrhenius plots of grain and grain boundary resistivities. As expected, the grain resistivity is independent on the grain size. In contrast, the grain boundary resistivity decreases with increasing of the soaking time, though this effect is more significant for pellets sintered for 1 h and 5 h. Nevertheless the grain growth kinetics is accelerated for higher soaking times; its effect on the electrolyte resistivity is negligible.

References

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