11th International Conference on Advanced Materials

Rio de Janeiro Brazil September 20 - 25

ICAM2009

Low frequency dispersion in ionic conduction of (1-x)(NaI-4AgI)-xAl_2O_3

L. A. Rodriguez -G(1)*, W. O. Bucheli(2), H. Correa(3), J. E. Diosa(1) and R. A. Vargas(1)

(1) Departamento de Física, Universidad del Valle, A.A. 25360, Cali, Colombia, e-mail: luisalfredo85@gmail.com
(2) Instituto de Ciencia de Materiales de Madrid, CSIC, Cantoblanco, 28049 Madrid (Spain)
(3) Laboratorio de Optoelectrónica, Universidad del Quindío, Armenia, Colombia
* Corresponding author.

Abstract – We investigate the temperature dependence of the long range ionic correlation in the highly disordered structure of the of the (1-x)(NaI-4AgI)-x(Al_2O_3). (x = 0.1, 0.2 and 0.3) composites by admittance measurements in the audio frequency range. A non-Arrhenius behavior is observed in the temperature (T) dependence of the real part of the conductivity, σ', that can be well fitted to an exponential-type expression, where the fitting parameters depend on the alumina content and the frequency response behavior of conductivity in the various dispersive regions with identical shape of the spectra.

In this paper we consider conductivity spectra of silver-ion conducting materials with different microstructure in order to access ion dynamics contributions from different structural parts of the sample, such as intergrain or grain boundaries charge transport, i.e., to investigate the influence of the microstructure on the overall conductivity. Conductivity measurements were carried out on the (1-x)(NaI-4AgI)-xAl_2O_3 (x = 0.1, 0.2 and 0.3) composites in order to look at the effect of the dispersed nanoparticles of Al_2O_3 on the overall ionic conductivity of the NaI-4AgI two phase system.

The different samples with composition (1-x)(NaI-4AgI)-xAl_2O_3 (x = 0.1, 0.2 and 0.3) were prepared form previously grown polycrystalline samples of NaI-4AgI and nanoparticles of Al_2O_3 (grain size 565.3 Å, Aldrich). The composites were prepared by thoroughly mixing the component in a agate mortar and then heated for 1 hour at 120 °C. Disc shape samples of typical size 6.0 mm diameter and 0.5 mm thickness were prepared by uniaxial pressing at 2.0×10^5 Pa. The electrodes were prepared with conducting silver paint. Admittance spectroscopy measurements [1] were performed in the frequency range from 20 Hz to 1 MHz using precision LCR meter HP 4284A at different fixed temperatures between 320 K and 416 K.

The electrolyte composites show a non-Arrhenius behavior in the temperature (T) dependence of the real part of the conductivity, σ', that can be well fitted to the expression $\log(\sigma') = \exp[-((1000/T) - k_1) / k_2] + C$, where k_1, k_2 y C are fitting parameters that depend on the alumina content and the frequency response behavior of conductivity in the various dispersive regions with identical shape of the spectra. It is clearly observed in Fig. 1 that the non- Arrhenius behavior is obeyed equally well by any component of the conductivity spectra (independently on the frequency range). This observation may imply that the contributions to the overall conductivity from different structural part of the sample, such as those related to ion blocking at grain boundaries and at the electrodes (dominating at lower frequencies) [2] or the bulk of the grains dominating at higher frequencies are determined by ion hopping even when they are affected by the presence of outer and inner surfaces between different parts of the composite.

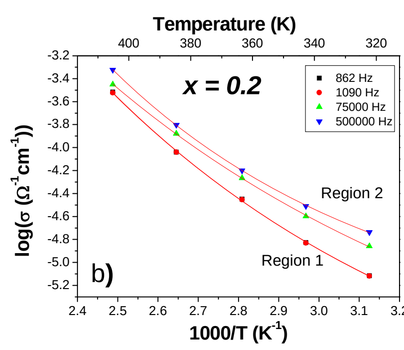

Figure 1: Temperature dependence of the real part of conductivity plotted as log(σ) vs 1000/T at different frequencies for the 0.8(NaI-4AgI)-0.2(Al_2O_3).

Reference

[1] Andrew K. Jonscher, Electrochimica Acta 35, No. 10, 1595 (1990).
[2] Barsoukov E and Mc Ross Donald J. Impedance Spectroscopy Theory, Experimental, and Applications (A Jhon Wiley & Sons, New Jersey, 2005) p. 2-7.