INVESTIGATION OF STRONTIUM TITANATE CERAMICS BY IMPEDANCE SPECTROSCOPY

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Strontium titanate ($SrTiO_3$) is a perovskite oxide with a simple cubic crystalline structure at room temperature. This material is a mixed conductor, enabling a duality of the conductivity from predominantly electronic (via electrons or electron holes) to ionic (via oxygen vacancies)[1]. The purpose of this study is to examine electrical characteristics such as the ionic conductivity alongside the conductivity of electrons in a small sample of strontium titanate ceramics at different temperatures.

To obtain data, the sample is put in an impedance spectrometer, and a periodic sine waveform voltage signal is sent to it through a buffer. The measurements are performed in a frequency range of 10 Hz to 2 MHz. The temperature is varied from 300 K to 800 K in 20 K steps to acquire each impedance spectrum, as well as a second set of measurements is performed from 800 K down to 300 K. A computer-controlled power supply for the heater is used to control the temperature of the sample. The electrical signals are measured by a two-channel computer oscilloscope TiePie Handyscope HS3. The current is converted into voltage and measured. These steps result in frequency dependencies of the real and imaginary parts of impedance at different temperatures from which the ceramics can be characterized with the help of equivalent circuits. In this case a parallel (Maxwell) model is used. From the parameters of this equivalent circuit the value of conductivity can be found. It has been found, that the ionic conductivity follows the Arrhenius dependency:

$$\sigma = \frac{A_R}{T} e^{\frac{E_A}{k_B T}} \tag{1}$$

where A_R is constant proportional to the number of carrier ions, k_B – Boltzmann constant, and E_A – activation energy.

The results of this investigation show that the electrical characteristics of the material are dependent on the temperature of the sample and frequency of the applied signal through the sample.

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Keywords: Ceramics; Impedance Spectroscopy; Ionic Conductivity

[1] I. Denk, W. Münch, and J. Maier, “Partial conductivities in SRTIO 3 : bulk polarization experiments, oxygen concentration cell measurements, and Defect-Chemical Modeling,” (Journal of the American Ceramic Society, vol. 78, no. 12, pp. 3265–3272, Dec. 1995)