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Impedance spectroscopy theory and applications

Nasr Sdiri
National Center of Researches in Materials Sciences, Tunisia

Impedance spectroscopy (IS) is the measurement of electrical impedance, admittance, or some other closely related quantity as a function of frequency. It is used to resolve processes of electrical polarization according to their relaxation frequencies or time constants. The technique can be used to characterize ionic or electronic conductors as well as dielectric materials. It is commonly applied to electro ceramics, solid electrolytes, dielectrics, including polymers and glasses, and to integrated energy conversion devices such as batteries and fuel cells. Material Impedance spectroscopy is a powerful technique used for the characterization of electrical proprieties of materials (ceramics, polymers,..) and for investigation of Kinetics of reactions in materials. These properties are temperature dependent. Impedance spectroscopy provides the contribution of different micro structural features of a material in the row impedance of materials (grains, grain Boundaries,..). This technique has the inherent potential of non-destructive testing. The principle of the impedance spectroscopy experiment is to apply a sinusoidal electrical stimulus (either voltage or current) to a sample and observe the response (respectively current or voltage). The data resulting from such a measurement (usually a list of f, Z_{re}, Z_{im}) are analyzed using a complex nonlinear least squares (CNLS) fitting code, to determine the parameters of a circuit equivalent. Through the system in terms of amplitude and phase shift compared to voltage-time function. The complex value of impedance can thus be described in terms of its real and imaginary values at different frequencies. The results of an impedance measurement can be graphically demonstrated using bode and Nyquist or Cole-Cole plot for all applied frequencies. In this presentation, I will present our research on impedance techniques:

- Electrical conductivity and dielectric analysis of the perovskite $La_{0.7}Ca_{0.3}xK_xM_nO_3$ (x = 0.00, 0.05 and 0.10).
- Studies of (90-x) P_2O_5-xB_2O_3-$10Fe_2O_3$ glasses by impedance spectroscopy methods (x = 0 mol.%, 10 mol.%, 20 mol.%, 30 mol.%,40 mol.%)
- $10B_2O_3$–(90 – x) P_2O_5– xNa_2O) with x=0, 5, 10, 15, 20 mol%.

sdirinasr@yahoo.fr