Einladung zu einem Gastvortrag

Sehr geehrte Damen und Herren,

im Rahmen des SFB TR 39 - PT-PIESA laden wir Sie recht herzlich zu einem Gastvortrag von Herrn Prof. Dionizy Czekaj von der Schlesischen Universität in Katowice (Polen) zum Thema:

“Characterization of piezoelectric ceramics and thin films by impedance spectroscopy”

ein.

Der Vortrag findet statt:

am: 11.10.2016

um: 10:00 Uhr

wo: Fraunhofer IWU Dresden
Nöthnitzer Straße 44
01187 Dresden
Konferenzraum 102

Abstract

Ferroelectric materials such as barium strontium titanate ($Ba_{1-x}Sr_xTiO_3$ – BST), lead zirconium titanate ($PbZr_{1-x}Ti_xO_3$ – PZT) or bismuth titanate ($Bi_4Ti_3O_{12}$) exhibit a lot of useful properties. High dielectric coefficients over a wide temperature and frequency range are used as dielectrics in integrated or surface mounted device capacitors. The large piezoelectric coefficient is applied in variety of electromechanical sensors, actuators and transducers. Infrared sensors need a high pyroelectric coefficient which is available with this class of materials. The significant non-linearities in electromechanical behavior, field tunable permittivities and refractive indices, and electrostrictive effects open up a broad field for further different applications. In addition, there is a growing interest in ferroelectric materials for memory applications, where the direction of spontaneous polarization is used to store information digitally.

In order to address a problem of simultaneous optimization of dielectric properties an "electrical microstructure" of ferroelectric ceramics and thin films have been studied by complex impedance spectroscopy (IS) using impedance analyzer and sandwich-type capacitor design. IS was utilized to characterize the different electrically active regions in piezoelectric ceramics and thin films both qualitatively by demonstrating their existence and quantitatively, by measuring their individual electric properties. The immittance properties i.e. complex impedance (Z^*), complex modulus (M^*), complex admittance (Y^*), complex dielectric permittivity (ε^*) and dielectric losses ($\tan\delta$) were studied by observing how the system responded to an electrical stimulus that was applied to the electrodes.

The immittance spectra for most of the samples under study and all temperatures exhibited some common features. The idealized impedance diagram (*Z″* vs. *Z′*), appears in the form of a succession of semicircles representing electrical phenomena due to bulk material, grain boundary effect and interfacial phenomena if any. When overlapping between processes increases, one may need representations based on combined spectroscopic plots of the imaginary components of impedance, *Z″* and electric modulus *M″* to reveal the bulk, grain boundary and electrode components of the impedance spectra. Another possible alternative representation of immittance data are possible and are briefly discussed.

Quality of the measured impedance data is essential for a proper analysis. In that connection the Kramers-Kronig analysis present a very useful tool for data validation. Experimental data of IS were also fitted to the corresponding equivalent electric circuit by the complex non-linear least squares method (CNLS). The validity of the fitting procedure was estimated.
It should be stressed here that the IS is a very sensitive technique but it does not provide a direct measure of the physical phenomena. Other experiments should also be carried out, together with good physical knowledge of the system (crystal structure, microstructure, grain size and/or shape distribution, surface composition, thickness, porosity, presence of various layers, hydrodynamic conditions, etc.). Interpretation of impedance data requires use of an appropriate model that represents various (macroscopic) processes involved in the transport of mass and charge. This is a quite difficult task which must be carried out very carefully.