Relaksoriaus savybių tyrimas $BaTiO_3$ pagrindu pagamintuose kietuosiuose tirpaluose

Relaxor properties of $BaTiO_3$-based solid solutions

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Barium titanate (BTO) is a first inorganic material where the ferroelectricity was discovered. Barium titanate has a perovksite structure in which ferroelectricity occurs due to the off-centering of Ti ions in oxygen octahedral cage. The material undergoes three consecutive phase transitions [1]. The high temperature phase is paraelectric which transforms to the tetragonal, orthorhombic and rhombohedral ferroelectric phases when the temperature decreases.

Barium titanate can be considered as multifunctional materials for different applications. The largest application area of BTO is multilayered ceramic capacitors due to its large weakly temperature dependant permittivity in the vicinity of room temperature. Unfortunately, the loss and energy storage density of such capacitors are strongly dependent on the domain structure of the ferroelectric phase of BTO. In order to maximize the energy storage density and decrease the loss which arises due to domain wall motion, it is necessary to modify BTO to pin the domains or reduce their density.

Isovalent substitutions such as Ce^{4+}, Zr^{4+}, Hf^{4+} or Sn^{4+} instead of titanium ion modifies the phase transitions of barium titanate. Some of these ions can be substituted throughout all the concentration range. The material undergoes crossover from ferroelectric properties to a relaxor properties.

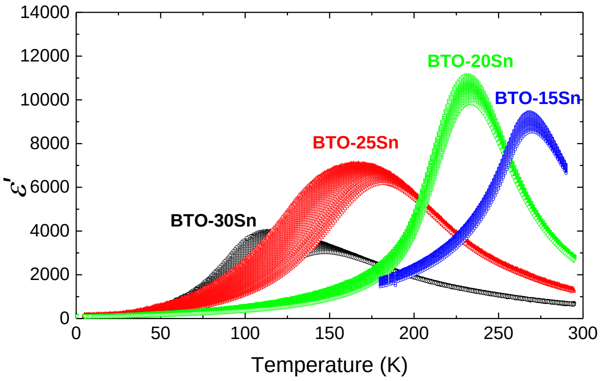

Fig 1. Temperature dependence of permittivity for $BaTi_{1-x}Sn_xO_3$ solids solutions.

In this contribution we will focus on the Sn^{4+} substituted barium titanate ($BaTi_{1-x}Sn_xO_3$) in the crossover region (i. e. $0.15 \leq x \leq 0.3$) between ferroelectric and relaxor behavior. The dynamics of the crossover will be studied by broadband dielectric spectroscopy methods from milihertz to terahertz range. Low frequency (<1 MHz) dielectric spectroscopy data is depicted in figure 1. It is clearly seen that the increase of tin in BTO results in diminishing sharp phase transitions to one broad dielectric anomaly. This anomaly shifts to lower temperature region and broadens. The compositions with the largest compositions (x > 20 % Sn) clearly exhibit relaxor features.

Also, the NMR studies of tin and titanium ions will be presented. Such experimental technique will provide some insights about different displacements of a titanium ions surrounding tin. The titanium NMR spectra is depicted in figure 2.

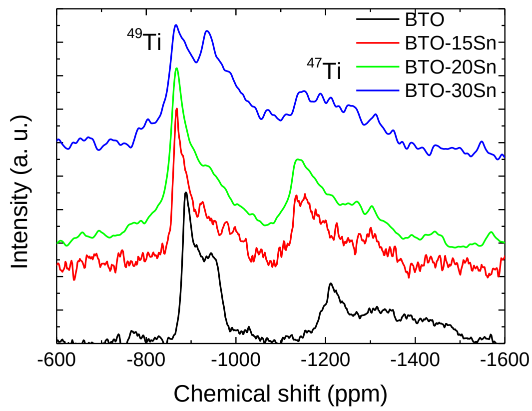

Fig 2. ^{47,49}Ti NMR spectrum for all investigated compositions at room temperature.

Keywords: dielectric spectroscopy, relaxors, polar nano regions.

Literature

[1] P. W. Forsbergh, Domain Structures and Phase Transitions in Barium Titanate, Phys. Rev. 76, 1187 (1949).