LEAD INDUCED FERROELECTRIC STATE IN INCIPIENT FERROELECTRICS $SrTiO_3$ AND $CaTiO_3$

A.V.Sotnikov[1,2], E.P.Smirnova[2], V.V.Lemanov[2], and M.Weihnacht[1]

[1] Leibniz Institute for Solid State and Materials Research Dresden, Helmholtzstr. 20, D-01069 Dresden, Germany

[2]A.F.Ioffe Physical-Technical Institute, Polytekhnicheskaya 26, 194021 St. Petersburg, Russia

There is a considerable renewed interest in incipient ferroelectrics, which have a polar soft mode but never exhibit a ferroelectric (FE) phase transition down to T = 0 K. $SrTiO_3$ is an incipient ferroelectric with extrapolated Curie-Weiss temperature of T_0 = + 40 K, and recent study shows that $CaTiO_3$ is a "frozen" incipient ferroelectric with extrapolated temperature T_0 = - 110 K. $SrTiO_3$ at $T \rightarrow 0$ K can be considered as a system which is near the limit of the stability of its paraelectric phase. Small perturbations such as electric fields, pressure and impurities can induce a ferroelectric phase transition in this system. The ferroelectrically active ion Pb^{2+} with high polarizability induces ferroelectricity in both $SrTiO_3$ and $CaTiO_3$ but critical impurity concentration and transition temperature vs concentration dependence are quite different. The aim of the present work is to compare induced ferroelectric phase transitions and specific features of dielectric behavior of Pb doped $SrTiO_3$ and $CaTiO_3$. It is important not only in the framework of a general problem of incipient ferroelectricity but for the application of $SrTiO_3$- and $CaTiO_3$ based materials as well.

Ceramic samples of strontium titanate and calcium titanate with Pb^{2+} were prepared with a conventional ceramic technique. An X-ray diffraction study showed the samples to be of single-phase perovskite structure. Dielectric spectra were measured using a Solartron SI 1260 Impedance/Gain-Phase Analyzer interfaced with a computer. The measurements were performed at frequencies between 10 Hz and 1 MHz, in a temperature range between 4.2 K and 400 K by cooling at a constant rate of 1 K/min. Polarization loops measurements were used to identify the FE state.

Dielectric relaxations of different types from simple Debye-like in $SrTiO_3 : Pb^{2+}$ to a relaxor-type with a broad distribution of relaxation times in $CaTiO_3 : Pb^{2+}$ were found. The main features and mechanisms of observed dielectric relaxation, FE- and relaxor-type behavior are discussed.