Capacitance hysteresis on the temperature dependence for ferroelectric barium-strontium titanate capacitors

A.I. Dedyk[1], Yu.V. Pavlova[1], O.V. Pakhomov[2], A.S. Starkov[2], I.A. Starkov[3], A.A. Semenov[1], S.F. Karmanenko[1]

1 – Saint Petersburg Electrotechnical University, Saint Petersburg, 197376, Russia
2 - Saint Petersburg University of Low temperature and Food technologies, Saint Petersburg, 197376, Russia
3 – Institute for Microelectronics, technische Universitat at Wienn, A-1040, Wien, Austria.

corresponding author e-mail: oleg_cryogenics@gmail.com

Barium-strontium titanate (BST) ferroelectric ceramics is widely used for the purpose to create tunable temperature elements using electrocaloric effect (ECE) that have pushed active research of temperature-capacitance dependencies of the layered capacitors based on the BST ceramics.

The BST ferroelectric ceramic of 0,5 mm thick and 6 mm in diameter had the following composition - $Ba_{0.55}Sr_{0.45}TiO_3$ with 12 wt % of Mg-containing additive. The ceramics were covered by gold electrodes. The measurements of differential capacitance was carried out at frequency 1 MHz be mean of RLC –meter in the region from 0 to 900 V. The temperature measurement cycle was composed of the cooling of the samples from 290 K to 140 K and further heating to 290 K at 10 values of bias voltage.

Temperature dependencies of the capacitance showed the hysteresis dependence around the temperature of the maximum in ferroelectric phase. At the conditions of cooling and bias voltage absence the capacitance value on C(T) dependence were higher in comparison with heating process (Fig. 1).

At the cooling process and bias voltage absence the capacitance value on *C(T)* dependence were higher in comparison with heating process (Fig. 1).

The temperature of maximum at cooling process was $T_m = 215$ K, and during heating $T_m = 217$ K.

At the increase of bias voltage the capacitance was decreased and the temperature of capacitance maximum was shifted to right (higher temperature region) that had ordinary character for the ferroelectrics with spread phase transition. This kind of the temperature maximum shift at the dependence $C_d(E, T)$ is ordinary behavior for the ferroelectrics having spread phase transition of the second order [1].

The theoretical description and modeling of the obtained experimental results were performed basing on the modified Landau-Khalatnikov theory. The model parameters were derived from the comparison between experimental and theoretical results.

References

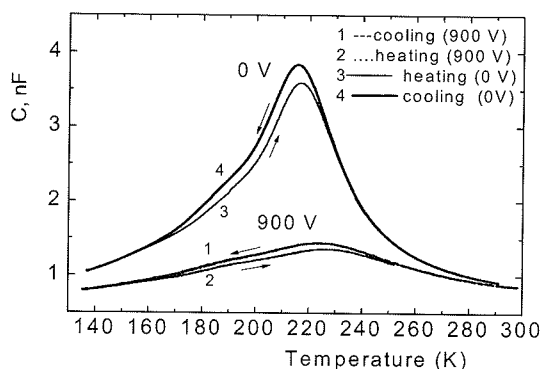[1] *Guzhva M.E.,Lemanov V.V.,Markovin P.A.. Physics of the Solid State, v43, 2001*

Fig.1 Temperature dependencies of ferroelectric ceramic capacitance at bias voltage 0 and 900 V (cooling and heating lines are indicated)