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EFFECT OF ISOVALENT SUBSTITUTION AND DOPANTS OF 3d-METALS ON THE PROPERTIES OF FERROELECTRIC-SEMICONDUCTORS

Oleg V'yunov, Leonid Kovalenko and Anatolii Belous

V.I. Vernadskii Institute of General and Inorganic Chemistry, Kyiv, Ukraine

PTCR effect (positive temperature coefficient of resistance) occurs in ceramic materials based on doped barium titanate above the temperature of phase transition. Varistor effect (decrease resistance under external electric voltages) limits the application of such materials in devices operating under high electric voltages. Isovalent substitution and introduction of acceptor dopants (in particular manganese ions) in synthesized materials is known to improve the above electric characteristics due to change in grain size and resistance of grain boundaries. However distribution of manganese dopants in polycrystalline materials is studied insufficiently. Therefore the aim of this work was to study the effect of manganese ions in (Ba,Ca,Sr,Y)TiO₃ ceramic on properties of grains, outer grain layers and grain boundaries of PTCR ceramics.

PTCR ceramics were synthesized by solid state reaction technique using extra-pure initial reagent. For uniform distribution in ceramics manganese has been precipitated from solutions. Electrophysical properties of materials were studied in a wide frequency and temperature range. It has been found that increase of manganese content of barium titanate ceramics increases the resistance of grain boundaries, but practically does not change the resistance of grain. This occurs because manganese in the concentration range investigated does not incorporate in crystalline lattice of PTCR barium titanate and, therefore, does not compensate excess charge in titanium site. Analysis of temperature dependencies of resistance of grain, outer grain layer and grain boundaries of PTCR ceramic with manganese dopants shows that resistance of outer grain layer changes with temperature like resistance of grain. Resistance of grain boundaries of PTCR barium titanate increases with manganese content. The results obtained showed that increase of resistance change value of PTCR ceramics with manganese dopants occurs due to change of electrophysical properties of outer grain layers and grain boundaries. Introduction of manganese in ceramics is accompanied with considerable decrease of varistor effect due to the formation of high-resistance outer layer. Thus investigations of PTCR ceramics based on barium titanate in wide frequency and temperature ranges allow us to conclude that manganese ions are mainly at grain boundaries and slightly affects the resistance of grains. Such behaviour essentially improves properties of PTCR materials.