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FEATURES OF STRONTIUM-CONTAINING PIEZOCERAMICS SINTERING

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The paper describes the use of ceramic ferroelectric material $PZTS_T$ – 3. The composition of the material is considered. The specificities of sintering of a ferroelectric ceramic material are explained. The corresponding illustrations and tables are given. The raw material for the production of the material is also described. Technological factors affecting the course of synthesis are explained.

Keywords: ceramics, sintering, temperature, carbonate, composition.

Possessing a complex of valuable electrophysical properties, piezoceramic materials are widely used in the development of electronic devices with high performance characteristics. With the development of ceramic production, the compositions are constantly becoming more complex, and recently a great deal of attention has been paid to the technology of their production.

Multicomponent solid solutions are obtained mainly by the method of solid-phase interaction of oxides and carbonates, since the realization of the methods of solution chemistry in some cases is not possible because of the various conditions for the precipitation of constituent components. The implementation of the ceramic technology requires consideration of a number of factors affecting the formation of the electrophysical properties of piezoceramic materials, namely: the physico-chemical state of the raw materials components (pre-production history, impurity composition, structure, dispersion) and their preparation; type of modifying additives; the weighing error and the method of preparation of the mixture of the original components; activity of mechanically prepared charge (homogeneity, dispersity, substructure); type of hardware processing of technological operations; temperature - time regime, a method of picking the charge (in the form of powder, briquettes, granules), atmosphere; dispersion of the synthesized material, impurity composition [1, 2].

Taking into account and overcoming the technological factors of the ceramic technology that adversely affect the electrophysical properties of powder piezomaterials allows one to overcome the advantages of the methods of solution chemistry and produce materials with high and reproducible performance properties.

Ferro-hard material $PZTS_T$ – 3 finds the widest application in the acoustic converters working on radiation. Its composition is located near the morphotropic phase transition from the side of the tetragonal region.

According to the technological regulations, lead and strontium carbonates and a number of modifying additives in the form of oxides (ZnO, Bi_2O_3, MnO_2, La_2O_3) are used in the production of this material.

Strontium carbonate is used in the composition for partial replacement of lead oxide with strontium oxide. With the introduction of this material in production, a number of issues arose associated with its certification of electrophysical parameters.

According to the technical conditions during the certification, the sintering temperature of the products in the form of disks measuring 10 × 1 mm was carried out in the air in the temperature range 1120 – 1160 °C in 20 °C increments. However, a significant spread of the parameters was noticed, and in some cases it was necessary to raise the temperature to 1180 °C. Studies have shown that the reason for such negative results is the fact that the synthesis temperature of solid solutions of 860 ± 20 °C is not sufficient for the decomposition of strontium carbonate and the reaction of its interaction with TiO_2 and ZrO_2 [1].

In fact, strontium carbonate does not undergo changes in the synthesis process, and its decomposition is evidently realized already when the ceramics are sintered, and its degree of decomposition affects the dispersion of electrophysical properties. On the other hand, an increase in the synthesis temperature is unacceptable, since the probability of loss of lead oxide is great, and the process of further processing of the material, in particular its grinding, becomes difficult. To confirm this hypothesis, gravimetric studies were carried out, and it was shown that indeed strontium carbonate decomposes in the temperature range 1180 – 1200 °C (depending on the raw material qualification). Chemical substitution of lead does not actually occur during the synthesis, but is carried out only when the ceramics are sintered.

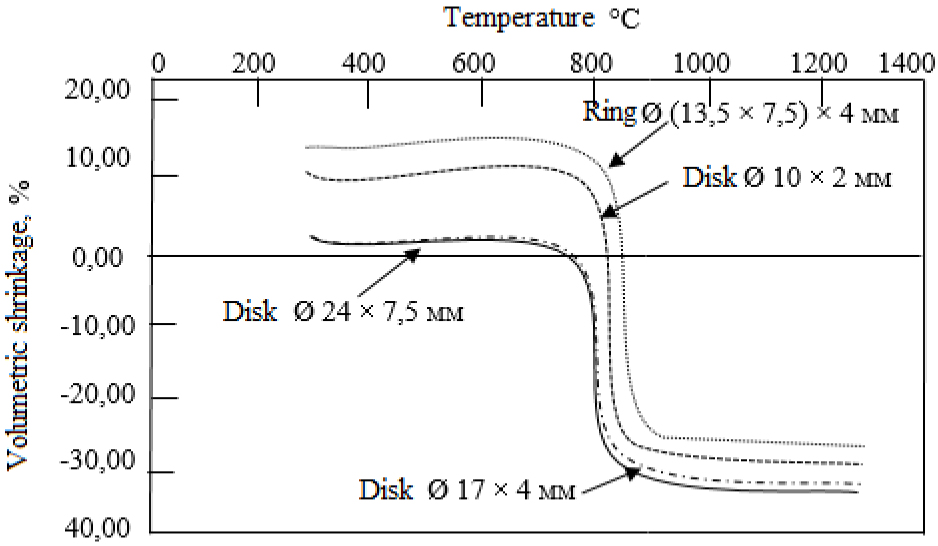
Despite the small content of SrO in the composition (Table 1), a smooth shrinkage increase up to a temperature of 1200 ° C is observed on the shrinkage curve (Figure 1), due to the decomposition of strontium carbonate and the final formation of the ceramic structure.

Table 1 – Composition of material $PZTS_T$ – 3 at different ratios of ZrO_2 and TiO_2

Batch components	The ratio of ZrO_2 to TiO_2 in the material of $PZTS_T$ – 3		
	0,530 : 0,470	0,525 : 0,475	0,520 : 0,480
PbO	64,6543	64,6970	64,7398
SrO	1,5797	1,5808	1,5818
ZrO_2	19,9130	19,7381	19,5631
TiO_2	11,4504	11,5799	11,7096
Bi_2O_3	0,9665	0,9671	0,9677
MnO_2	0,2705	0,2706	0,2706
ZnO	0,5064	0,5067	0,5070
La_2O_3	0,6589	0,6593	0,6598

It was decided to use a higher sintering temperature of ceramics with the use of atmosphere-creating lead-containing zirconium backfill. Sintering was carried out in the temperature range 1220 – 1260 °C. As a result, it turned out that at the sintering temperature of 1240 °C, optimum results were obtained, which exceeded the level of about 8 – 10 % of the properties of ceramics sintered at low temperatures. The obtained results testify to the necessity of changing the technical conditions for attestation of materials by electrophysical parameters.

In the second stage of the study, strontium oxide, previously obtained from carbonate, was used as raw material. The aim was still to sinter the ceramics at low temperatures and to raise the level of properties both at high temperatures. However, the results showed that although it was possible to slightly improve the sintering properties in the temperature range 1120 – 1160 °C in steps of 20 °C, they still remained lower than in the high-temperature roasting, although their dispersion was



insignificant. The proposed variant is not technological, since strontium oxide is not a marketable product because of its hygroscopicity.

Figure 1 – Dependence of volumetric shrinkage of samples of ceramics $PZTS_T$ – 3 different sizes from temperature.

Thus, as a result of these studies, along with the above factors, one more technological factor that influences the electrophysical properties of the piezoceramic material has been revealed.

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В работе описано применение керамического сегнетожесткого материала ЦТССт – 3. Рассмотрен состав материала. Объяснены особенности спекания сегнетожесткого керамического материала. Приведены соответствующие иллюстрации и таблицы. Также описано сырье для производства материала. Объяснены технологические факторы, влияющие на протекание синтеза.

Ключевые слова: керамика, спекание, температура, карбонат, состав.

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