The structure and phase composition of the radiotransparent ceramics

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The most interesting from the point of view of creation of radiotransparent materials is a multicomponent system SrO–BaO–Al_2O_3–SiO_2, due to the presence of two crystalline phases in it – Celsian ($BaO \cdot Al_2O_3 \cdot SiO_2$) and Slavsonite ($SrO \cdot Al_2O_3 \cdot SiO_2$). It is known that Slavsonite and Celsian have high radiophysical and physico-mechanical properties: the permittivity is in the range of 6.2-7, the tangent of the dielectric loss angle is $tg\delta \cdot 10^{-4}$ = 1 – 50, low TLFE, $\alpha \cdot 10^6$ 1/degree = 2.5 – 2.7, peak time melting point is above 1600 °C.

The aim of the work was to justify the choice of the areas of a multicomponent system SrO–BaO–Al_2O_3–SiO_2 and to study their structural and phase composition. For this purpose, the effect of the ratio of the crystalline phases of Slavsonite and Celsian (phase ratio $SrAl_2Si_2O_8$: $BaAl_2Si_2O_8$ is: C1 - 1:3; C2 - 1:1 and C3 - 3:1) on the dielectric properties of ceramics were investigated.

It is confirmed that the phase composition of the obtained materials corresponds to the composition of the solid solution, and with the increase of barium oxide in the composition of the masses, the composition of the solution varies from $Ba_{0.5}Sr_{0.5}Al_2Si_2O_8$ to $Ba_{0.75}Sr_{0.25}Al_2Si_2O_8$. A positive effect with the introduction of the second bivalent cation, in particular strontium oxide in the celesium composition, is reflected in the weakening of the growth of the permittivity with increasing temperature. Therefore, it can be considered that the production of thermally stable solid solutions of the Celsian-Slavsonite composition will contribute to an increase in the stability of the dielectric characteristics during the exploitation of the material under conditions of high temperature loads.

The necessity of modification of model masses with the use of intensifiers of sintering and phase formation is established. To ensure the maximum level of sintering, it is recommended to introduce 2 mass. % Li_2O into the composition of masses, which ensures the production at 1450°C of Celsian-Slavsonite ceramics with the following properties: W = 0 %, ρ_{prop} = 2960÷3025 kg/m^3; ε = 7.3÷8.7; $tg\delta$ = 0.0077÷0.0096; σ_{st}= 110÷180 MPa; σ_{zg}= 15÷35 MPa. Based on the studies carried out in a multicomponent system SrO–BaO–Al_2O_3–SiO_2 we have determined the prospective compositions of ceramic materials with a lowered dielectric constant and a tangent of the dielectric loss angle.