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Phase diagram of the Al_2O_3-ZrO_2-Sc_2O_3 system for creation of new materials

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The system Al_2O_3–ZrO_2–Sc_2O_3 is the last unstudied one in the line of systems Al_2O_3–$Zr(Hf)O_2$–REE_2O_3, where REE – rare earth elements. Materials of these systems are promising as structural and functional materials, in particular, materials based on directionally solidified eutectics retain strength at high (up to 1600 °C) temperatures, as electrolytes for solid oxide fuel cells (SOFC), thermal barrier coatings (TBC) for gas turbine engines that work at high temperatures. The creation of materials in these systems needs information about their phase diagrams.

It is known that materials from ZrO_2-riched area are widely used as electrolytes for solid oxide fuel cells. Also, properties of materials are interesting in the whole range of concentrations. It's necessary to know what phases are forming in the different area of phase diagram and which compounds are there. For this, we have to know data about bounding binary systems.

The objective of this work is to specify bounding binary systems and to construct liquidus surface for the ternary system Al_2O_3–ZrO_2–Sc_2O_3. Powders of appropriate composition were pelletized and annealed at 1300 and 1550 °C during 275 and 170 h in air, respectively. Investigations were performed using XRD (CuKα radiation with Ni filter), DTA and microstructural analysis. Periods of crystal lattices were calculated using program LATTICE.

Liquidus of the system studied consists of six fields of primary crystallization F-, T-ZrO_2, Al_2O_3, S, $ScAlO_3$ and C-Sc_2O_3 phases. These fields intersect in nine monovariant curves, that finishes in two transition (U_1, U_2) and two ternary eutectic points (E_1, E_2). One quasibinary eutectic point L⇄F+$ScAlO_3$ is also expected in the system.

New found binary and ternary eutectics can be obtained as nanoscale composite materials.