PHASE DIAGRAMS OF THE SYSTEMS Al_2O_3–$Zr(Hf)O_2$–$Ln(Y)_2O_3$ AS GUIDE FOR CONSTRUCTING NEW OXIDE MATERIALS

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Ternary systems Al_2O_3–$Zr(Hf)O_2$–$Ln(Y)_2O_3$ Ln=lanthanides) play a great part in modern materials science. Materials in these systems by this time are used as structural materials, solid electrolytes, thermal barrier coatings, functional and refractory materials etc.

Phase equilibria in the ternary systems Al_2O_3–ZrO_2–Ln_2O_3 (Ln = La, Nd, Sm, Gd, Y, Er, Yb) were investigated in all range of concentrations and 1250–2700°C temperature range using a number of methods such as differential and derivative thermal analysis in controlled medias, X-ray diffraction phase analysis, local X-ray spectral analysis, chemical analysis, electron and optical microscopy, petrography. The phase diagrams of the systems studied are presented as projections of liquidus and solidus surfaces, isothermal at 1250/1650°C sections and isopleths, melting diagrams and reactions schematics.

The interaction in the systems is characterized by the absence of ternary compounds and regions of appreciable solid solutions based on the binary compounds and components, that is explained by the type of chemical links and dimension factor. The phase equilibria in the systems are determined by zirconia as the most stable compound. As a consequence it has the largest primary crystallization field that increases from La to Lu and coexists with majority phases of the systems. Solidification in the systems is completed in eutectic reactions. New 13 quasibinary and 26 ternary eutectics were found for the first time. Their temperatures rise from 1660°C for the La_2O_3 system to 1840°C for the Lu_2O_3 system. On the base of microstructure investigations it was established that three-phase alumina-rich eutectics crystallizes according to the mechanism of cooperative growth. It opens up possibilities to obtain composite materials using directional solidification method. The influence of superstructure-type compounds $Ln_2Zr_2O_7$ and $Zr_3Ln_4O_{12}$ on the phase diagrams structure was established. Their temperature stability do not changes when the third component (Al_2O_3) is added. Phase transformations of solid solutions F⇆T on the base of ZrO_2 and X⇆H⇆A⇆B⇆C on the base of Ln_2O_3 run including liquid according to the transformation mechanism.

The established regularities allowed to forecast phase diagrams including other members of the lanthanides as well as of the systems-analogues Al_2O_3–HfO_2–$Ln(Y)_2O_3$. The selective experiments confirmed the correctness of the forecast. The attempt to establish the regularities of ternary eutectics crystallization was made. It was revealed that the mechanisms proposed in this investigation and literature had not exhausted all possibilities of ternary eutectics crystallization.