Phase relation in the $ZnSb_2O_6$–$ZnTa_2O_6$ system

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Transition metal antimonates and tantalates with the general formula MM'_2O_6 (M =Zn, Cd, Pb, Ni etc, M'=Sb, Ta) have been investigated primarily because of their interesting structure, electronic and optical properties. Recently, $ZnSb_2O_6$ has received much attention for its wide application in photocatalysis [1] and gas sensors [2]. $ZnTa_2O_6$ ceramics have drawn much interest in microwave application for their excellent microwave dielectric properties [3].

For the obtain new materials, the substitution or doping of cation is one of the most promising methods which lead to improved optical and electrical properties, modified band gap energy, and others. For example, partial substitution of Zn by Co, Ni, or Cu ions in the $ZnSb_2O_6$ lattice, reduced the conductivity and increased the negative Seebeck coefficient [4].

In view of the fact that the phase relations in the $ZnSb_2O_6$–$ZnTa_2O_6$ system have not been investigated yet, the aim of the present work was, first of all, answering the question whether the compounds, $ZnSb_2O_6$ and $ZnTa_2O_6$, form a solid solution and if it is so - to investigate its range homogeneity and thermal stability.

The properties of the components of the $ZnSb_2O_6$–$ZnTa_2O_6$ system are well known. $ZnSb_2O_6$ crystallizes in the tetragonal system and demonstrates the tri-rutile structure. The $ZnSb_2O_6$ compound is stable in air up to 1250°C, after that undergoes decomposition to α-$Zn_7Sb_2O_{12}$, with a deposition of $Sb_4O_{6(g)}$ and $O_{2(g)}$ [5]. $ZnTa_2O_6$ occurs in two polymorphous forms: the low-temperature tetragonal modification and high-temperature orthorombic modification [6]. The temperature of polymorphous transformation of these modifications is 900°C [7].

The samples for the experiments were prepared from appropriate mixtures of oxides (ZnO, Ta_2O_5, α-Sb_2O_4) as well as from the specially synthesized compounds: $ZnSb_2O_6$ and $ZnTa_2O_6$. The composition of these samples was selected in such a way that they represented the whole components concentration range of the $ZnSb_2O_6$–$ZnTa_2O_6$ system. The reacting substances were weighed in appropriate portions, homogenized by grinding in the mortar and heated in air in the temperature range 700-1200°C. The phase compositions of the samples, after subsequent stages of their heating, was determined on the basis of XRD results (EMPYREAN II, PANalytical, CuKα/Ni radiation). After the last stage of heating, all samples were subjected to DTA–TG examination (F. Paulik – L. Paulik – L. Erdey derivatograph, MOM Budapest or SDT 2960 apparatus, TA Instruments).

The results obtained within this work have shown that, in the $ZnSb_2O_6$–$ZnTa_2O_6$ system, substitution solid solution with tri-rutile-type structure and with the general formula $ZnSb_{2-x}Ta_xO_6$ forms. The homogeneity of new solid solution and its thermal stability are determined. The research in order to determine whether in this system also forms a solid solution with the structure of $ZnTa_2O_6$ is continued.

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