High–temperature reactions in the ternary VO_2–$Nb_2O_5(Ta_2O_5)$–Fe_2O_3 systems

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The binary and ternary mixture oxides of the transition elements with the general composition MO_2, *e.g*. $CrVSbVO_6$, $Cr_2V_2WO_{10}$, $Cr_2Nb_2WO_{10}$, $NiV_2Nb_2O_{10}$, $CrVNbO_6$, $FeVSbO_6$, $Fe_{1-x}Cr_xVSbO_6$ show interesting electrical, magnetic and structural properties [1-5]. Some of these phases are currently being investigated as potential candidates for electrodes in the rechargeable lithium batteries [6] and as materials in the photoelectrolysis of water [7].

The investigations of solid-state reactions occurring among the oxides V_2O_4 (VO_2), Fe_2O_3 and Nb_2O_5 showed that in the system V-Fe-Nb-O the compound with the rutile-type structure is formed, possessing the formula $FeVNbO_6$ [1]. The research indicated that this compound was obtained in the following manner: first $V_2Nb_2O_9$ was prepared by heating either a V_2O_4 and Nb_2O_5 or V_2O_5 and NbO_2 mixture in evacuated quartz tubes at 1000°C. Then Fe_2O_3 was mixed with $V_2Nb_2O_9$ in 1:1 stoichiometric quantities and heated in vacuum at 1000°C.

The aim of the present work was, first of all, answering the question whether a compound analogous to $FeVNbO_6$ is formed in the system VO_2–Ta_2O_5–Fe_2O_3. In such a case our further aim was carrying out a primary research on the structure and the thermal properties of these compounds. The present study is to confirm whether or not solid solutions with structure $FeVNb(Ta)O_6$, $FeNbO_4$ and/or $FeTaO_4$ are formed in the investigated systems. The aim was also to investigate their range of homogenity and thermal stability.

The research was started with attempts to synthesise the compounds $FeVNbO_6$ and $FeVTaO_6$. For this purpose, the several samples were preparated from the oxides VO_2, Nb_2O_5 (Ta_2O_5) and Fe_2O_3. The reacting substances were weighed in appropriate portions, homogenized by grinding in the mortar, shaped into pellets and heated, depending on the composition, in the temperature range 600–1200°C.

The kind of phases contained in the samples was identified on the base of X-ray phase analysis results (the diffractometer EMPYREAN II, PANalytical with CuKα/Ni radiation).

The DTA–TG investigations in the temperature range 20-1500°C were performed by means of an SDT 2960 (TA Instruments).

Preliminary results showed that in the systems VO_2–Nb_2O_5–Fe_2O_3 and VO_2–Ta_2O_5–Fe_2O_3, the solid solutions with the orthorhombic structure $FeNbO_4$ as well as $FeTaO_4$, are formed. The research in order to determine whether in the VO_2–$Nb_2O_5(Ta_2O_5)$–Fe_2O_3 systems also form the solid solutions with the rutile-type structure is continued.

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