Phase diagram on the system SnO_2–V_2O_5–MoO_3

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The system SnO_2–V_2O_5–MoO_3 is of scientific and practical interest, since it has a low melting temperature and the glasses synthesized possess interesting properties such as high electric conductivity, low melting temperature, significant transparency in IR range, and high value of refractive index [1–3]. However, the phase diagram of the system has still not been studied.

In our former studies on the phase equilibrium in the two-component system SnO_2–V_2O_5 [4] it was established that it appears to be a simple eutectic system with the eutectic point at 50 mol% V_2O_5. The phase diagram of the system V_2O_5–MoO_3 is also known [5, 6]. It contains a chemical compound with composition $V_2O_5{\cdot}MoO_3$ (V_2MoO_8), which melts congruent at 635 °C. The third binary system, SnO_2–MoO_3, has been the subject of investigation [7, 8] as the formation of a congruent composition $2MoO_3{\cdot}SnO_2$ (Mo_2SnO_8) ($T = 903$ °C) was established.

The purpose of the present study was to determine the phase diagram in the system SnO_2–V_2O_5–MoO_3 by X-ray diffraction and by thermal difference analysis.

The preliminary estimation for the probable quasi-binary sections, made on the basis of the singular triangulation method [9], is shown in Fig. 1. At first the composition which corresponds to the crossing point *X* was studied. The batch was melted at 650 °C for 20 min, and the melt was quenched on copper plate. The X-ray pattern of the composition *X* shows characteristic interplanar spacing for SnO_2 ($d = 3.34; 2.64; 1.75$) and for V_2MoO_8 ($d = 4.12; 3.56; 3.23; 2.70; 2.64$), which was a proof for the absence of a ternary compound in the system. Moreover, the character of the phases precipitated shows that the section Mo_2SnO_8–V_2O_5 is not real. Most probable it should be the quasi-binary sections: SnO_2–V_2MoO_8 and Mo_2SnO_8–V_2MoO_8.

Section SnO_2–V_2MoO_8: The compositions from this section are shown in Table I. The synthesis was performed by two methods: (a) form oxides (SnO_2, V_2O_5, MoO_3), (b) from preliminary synthesized compounds (V_2MoO_8, Mo_2SnO_8). In both cases the batches were melted at 700–800 °C for 20 min in air and then super cooled. The samples were analyzed by DTA (Paulik-Paulik, Hungary, 10 °C/min, etalon substance Al_2O_3) and XRD (DRON-UM1, Cu K_α radiation).

All endothermic effects and the identified crystal phases are presented in Table I. The analysis of the results allows the construction of the polythermic section shown in Fig. 2. It appears to be a simple eutectic system with eutectic composition at 50 mol% V_2MoO_8 and eutectic temperature 500 ± 10 °C.

Section Mo_2SnO_8–V_2MoO_8: The compositions of this section are given in Table II. The methods and the analysis are the same as for the previous section. In Fig. 3 is shown the phase diagram, constructed from DTA and

TABLE I Section SnO_2–V_2MoO_8

N	SnO_2 (mol%)	V_2MoO_8 (mol%)	Endothermic effects	Identified crystal phases
1.	90	10	500 °C, 998 °C	Basic phase SnO_2
2.	80	20	490 °C, 900 °C	SnO_2, weak lines
3.	70	30	495 °C, 795 °C	SnO_2, V_2MoO_8
4.	60	40	500 °C, 710 °C	SnO_2, V_2MoO_8
5.	50	50	520 °C	V_2MoO_8, SnO_2
6.	40	60	490 °C, 560 °C	V_2MoO_8, SnO_2
7.	30	70	500 °C, 570 °C	V_2MoO_8, SnO_2
8.	20	80	500 °C, 610 °C	V_2MoO_8, SnO_2
9.	10	90	500 °C, 630 °C	V_2MoO_8-basic phase

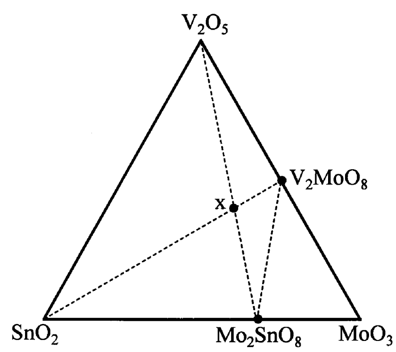

Figure 1 Possible quasi-binary sections in the system SnO_2–V_2O_5–MoO_3.

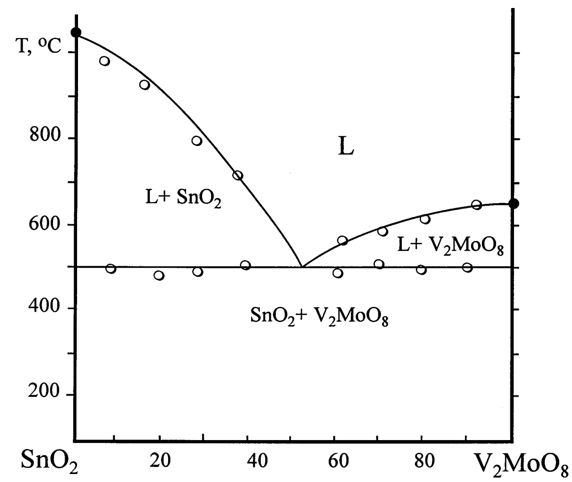

Figure 2 Phase diagram of the section SnO_2–V_2MoO_8 according to DTA and XRD data.

TABLE II Section V_2MoO_8–Mo_2SnO_8

N	V_2MoO_8 (mol%)	Mo_2SnO_8 (mol%)	Endothermic effects	Identified crystal phases
1.	10	90	440 °C, 880 °C	Mo_2SnO_8-weak lines
2.	20	80	450 °C, 770 °C	Mo_2SnO_8-basic phase, V_2MoO_8-weak lines
3.	30	70	450 °C, 705 °C	Mo_2SnO_8, V_2MoO_8
4.	40	60	455 °C, 635 °C	Mo_2SnO_8, V_2MoO_8
5.	50	50	415 °C, 515 °C	Mo_2SnO_8, V_2MoO_8
6.	60	40	500 °C	Mo_2SnO_8, V_2MoO_8
7.	70	30	450 °C, 575 °C	V_2MoO_8, Mo_2SnO_8
8.	80	20	440 °C, 600 °C	V_2MoO_8, Mo_2SnO_8
9.	90	10	450 °C, 620 °C	V_2MoO_8-basic phase

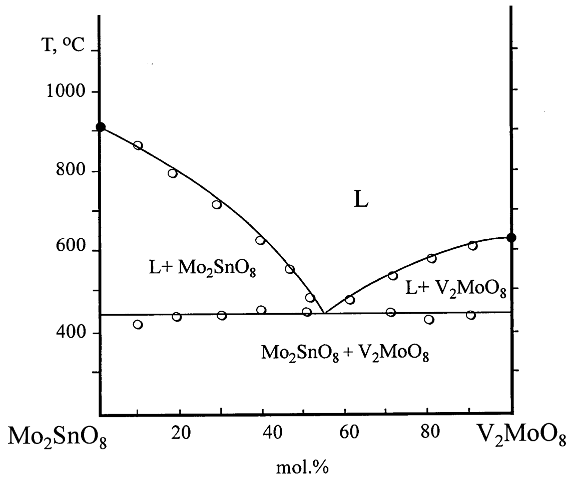

Figure 3 Phase diagram of the section Mo_2SnO_8–V_2MoO_8 according to DTA and XRD data.

XRD data. This section appears to be a eutectic system with an eutectic point at 55 mol% V_2MoO_8 and temperature 450 ± 10 °C.

Additionally, samples which belong to other polythermic sections were synthesized with an aim to precisely identify the position of the triple eutectics of the diagram. By summarizing the results the most probable phase diagram of the three-component system SnO_2-V_2O_5 was constructed (Fig. 4).

The presence of two saddle-like points (n_1 and n_2); three triple eutectics (E_1, E_2, and E_3); and five fields

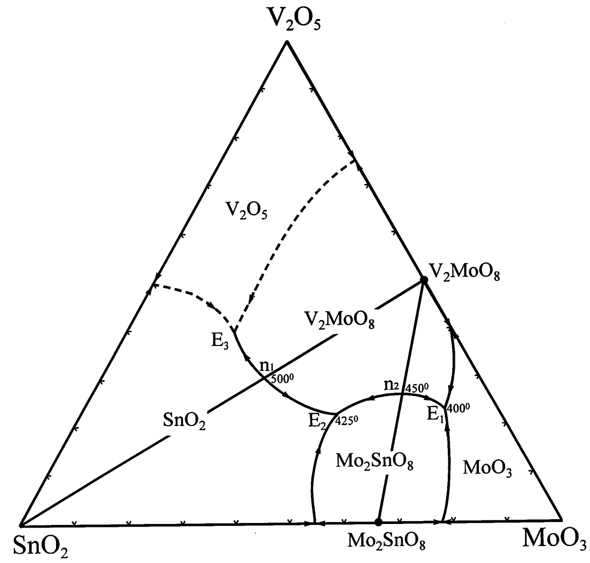

Figure 4 Phase diagram of the system SnO_2–V_2O_5-MoO_3.

of primary crystallization (SnO_2, Mo_2SnO_8, V_2MoO_8, MoO_3, and V_2O_5) was established. However, the formation of a triple chemical compound based on starting oxides was not found.

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