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3. THE INFLUENCE OF SOME ADDITIONS ON THE PROPERTIES OF GLASSES IN THE SYSTEM SiO_2–Al_2O_3–MgO–CaO

by

N. N. Yermolenko, I. K. Nemkovich, and I. L. Rakov

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13. ABSTRACT

Results are presented from a study of the influence of given glass additions and fluorine on the physicochemical properties of glass 5/10, lying in the most readily fusible range of a given system, and two glasses having the identical molar content of oxides MgO and CaO. Crystallization capacity and the influence of additions on softening temperature and thermal expansion are given.

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3. THE INFLUENCE OF SOME ADDITIONS ON THE PROPERTIES OF GLASSES IN THE SYSTEM SiO_2–Al_2O_3–MgO–CaO

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The glasses of this system can be obtained from inexpensive and non-scarce raw materials: sand, kaolin, dolomite, and chalk. Furthermore they possess a number of very valuable properties because they do not contain the oxides of alkali metals.

In the work described in the present section a study was made of the influence of additions of P_2O_5, TiO_2, $ZrSiO_4$, Cr_2O_3, and fluorine on the physicochemical properties of glass 6/10, lying in the most readily fusible range of the system SiO_2–Al_2O_3–MgO–CaO [42], and two glasses having the identical molar content of oxides MgO and CaO [43].

The chemical compositions of the initial glasses are shown in Table 11.

The glasses were cooked in quartz crucibles with a capacity of 1 liter in kerosene furnace at temperature of 1450-1460° for 5-6 hours. The composition 6/10 with the addition of 2 and 2.5 g Cr_2O_3 per 100 g of glass was crystallized during development. This same composition upon introduction into it of 1-5 g of P_2O_5

Table 11

(2) Номер стекла	(1) Состав стекла, мол. %			
	SiO_2	Al_2O_3	MgO	CaO
6/10	45	10	15	30
12	50	10	20	20
16	45	5	25	25

KEY: (1) Composition of glass, mole %; (2) Number of glass.

gives opal glass. Crystallized glasses were also obtained on the basis of compositions 12 and 16 with additions of 1-5 g of Cr_2O_3, and also composition 16 with the addition of 4-5 g of TiO_2 per 100 g of glass. Under the indicated conditions the remaining compositions were welded well. The glasses obtained were thoroughly annealed.

Crystallization capacity was determined in a gradient furnace by the method of I. F. Ponomarev.

The temperature of the onset of softening was established based on the beginning of the immersion of a needle into the sample of glass during its heating. Thermal expansion was studied with the help of a quartz dalatometer designed by the Glass Institute.

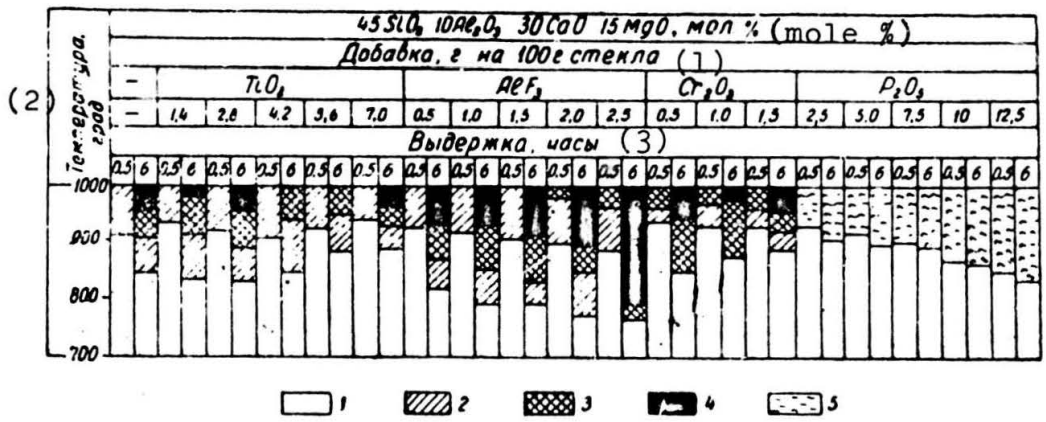
The results of the determination of crystallization capacity, softening temperature, and thermal expansion are shown in Figs. 13-16.

The chemical resistance of experimental glasses was determined with respect to water. A suspension of powdered glass with grain sizes from 0.25 to 0.5 mm was held in 100 ml of boiling water for five hours. Water resistance was evaluated according to the loss of weight of the powder during the experiment and was expressed in percentages with respect to its original weight.

All glasses were sufficiently resistant against water. The losses of weight during the test comprised 0.02-0.16%.

As can be seen from the drawings, additions of P_2O_5, $ZrSiO_4$, TiO_2 and Cr_2O_3 do not exert a noticeable influence on the softening temperature of experimental glasses in the system SiO_2–Al_2O_3–MgO–CaO; the introduction of fluoride compounds AlF_3 and Na_2SiF_6 into the glass compositions causes a significant lowering in this property. These additions influence the thermal expansion of alkali-free glasses somewhat differently. A lowering in the thermal expansion of initial glasses is caused by additions of $ZrSiO_4$. Phosphorus oxide and the chromic oxide, on the contrary, increase the expansion coefficient of the alkali-free glasses studied.

The behavior of additions of TiO_2, Na_2SiF_6, and AlF_3 in the glass depends on the content of aluminum oxide in it. In glasses with 10 mole % Al_2O_3 additions of AlF_3 and Na_2SiF_6 lead to a certain increase, and TiO_2 barely changes the thermal expansion of the glass. In glass containing 5 mole % of aluminum oxide TiO_2 causes a pronounced decrease, and Na_2SiF_6 at first facilitates an insignificant lowering, and then an increase in the expansion coefficient of experimental glass.



(2)

Fig. 13. The crystallization capacity of glass 45 SiO_2, 10 Al_2O_3, 30 CaO, 15 MgO (mole %) with additions of P_2O_5, TiO_2, Cr_2O_3, and AlF_9. 1 – no crystallization; 2 – crystalline film; 3 – crystalline shell; 4 – complete crystallization; 5 – opalescence. KEY: (1) Addition, g per 100 g of glass. (2) Temperature, deg. (3) Time lag, hours.

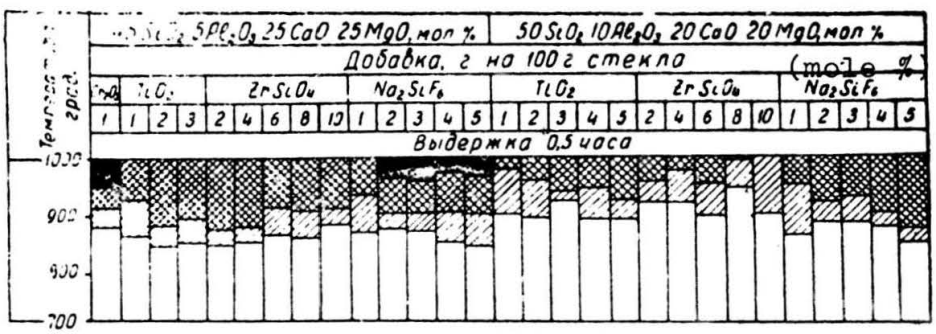


Fig. 14. The crystallization capacity of glass 45 SiO_2, 5 Al_2O_3, 25 CaO, 25 MgO, and 50 SiO_2, 10 Al_2O_3, 20 CaO, 20 MgO (mole %) with additions of TiO_2, $ZrSiO_4$, and Na_2SiF_6 with time lag of 0.5 hours (designations the same as in Fig. 13).

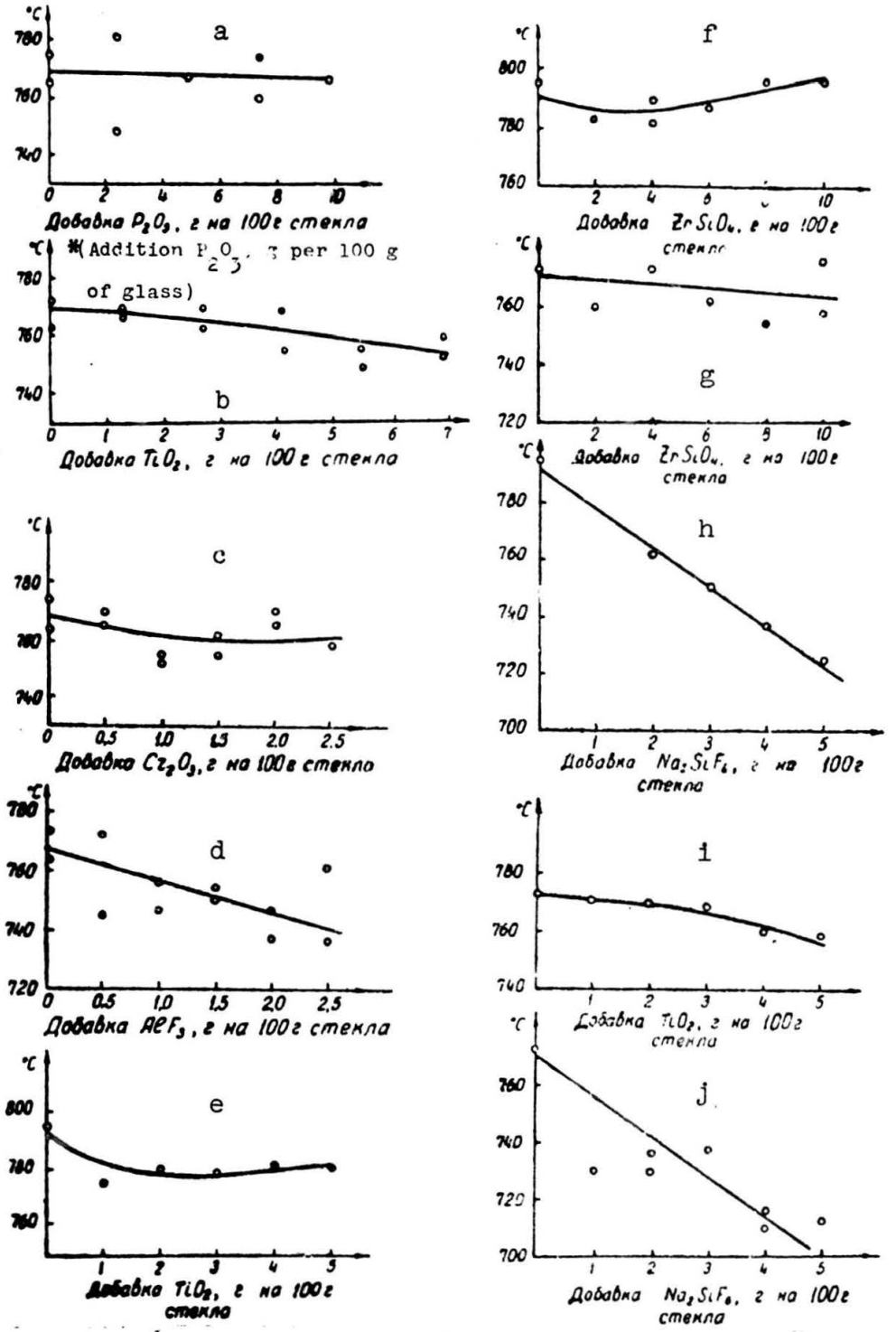


Fig. 15. The influence of additions on the softening temperature of glasses in the system SiO_2–Al_2O_3–MgO–CaO: a, b, c, d – 45 SiO_2, 10 Al_2O_3, 15 MgO, 30 CaO; e, f, g, h – 50 SiO_2, 10 Al_2O_3, 20 MgO, 20 CaO; i, j – 45 SiO_2, 5 Al_2O_3, 25 MgO, 25 CaO (mole %).

*Translator's note: Same heading for each of the ten graphs. The only change is the chemical compound.

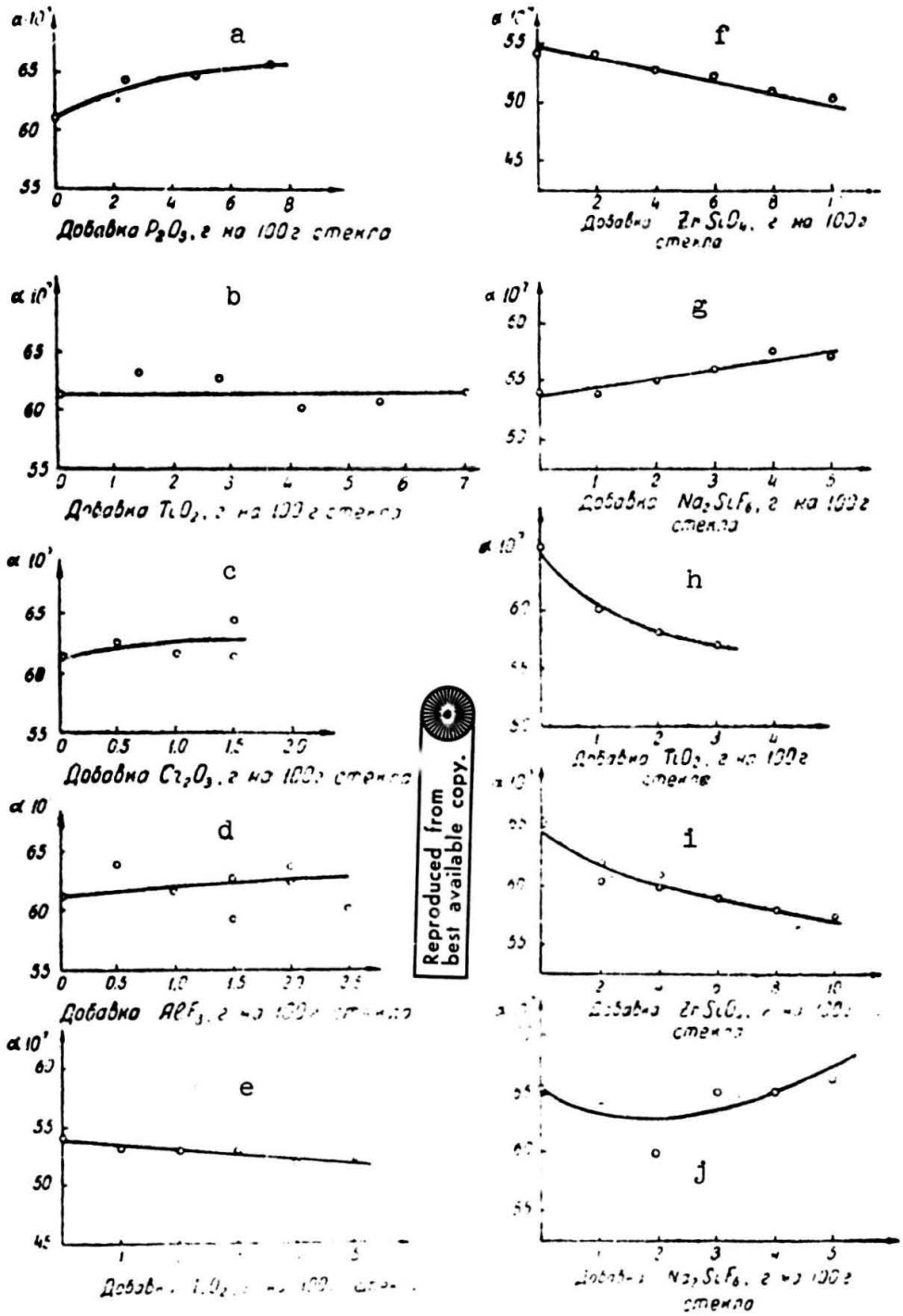


Fig. 16. The influence of additions on the thermal expansion of glasses in the system SiO_2—Al_2O_3—MgO—CaO: a, b, c, d – 45 SiO_2, 10 Al_2O_3, 15 MgO, 30 CaO; e, f, g – 50 SiO_2, 10 Al_2O_3, 20 MgO, 20 CaO; h, i, j – 45 SiO_2, 5 Al_2O_3, 25 MgO, 25 CaO (mole %). [Designations the same as in Fig. 15].