ISSN 0036-0236, Russian Journal of Inorganic Chemistry, 2016, Vol. 61, No. 10, pp. 1321–1324. © Pleiades Publishing, Ltd., 2016.
Original Russian Text © E.M. Dvoryanova, S.S. Likhacheva, I.K. Garkushin, I.M. Kondratyuk, E.I. Frolov, 2016, published in Zhurnal Neorganicheskoi Khimii, 2016, Vol. 61, No. 10, pp. 1375–1378.

PHYSICOCHEMICAL ANALYSIS OF INORGANIC SYSTEMS

Phase Equilibria in the NaCl–KI–K_2CrO_4 Stable Triangle of the Na,K||Cl,I,CrO_4 System

E. M. Dvoryanova*, S. S. Likhacheva, I. K. Garkushin, I. M. Kondratyuk, and E. I. Frolov

Samara State Technical University, ul. Molodogvardeiskaya 244, Samara, 443100 Russia

**e-mail: dvoryanova_kat@mail.ru*

Received July 2, 2015

Abstract—The NaCl–KI–K_2CrO_4 stable triangle was studied by differential thermal analysis. The melting temperature, melt composition, and specific melting enthalpy corresponding to the ternary eutectic were determined in the system. The compositions of crystallizing phases in the eutectic were confirmed by X-ray diffraction.

DOI: 10.1134/S0036023616100077

OBJECTS AND METHODS OF STUDY

Multicomponent mixtures based on halide salts and chromates of s^1 elements have a number of properties, such as low viscosity and high heat and electrical conductivity, that enable their use as a basis for the production of heat-retaining materials and some other functional materials [1–3]. Quaternary reciprocal systems based on halides and chromates of alkali metals are poorly studied, so their investigation is topical for the acquisition of information about phase equilibria and crystallizing phases in stable system elements.

In this work, the NaCl–KI–K_2CrO_4 stable triangle of the quaternary reciprocal Na,K||Cl, I,CrO_4 system was selected for study. The data on the binary systems bounding the stable triangle were taken from the literature: NaCl–KI, NaCl–K_2CrO_4 [4], KI–K_2CrO_4 [5]. All the bounding binary systems are eutectic systems.

EXPERIMENTAL

The studies were performed by differential thermal analysis on a DTA setup of conventional design [5].

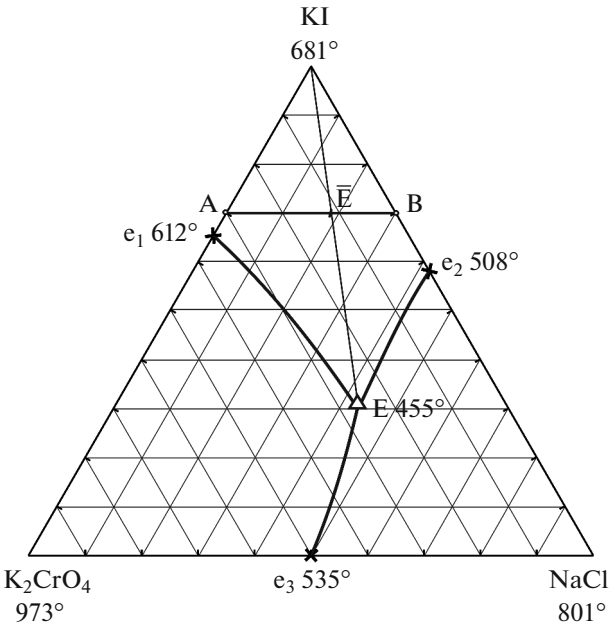

Fig. 1. NaCl–KI–K_2CrO_4 triangle and the position of polythermal section AB.

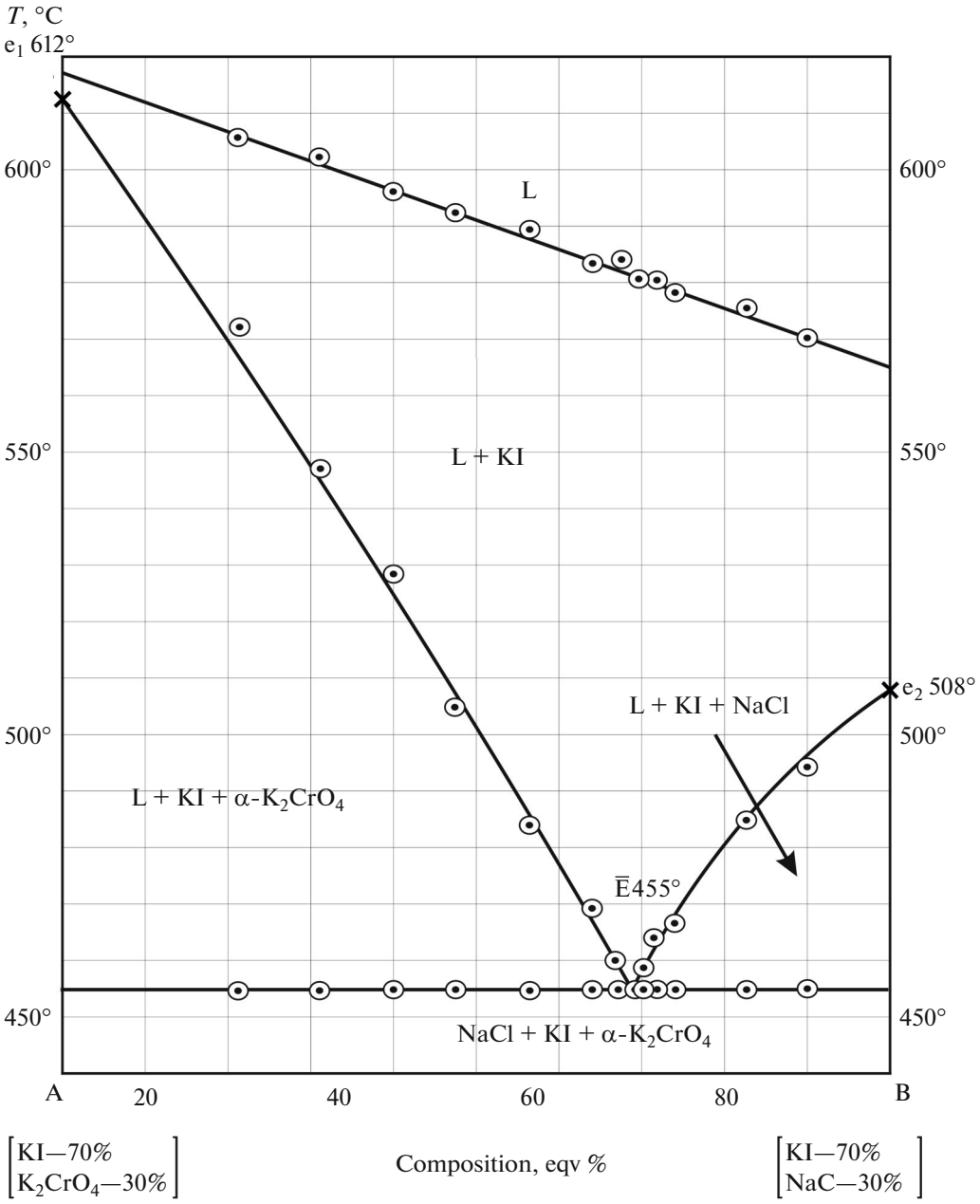

Fig. 2. *T*–*x* diagram of polythermal section AB in the NaCl–KI–K_2CrO_4 ternary system.

Phase equilibria in the stable triangle

System	Diagram element	Phase reaction
NaCl–KI–K_2CrO_4	Point	Liq ⇄ NaCl + KI + α-K_2CrO_4
	Monovariant lines: e_1–E	Liq ⇄ α-K_2CrO_4 + KI
	e_2–E	Liq ⇄ NaCl + KI
	e_3–E	Liq ⇄ α-K_2CrO_4 + NaCl

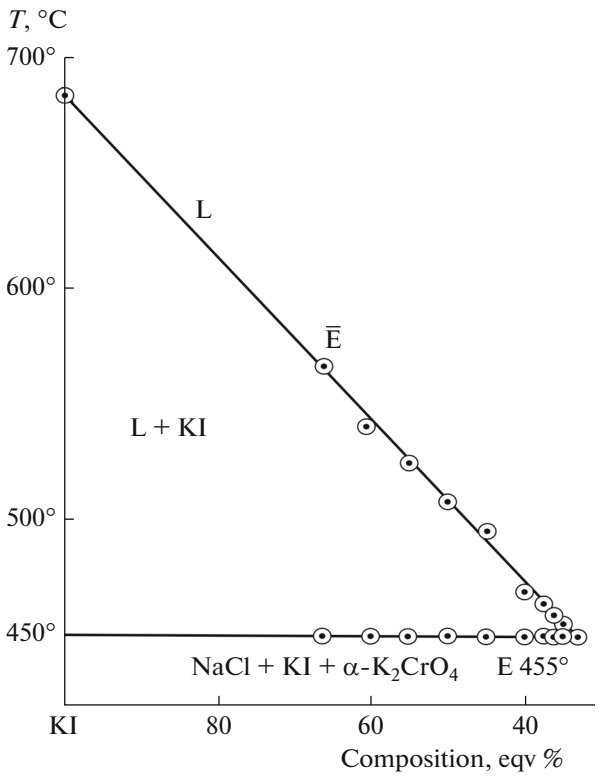

Fig. 3. T–x diagram of polythermal section KI $\rightarrow \overline{E} \rightarrow$ E in the NaCl–KI–K_2CrO_4 ternary system.

The used reagents of chemically pure grade (NaCl, KI, K_2CrO_4) were preliminary dried by calcination and remelted. The melting temperatures of the compounds corresponded to the reference data [7, 8]. The compositions are given in equivalent molar fractions expressed in percent.

The liquidus projection onto the NaCl–KI–K_2CrO_4 system triangle is shown in Fig. 1. The polythermal section A[70% KI + 30% K_2CrO_4]–B[70% KI + 30% NaCl], whose T–x diagram is shown in Fig. 2, was selected for study. This section was used to determine the ratio between potassium chromate and sodium chloride in the ternary eutectic. The content of the third component, namely, potassium iodide, and the eutectic melting temperature were determined by a further study of the invariant section passing from the sodium iodide vertex through the point of intersection of the two branches of secondary crystallization of potassium chromate and sodium chloride (Fig. 3).

RESULTS AND DISCUSSION

The NaCl–KI–K_2CrO_4 stable triangle has been studied and analyzed. The crystallization surface is presented by the sodium chloride, potassium iodide, and potassium chromate fields. Phase equilibria in the NaCl–KI–K_2CrO_4 system are presented in the table. The characteristics of the melt whose composition corresponds to invariant equilibrium, i.e., the eutectic (E 455°C) with 42.5% NaCl, 26.5% K_2CrO_4, and 31.0% KI, were determined in this system. The results of X-ray diffraction analysis for a eutectic sample are shown in Fig. 4 to confirm the compositions of phases crystallizing in the system.

The specific melting enthalpy determined for the ternary eutectic by comparison with the specific melting enthalpy of a reference component ($PbCl_2$, melting at 495°C, 85 ± 5 kJ/kg) is 185 ± 5 kJ/kg according to the results of seven measurements [9]. The molar melting enthalpy is 18 ± 0.5 kJ/mol.

ACKNOWLEDGMENTS

The studies were performed on the equipment of the Shared Facilities Center “Study of the Physico-

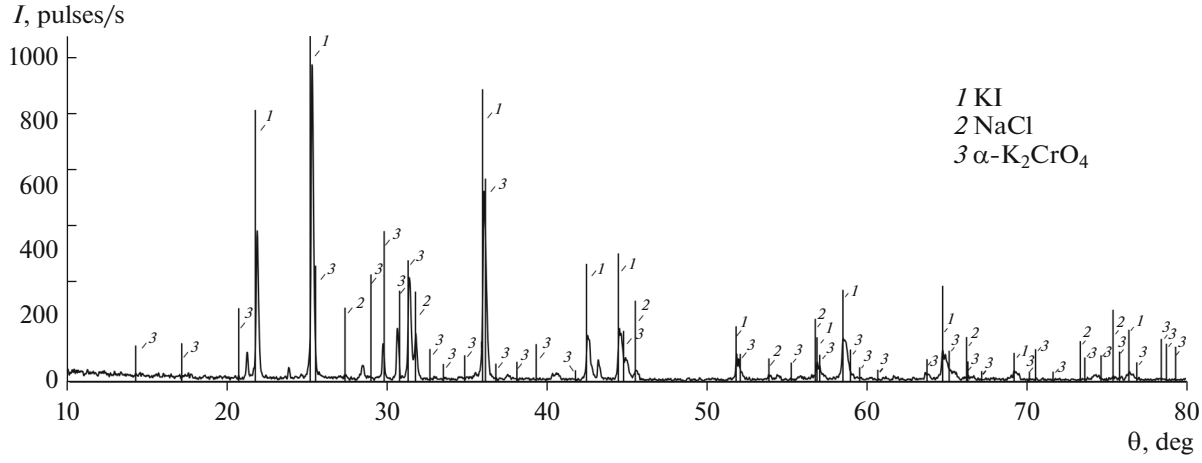

Fig. 4. X-ray diffraction pattern of a eutectic sample with the composition (%): NaCl, 42.5; K_2CrO_4, 26.5; KI, 31.0.

chemical Properties of Compounds and Materials" of the Samara State Technical University.

This work was performed within the Governmental Task for the Samara State Technical University (project code 1285).

REFERENCES

1. I. K. Garkushin, E. O. Ignat'eva, and E. M. Dvoryanova, RF Patent No. 2011141995 (2011).
2. I. K. Garkushin, E. O. Ignat'eva, and E. M. Dvoryanova, RF Patent No. 2011143547, Byull. Izobret. No. 29 (2011).
3. V. Ya. Anosov, M. I. Ozerova, and Yu. Ya. Fialkov, *Major Methods of Physicochemical Analysis* (Nauka, Moscow, 1976) [in Russian].
4. V. I. Posypaiko and E. A. Alekseeva, *Melting Diagrams for Salt Systems. Ternary Reciprocal Systems* (Khimiya, Moscow, 1977) [in Russian].
5. E. O. Ignat'eva, E. M. Dvoryanova, and I. K. Garkushin, *Proceedings of the 6th International Conference "Quality Strategy in Industries and Education"* (Varna, Dnepropetrovsk, 2010), p. 168 [in Russian].
6. V. P. Egunov, *The Introduction to Thermal Analysis* (SamVen, Samara, 1996) [in Russian].
7. *The Thermal Constants of Materials. Handbook*, Ed. by V. P. Glushko (VINITI, Moscow, 1981), Vol. 10, Pt. 1 [in Russian].
8. *The Thermal Constants of Materials. Handbook*, Ed. by V. P. Glushko (VINITI, Moscow, 1981), Vol. 10, Pt. 2 [in Russian].
9. N. A. Vasina, E. S. Gryzlova, and S. G. Shaposhnikova, *Thermophysical Properties of Multicomponent Salt Systems* (Khimiya, Moscow, 1984) [in Russian].

Translated by E. Glushachenkova