The Research of noncongruent phase transition properties in coulomb systems based on the model of the binary ionic mixture

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A simple model of Coulomb noncongruent phase transition (NCPT) gas-liquid type with an upper critical point in modified model with no associations [1] of a binary ionic mixture (BIM ) on a homogeneous compressible ideal background (or non-ideal) electron gas was built in this work/ BIM (~)/In the case of one ion species this modification is a superposition of correlated only "in average" models OCP of ions and OCP of electrons on the electrostatic compensating background (Double OCP [2]). The analytical approximation (EoS) of Potekhin and Chabrier [3] was used for describing the ion-ion correlations (Coulomb nonideality) in combination with "linear mixture" approximation (LM - Linear Mixing Rule).Ichimaru approximation was used for describing the electron-electron corellations [4]. Phase equilibrium for the charged components was calculated according to the Gibbs-Guggenheim conditions [1], the equality of generalized electrochemical potentials.

Because of the taken simplifications the BIM (~) model allows to calculate full set of parameters of the phase equilibrium and trace in details features of the realization of noncongruent equilibrium in comparison with the simpler (standard) forced-congruent evaporation mode. In particular, in BIM (~) there were reproduced two-dimensional ("banana-like") structure of two-phase region *Р–Т* boundary of phase diagram and the characteristic nonmonotonic shape of caloric phase enthalpy-temperature diagram, similar to those obtained previously in the calculations of the noncongruent evaporation of reactive plasma products in high-temperature heating with the uranium-oxygen system [5].The parameters of critical points (CT) line were calculated on the entire range of proportions of ions 0 < *х* < 1, including two reference values, when CT of noncongruent evaporation coincides with two "end" points on the boundary of the two-phase region - a point of extreme temperature and extreme pressure, *хТ* and *хР*. On the *х-Т* diagram there were calculated high-temperature fields of so-called "retrograde" regime of crossing two-phase area with isotherms, isobars and isoentropes. Finally, it is clearly demonstrated the low-temperature property of noncongruent gas-liquid transition - "distillation" , which is weak in chemically reactive plasmas [5-6], and in contrast, is clearly seen in the exotic realization of noncongruent transition in superdense nuclear matter [7].

References

1. Iosilevskiy I. Thermodynamics of non-ideal plasmas, in: “Encyclopedia of Low-Temperature Plasma Physics” (Suppl. B, V.III-1), Eds. A.Starostin and I.Iosilevskiy, Moscow: Fizmatlit, 2004, PP.349-428 (in Russian)
2. Iosilevskiy I., High Temperature **23**, 807 (1985) [arXiv:0901.3535](http://xxx.lanl.gov/abs/0901.3535)
3. Potekhin A.Y., Chabrier G. Phys. Rev. **E** **62,** 8554 (2000) // **E** **79**, 016411 (2009)
4. Ichimaru S., Iyetomi H., and Tanaka S., Phys. Rep. **149**, 91 (1987).
5. Iosilevskiy I., Hyland G., Yakub E., Ronchi C. Int. Journ. Thermophys. **22,** 1253 (2001)
6. Iosilevskiy I., Gryaznov V., et al. Bulletin Russ. Acad. Sci. (Izvestia RAS), N **5**, 115 (2011)
7. Hempel M., Dexheimer V., Schramm S., Iosilevskiy I., Phys. Rev. C **88**, 014906 (2013)