Non-Congruent Phase Transitions in Compounds and Chemical Mixtures

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Non-congruent phase transition (NPT) is discussed as general form of phase coexistence in complex systems (high-energy-density compounds and/or chemical mixtures). One finds NPT widely in terrestrial and astrophysical applications. The basic feature of NPT is their ability to vary chemical composition of coexisting phases with no violation of total composition of two-phase system. Non-congruence leads to essential change in properties of phase transition in comparison with standard phase transitions in ordinary substances. Non-congruent phase transformation *dynamics* is defined as strong dependence of phase transition parameters on the rapidity of the transition, while the NPT *thermodynamics* is the essential change in properties of two-phase region boundaries including critical point(s). Several examples of non-congruent fluid-fluid phase transitions are considered. The basic case is non-congruent evaporation in high-temperature uranium–oxygen system, which parameters up to the critical point have been studied thoroughly in frames of nuclear reactor safety problem [1]. Two representations for this non-congruent phase coexistence are comparatively discussed: molecular and highly ionic ones. The second example [2] is non-congruence of hypothetical "plasma" and/or "dissociative" phase transitions in H_2/He (or even in H_2/He/H_2O/NH_3/CH_4) mixture in conditions of interiors of giant and extrasolar planets. The third example is the non-congruence of gas-liquid phase transitions in ionic liquids and molten salts. We stress basic difference from the viewpoint of non-congruency between phase transitions in real molten salts and in their standard two-component modeling equivalents (hard and soft "primitive" models) traditionally studied via numerical simulations. Non-congruence in other mixtures and compounds (oxides, hydrides, metallic alloys) are also briefly discussed.

[1] I. Iosilevski, G. Hyland, E. Yakub, C. Ronchi, *Int. J. Thermophys.* **22,** 1253, (2001); C. Ronchi, I. Iosilevskiy, E. Yakub, "*Equation of State of Uranium Dioxide*", Springer, Berlin, 2004, 366 pp.
[2] I. Iosilevskiy, V. Gryaznov et al., *Contrib. Plasma Phys.* **43**, 316 (2003).