Non-congruent phase transitions in plasmas of chemical mixtures

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The basic feature of high-temperature phase equilibrium in compounds of two or more chemical elements is their possible 'non-congruence', i.e. ability to vary stoichiometry of coexisting phases with no violation of total stoichiometry of two-phase system. Non-congruence leads to essential change in properties of inter-phase boundaries and critical point(s) in comparison with standard phase transitions in ordinary substances. Structure of non-congruent phase boundaries is similar but not equivalent to those in ordinary solution theory. The features and parameters of non-congruent evaporation in high-temperature uranium–oxygen plasma have been studied in frames of nuclear reactor safety problem [1]. Applied importance of these results [2] encouraged experimental efforts in frames of ISTC project with the use of strong shock wave and heavy ion beam irradiation techniques [3]. This study is in progress [5].

Non-congruence is not exclusion, but general rule. Hypothetical non-congruence [1] of 'plasma' phase transitions (PPT) in H2/He mixture in conditions of interiors of giant planets and brown dwarfs is under present discussion. As demonstrative example, non-congruence of PPT was estimated roughly for PPT variant of Saumon and Chabrier [4], which is widely used in astrophysical applications. The magnitude of estimated effect proved to be noticeable and its sigh is in agreement with really observed lowering of helium abundance in atmosphere of Jupiter and Saturn. This result approves providing of full-size calculation of non-congruence for every theoretically predicted phase transitions (ionization and dissociation driven) in H_2/He mixture of astrophysical objects.

Another example of hypothetical non-congruence is discussed for the case of gas-liquid phase transition in molten salts. Great number of such phase transitions is known. All of them must be non-congruent. The difference from the viewpoint of non-congruency between real phase transitions in molten salts and its simplified equivalents in ionic models is emphasized.

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