Relationship of the Physicochemical Constants with Periodic Law

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Different relationships between the various physical and chemical properties of isostructural compounds take place according to the Periodic Law that is a fundamental basis of Chemistry. Previous review articles evidenced the relation of thermodynamic data with Periodic Law and established a strict relationship between the enthalpy of formation, melting point and the atomic numbers of components in the semiconductor $A^{III}B^{V}$ phases, with diamond-like structure of sphalerite and wurtzite types. The proposed model was used for the critical assessment of the thermodynamic properties of isostructural compounds. The relationship between the reduced enthalpy ($^{\Delta_f H^o_{298}}/_{T_m}$), standard entropy ($S^o_{298}$), reduced Gibbs energy and the sum of the atomic numbers ($Z_i = Z_A + Z_B$) has been used for a critical assessment of the thermodynamic properties of $A^{III}B^{V}$ phases.

The Similarity Method was used for the critical analysis of specific heats $C^o_p(T)$ for solid state of the $A^{III}B^{V}$ isostructural phases. A critical analysis of heat capacities $C^o_p(T)$ was carried out for the pure elements of the Periodic System fourth group (C, Si, Ge, Sn) and isostructural phases $A^{III}B^{V}$ and $A^{II}B^{VI}$. It was found that the dependence of the heat capacities $C^o_p(T)$ from 0 to 1500 K follows certain regularity. Phases with the same sum of the atomic numbers of elements (Z_i), such as BN (hex) $Z_i = 12$ and glassy pure carbon $Z = 6$; BP and AlN ($Z_i = 20$); AlP ($Z_i = 28$) and pure Si ($Z = 14$); BAs and GaN ($Z_i = 38$); AlAs and ZnS ($Z_i = 46$); AlSb, GaAs, InP, CDs ($Z_i = 64$) and pure Ge ($Z = 32$); GaSb, InAs, and CdSe ($Z_i = 82$); InSb, CdTe ($Z_i = 100$) and pure grey Sn ($Z= 50$); have the same heat capacity experimental values of the solid state within the experimental uncertainty.

The second group is concerned of the rare earth metals and their compounds and the actinides. The "tetrad-effect" phenomenon was established and used for the analysis, correction and prediction of thermodynamic data for the lanthanide (Ln) compounds and the pure actinides (Ac). They are connected to the 4f-electrons of the lanthanide elements (Ln: La-Lu; their atomic numbers are 57-71) and 5f-electrons of the actinides with atomic numbers from89 to 102. The most sensitive to the tetrad-effect the thermodynamic functions of lanthanide and actinide compounds are standard entropies and entropies of formation, because they are the most susceptible to the influence of the 4f- and 5f electrons of the lanthanides and the actinides. We analyzed some classes of lanthanides with other elements of the Periodic Table, which account for only a sampling of the thousands of similar binary compounds possible. As an example, we use the tetrad-effect concept for the analysis and prediction of the standard entropies of the solid phases as the Ln2X3 (X=O, S, Se, Te). This approach can also be applicable to other classes of the Ln compounds as LnN, LnB_2, LnB_4, LnB_6, LnF_3, $LnIn_3$ and other compounds. Unfortunately, the actinides and the alloys on the base these elements are studied insufficiently, but it is possible to apply to them the same laws.

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