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Key words: Transition metal diborides, phase equilibria, solid solutions, high entropy diborides

Compositions in the AlB2-ScB2-YB2-ZrB2-HfB2-NbB2-TaB2 system were selected to determine the effect of electronic structure on phase equilibria and solid solubility. The Group IVB diborides have the highest stability considering a melting point criterion (e.g., ZrB2 with 10 valence electrons per unit cell, or 10 e-/uc) and three systems were investigated to characterize phase equilibria at or near this optimum valence electron sum. The materials were synthesized by hot-pressing diboride powder mixtures at 1750°C followed by heat-treatments at 1900 and 2000°C. The compositions in the system xScB2-(1-x)TaB2 (varying from 9 to 11 e-/uc, respectively), with a metal atom radius difference of 7.4%, exhibited complete solid solubility that could be attributed to the change of the net valence electron sum toward the optimum 10 e-/uc value. The xScB2-(1-x)ZrB2 system (varying from 9 to 10 e-/uc, respectively) was found to be quasi-binary, but exhibited insignificant solid solubility despite the metal atom radius of Sc being smaller than Zr by only 1.2%. The lack of solubility is attributed to an electronic structure based incompatibility. The system x(ZrB2)-(1-x)(0.5ScB2 - 0.5TaB2), with a valence electron sum of 10 e-/uc for all x, exhibited complete solid solubility. Very similar results were found for the YB2-ZrB2-TaB2 system, with the exception that significant solubility of ZrB2 in YB2 was observed. The unidirectional solubility is attributed to an electronic structure based stabilization of the YB2. The compatibilities observed for all compositions investigated indicate that ZrB2-ScB2-TaB2 and ZrB2-YB2-TaB2 are quasi-ternary systems. Additional 4, 5, and 6 component diboride systems with an average valence sum of 10 e-/fu were also investigated in the AlB2-ScB2-YB2-ZrB2-HfB2-NbB2-TaB2 system, and many formed solid solutions. The results confirm the significance of electronic structure for phase equilibria and solid solubilities for these diborides. The solid solutions also provide a basis for further investigations as high entropy boride systems.