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A thermodynamic analysis of the Ge-Ru system

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The experimental phase equilibria of the Ge-Ru system was first determined by Raub and Fritzsche [1] who reported the existence of two intermediate phases: GeRu which formed congruently at 1470°C and Ge_3Ru_2 which formed by a peritectic reaction at 1452°C. Later, Perring et al. [2] reinvestigated the phase relationship of this system by means of differential thermal analysis (DTA), X-ray diffraction (XRD) and electron probe microanalyses (EPMA). They found that GeRu and Ge_3Ru_2 melted congruently at 1510°C and 1551°C respectively.

The first optimization of the Ge-Ru system was performed by Charles et al. [3] on the basis of the experimental results of Perring et al. [2]. They noted a problem concerning the calculated temperature of the eutectic L ↔ GeRu + βGe_3Ru_2 equilibrium which differs from experiment by about 20°C equal to the melting point of GeRu (1508°C). Most recently, Long et al. [4] performed an assessment of the Ge-Ru system using the mixing enthalpies of the liquid calculated from the Miedema's empirical model [5] in spite of the fact that a factor of 4 could be noted between the experimental enthalpy of formation and the Miedema's model predicted one for the Ge_3Ru_2 phase. These authors adopted the peritectic reaction L + βGe_3Ru_2 ↔ GeRu instead of the eutectic equilibrium reported more recently by [2] and mentioned that further studies on this reaction are necessary.

In light of these results, we have reassessed the thermodynamic parameters of the Ge-Ru system to take into account the recent experimental data determined by [2-6]. Particular attention was accorded to the controversial equilibrium involving the liquid, βGe_3Ru_2 and GeRu phases. This work first provides a critical review of the experimental phase equilibrium and thermodynamic data available in the literature, then presents the thermodynamic models used, and discusses the results obtained.

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