JPEDAV (2004) 25:550
DOI: 10.1361/15477020421197
1547-7037/$19.00 ©ASM International

Fe-Gd-Mo (Iron-Gadolinium-Molybdenum)

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This ternary system was reviewed recently by [2001Rag]. Based mainly on the results of Zinkevich et al. [1999Zin1, 1999Zin2, 1999Zin3, 2000Zin1], the review presented a liquidus projection, three isothermal sections at 1200, 800, and 600 °C, and a reaction scheme from the solidification range to room temperature. Recently, [2002Zin] carried out a thermodynamic assessment of the system.

Binary Systems

In the Fe-Gd system, the four line compounds, $Fe_{17}Gd_2$, $Fe_{23}Gd_6$, Fe_3Gd, and Fe_2Gd, form through successive peritectic reactions. The Fe-Mo system shows a closed γ loop and a significant solubility of Mo in body-centered-cubic (bcc) Fe and of Fe in Mo. The intermediate phases R and σ form through peritectic reactions and decompose at or above 1200 °C. Two other intermediate phases μ and λ form through peritectoid reactions and are stable at lower temperatures. In the Gd-Mo system, there are no intermediate phases. A liquid miscibility gap is present with a monotectic reaction at 2472 °C. The final solidification is through a eutectic reaction at 1299 °C at the Gd end. In their ternary assessment, [2002Zin] used the binary descriptions of [2000Zin2] for Fe-Gd, [1988And] for Fe-Mo, and [2001Zin] for Gd-Mo.

Thermodynamic Assessment of the Ternary System

[2002Zin] modeled the Gibbs energy of the individual phases on the basis of a generalized sublattice formalism. The liquid phase was described using a regular solution model. It was found necessary to introduce a ternary interaction parameter to account for the presence of the liquid phase in the ternary region down to 650 °C. The terminal solid solutions face-centered cubic (fcc), bcc, and close packed hexagonal (cph) were modeled on the basis of a two-sublattice model. The excess free energy due to magnetic ordering was taken into account. The σ, R, and μ phases were treated by a three-sublattice model. The first and second sublattices are filled with Fe and Mo atoms, respectively, the third one being a solution sublattice containing both Fe and Mo atoms. The λ phase was treated as a stoichiometric phase. The ternary compound $Gd(Fe,Mo)_{12}$ ($ThMn_{12}$-type, tetragonal, denoted 1:12 by [2001Rag], and τ by [2002Zin]) was described by a four-sublattice model. This allowed modeling the homogeneity range of the compound represented by $Gd_{1+n}Fe_{12-x-y}Mo_x\square_y$, where □ is a vacancy, $0 < n < 0.2$, $1.3 < x < 3.7$, and $0.6 < y < 0.9$. The other ternary compound $Gd_3(Fe_{1-x}Mo_x)_{29}$ {$Nd_3(Fe,Ti)_{29}$-type monoclinic, denoted 3:29 by [2001Rag] and ζ by [2002Zin]} was not modeled. It is stable only over a narrow temperature range of ~1200-1000 °C. [2002Zin] computed a liquidus projection and three isothermal sections at 1200, 800, and 600 °C. These are in satisfactory agreement with the experimental diagrams reviewed in [2001Rag]. In addition, [2002Zin] computed three vertical sections (not shown here) at 8 and 9 at.% Gd and at 20 at.% Mo. There are no experimental results to compare with these computed sections.

References

1988And: J.O. Andersson, A Thermodynamic Evaluation of the Fe-Mo-C System, *CALPHAD,* Vol 12 (No. 1), 1988, p 9-23

1999Zin1: M. Zinkevich, N. Mattern, and K. Wetzig, Experimental Study of Ternary Fe-Gd-Mo Phase Diagram, *J. Phase Equilibria,* Vol 20 (No. 2), 1999, p 119-124

1999Zin2: M. Zinkevich, N. Mattern, H Wendrock, G. Behr, and K. Wetzig, Solidification Behavior of Fe-Gd-Mo Alloys, *J. Alloys Compd.,* Vol 283 (No. 1-2), 1999, p 265-281

1999Zin3: M. Zinkevich, N. Mattern, and K. Wetzig, Phase Relations in the Fe-rich Region of the Fe-Gd-Mo Ternary System at 800°C, *J. Phase Equilibria,* Vol 20 (No. 5), 1999, p 471-474

2000Zin1: M. Zinkevich, N. Mattern, H. Wendrock, and K. Wetzig, Phase Equiilibria in the Ternary System Fe-Gd-Mo at 600°C, *Mikrochim. Acta,* Vol 133 (No. 1-4), 2000, p 243-251

2000Zin2: M. Zinkevich, N. Mattern, and H.J. Seifert, Reassessment of the Fe-Gd (Iron-Gadolinium) System, *J. Phase Equilibria,* Vol 21 (No. 4), 2000, p 385-394

2001Rag: V. Raghavan, Fe-Gd-Mo (Iron-Gadolinium-Molybdenum), *J. Phase Equilibria,* Vol 22 (No. 2), 2001, p 147-153

2001Zin: M. Zinkevich, N. Mattern, and H.J. Seifert, Thermodynamic Assessment of the Gd-Zr and Gd-Mo Systems, *J. Phase Equilibria,* Vol 22 (No. 1), 2001, p 43-50

2002Zin: M. Zinkevich, N. Mattern, H.J. Seifert, and E. Gmelin, A Thermodynamic Assessment of the Fe-Gd-Mo System, *Scand. J. Metall.,* Vol 31, 2002, p 34-51