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Fe-Ti-Zr (Iron-Titanium-Zirconium)

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The earlier review of this system by [1992Rag] gave a peritectic type of pseudobianry section along the Fe_2Ti-Fe_2Zr join. More recently, a tentative isothermal section at 900 °C determined by [2007Zho] was reviewed by [2009Rag]. Very recently, [2010Zho] reported an isothermal section at 750 °C.

Binary Systems

There are two intermediate phases in the Fe-Ti system: Fe_2Ti (*C*14, $MgZn_2$-type hexagonal) and FeTi (*B*2, CsCl-type cubic) [1998Dum]. According to the Fe-Zr phase diagram proposed by [2002Ste], the intermediate phases in the system are: hexagonal Fe_2Zr (26.5-27.0 at.% Zr; *C*36, $MgNi_2$-type hexagonal, stable between 1345 and 1240 °C), cubic Fe_2Zr (27.5-34.4 at.% Zr; *C*15, $MgCu_2$-type cubic, stable from 1673 °C to room temperature), $FeZr_2$ (*C*16, $CuAl_2$-type stable between 951 and 780 °C), and $FeZr_3$ ($E1_a$, Re_3Nb-type orthorhombic, stable below 851 °C). The authors concluded that $Fe_{23}Zr_6$ (or Fe_3Zr) is not an equilibrium phase. The Ti-Zr phase diagram [Massaslki2] shows that βTi-βZr and αTi-αZr pairs form continuous solid solutions.

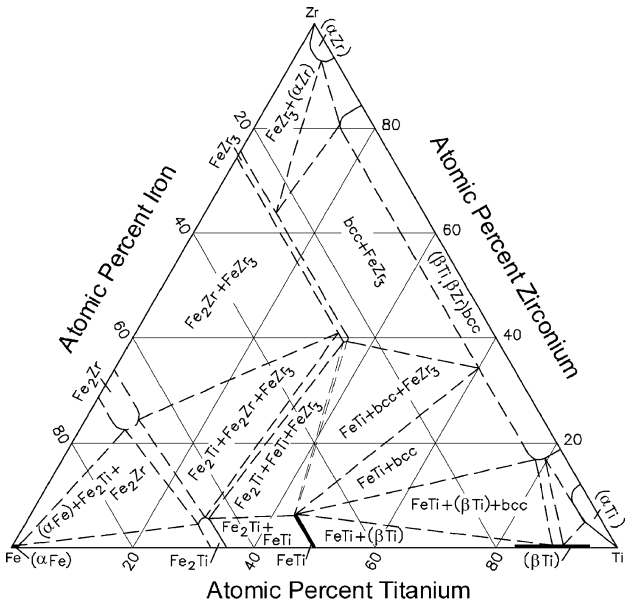

Fig. 1 Fe-Ti-Zr tentative isothermal section at 750 °C [2010Zho]

Ternary Isothermal Section

With starting metals of 99.9% Fe, 99.5% Ti, and 99.9% Zr, [2010Zho] prepared diffusion triples, where a pure Fe block was welded to a Ti-Zr couple. The arrangement was diffusion annealed at 750 °C for 5760 h. The phase compositions were measured with electron probe micro-analyzer. From the results of [2010Zho], a tentative isothermal section at 750 °C is shown in Fig. 1, drawn to agree with the accepted binary data and to be consistent with the observation of [2010Zho] that Ti and Zr substitute for each other within limits in the Fe-Ti and Fe-Zr binary compounds. Fe_2Ti and FeTi dissolve 5.6 and 6.3 at.% Zr, respectively. Fe_2Zr and $FeZr_3$ dissolve 8.5 and 35.7 at.% Ti. $FeZr_2$ is not stable at this temperature. $Fe_{23}Zr_6$, reported as a metastable phase by [2002Ste], was not found. No ternary phases were found [2010Zho].

References

1992Rag: V. Raghavan, The Fe-Ti-Zr (Iron-Titanium-Zirconium) System, *Phase Diagrams of Ternary Iron Alloys. Part 6*, Indian Institute of Metals, Calcutta, 1992, p 1223-1224

1998Dum: L.F.S. Dumitrescu, M. Hillert, and N. Saunders, Comparison of Fe-Ti Assessments, *J. Phase Equilib.*, 1998, **19**(5), p 441-448

2002Ste: F. Stein, G. Sauthoff, and M. Palm, Experimental Determination of Intermetallic Phases, Phase Equilibria, and Invariant Reaction Temperatures in the Fe-Zr System, *J. Phase Equilib.*, 2002, **23**(6), p 480-494

2007Zho: G.J. Zhou, S. Jin, L.B. Liu, H.S. Liu, and J.P. Jin, Determination of Isothermal Section of Fe-Ti-Zr Ternary System at 1173 K, *Trans. Nonferrous Met. Soc. China*, 2007, **17**(5), p 963-966

2009Rag: V. Raghavan, Fe-Ti-Zr (Iron-Titanium-Zirconium), *J. Phase Equilib. Diffus.*, 2009, **30**(1), p 109

2010Zho: G. Zhou, D. Zeng, and Z. Liu, Phase Equilibria in the Fe-Ti-Zr System at 1023 K, *J. Alloys Compd.*, **490**, p 463-467