JPEDAV (2004) 25:552
DOI: 10.1361/15477020421214
1547-7037/$19.00 ©ASM International

Fe-Nb-Ni (Iron-Niobium-Nickel)

V. Raghavan

The binary compound Ni_3Nb forms a low energy interface with Ni and is an effective strengthener of the Ni-based high temperature alloys. The previous review of this system by [1992Rag] presented a tentative isothermal section at 1000 °C from the work of [1989Sav]. Recently, [2001Tak] constructed an isothermal section at 1200 °C for the Nb-poor region.

Binary Systems

The Fe-Nb phase diagram [2002Oka] depicts two intermediate phases Fe_2Nb (ε) and Fe_7Nb_6 (μ). The former is a Laves phase of the *C*14 type. Its homogeneity range is smaller than what was shown in the earlier reports. The μ phase has the $D8_5$, Fe_7W_6-type structure. The Fe-Ni phase diagram [1991Swa] is characterized by a very narrow solidification range, with a peritectic reaction at 1514 °C between body-centered cubic (bcc) δ and liquid that yields the Fe-based face-centered cubic (fcc) solid solution. A continuous solution denoted γ between fcc Fe and Ni is stable over a wide range of temperature. At 517 °C, an ordered phase $FeNi_3$ forms congruently from γ. The Nb-Ni phase diagram [1998Oka] has two intermediate phases: Ni_3Nb (δ) and Ni_6Nb_7 (μ). Ni_3Nb is orthorhombic with the βCu_3Ti-type $D0_a$ structure. The μ phase has the $D8_5$, Fe_7W_6-type structure.

Ternary Isothermal Section

Using high-purity metals, [2001Tak] arc melted about ten alloys, which were given a final anneal at 1200 °C for 240 h. The phase equilibria were studied by scanning and transmission electron microscopy, electron probe microanalysis, and x-ray powder diffraction. The isothermal section constructed by them at 1200 °C is redrawn in Fig. 1 to agree with the accepted binary data. A ternary phase τ is present at this temperature at the composition Fe-22Nb-58Ni (at.%). It has a hexagonal structure (*hP*24), with the stacking sequence of *abcbcb*. A small liquid field is present around the composition Fe-20Nb-55Ni. Ni_3Nb dissolves up to ~10 at.% Fe, whereas the Laves phase Fe_2Nb dissolves up to ~44 at.% Ni. Tie-lines were determined by [2001Tak] between γ and Ni_3Nb and between Ni_3Nb and the solid solution based on Fe_2Nb as shown in Fig. 1. The phase equilibria in the Ni-rich corner of Ni-Nb-M (M: Fe, Co, Al, Ti) were examined by [1997Uey].

References

1989Sav: V.V. Savin, Formation and Stability of Laves Phases in the Nickel-Iron-Niobium System, *Fiz. Met. Metalloved.,* Vol 68 (No. 1), 1989, p 143-149 (in Russian); TR: *Phys. Met. Metallogr.,* Vol 68 (No. 1),1989, p 140-146

1991Swa: L.J. Swartzendruber, V.P. Itkin, and C.B. Alcock, The Fe-Ni (Iron-Nickel) System, *J. Phase Equilibria,* Vol 12 (No. 3), 1991, p 288-312

1992Rag: V. Raghavan, The Fe-Nb-Ni (Iron-Niobium-Nickel) System, *Phase Diagrams of Ternary Iron Alloys. Part 6,* Indian Institute of Metals, Calcutta, 1992, p 1025-1027

1997Uey: T. Ueyama, M.M. Ghanem, N. Miura, M. Takeyama, and T. Matsuo, Phase Stability of Ni_3Nb-δ Phase in Ni-Nb-M Systems at Elevated Temperatures, *THEROMEC-97, Int. Conf. Thermomech. Process. Steels Other Mater.,* 2nd ed., T. Chandra and T. Sakai, Ed., The Minerals, Metals and Materials Soc., Vol 2, 1997, p 1753-1760

1998Oka: H. Okamoto, Nb-Ni (Niobium-Nickel), *J. Phase Equilibria,* Vol 19 (No. 3), 1998, p 289

2001Tak: M. Takeyama, S. Morita, A. Yamauchi, M. Yamanaka, and T. Matsuo, Phase Equilibria Among γ, Ni_3Nb-δ and Fe_2Nb-ε Phases in Ni-Nb-Fe and Ni-Nb-Fe-Cr Systems at Elevated Temperatures, *Superalloys 718, 625, 706 and Various Derivatives,* E.A. Loria, Ed., The Minerals, Metals and Materials Society, 2001, p 333-344

2002Oka: H. Okamoto, Fe-Nb (Iron-Niobium), *J. Phase Equilibria,* Vol 23 (No. 1), 2002, p 112

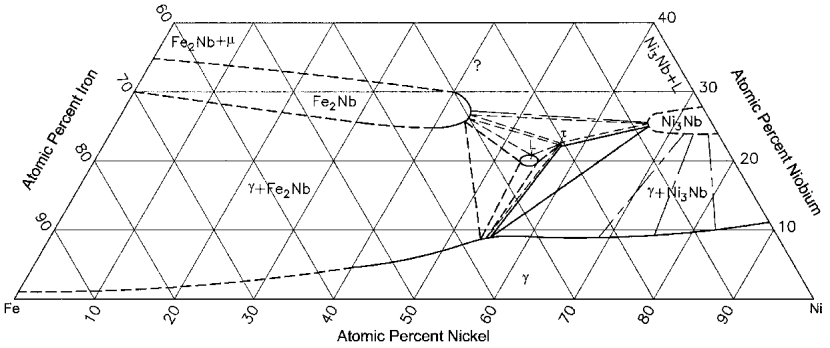

Fig. 1 Fe-Nb-Ni isothermal section at 1200 °C [2001Tak]