JPEDAV (2008) 29:448–449
DOI: 10.1007/s11669-008-9378-9
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Fe-Nd-Sb (Iron-Neodymium-Antimony)

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Recently, [2007Zen] determined an isothermal section for this ternary system at 500 °C, which depicts five ternary compounds.

Binary Systems

The Fe-Nd phase diagram depicts two intermediate phases: $Fe_{17}Nd_2$ (Th_2Zn_{17}-type rhombohedral) and $Fe_{17}Nd_5$ (hexagonal, space group $P6_3/mcm$). The Fe-Sb phase diagram [1997Ric] has two intermediate phases: $FeSb_{1-x}$ (41-49 at.% Sb; $B8_1$, NiAs-type hexagonal) and $FeSb_2$ ($C18$, marcasite-type orthorhombic). The Nd-Sb phase diagram [1992Cac] has the following intermediate phases: Nd_2Sb (La_2Sb-type tetragonal), Nd_5Sb_3 ($D8_8$, Mn_5Si_3-type hexagonal), Nd_4Sb_3 ($D7_3$, Th_3P_4-type cubic), NdSb ($B1$, NaCl-type cubic), and $NdSb_2$ ($SmSb_2$-type orthorhombic).

Ternary Compounds

Table 1 lists the structural characteristics of the five ternary compounds of this system: $Nd_6Fe_{13}Sb$ (τ_1 or A), $\sim NdFe_{2.5}Sb_2$ (τ_2 or B), $NdFe_{1-x}Sb_2$ (τ_3 or C) ($x \sim 0.35$), $NdFeSb_3$ (τ_4 or D), and $NdFe_4Sb_{12}$ (τ_5 or E) [2007Zen]. The notation τ_1, τ_2, etc. is adopted here in place of the symbols A, B, etc. used by [2007Zen]. The compounds found for the first time by [2007Zen] are τ_2 (B) and τ_4 (D).

Isothermal Sections

With starting metals of 99.9% Fe, 99.8% Nd, and 99.95% Sb, [2007Zen] arc-melted or induction-melted alloys under Ar atm. The final anneal at 500 °C for 200 h was followed by quenching in liquid nitrogen. The phase equilibria were studied with x-ray powder diffraction and scanning electron microscope equipped with energy dispersive analysis. The isothermal section constructed by [2007Zen] is redrawn in Fig. 1. No solubility of the third component in the binary compounds of the system was found.

The FeSb-Sb-NdSb region of the system was investigated at 597 °C by [1999Sol]. With starting metals of purity of 99.99% Fe, 99.9% Nd, and 99.999% Sb, [1999Sol] arc-melted under Ar atm alloy samples, which were annealed at 597 °C for 2 weeks and quenched in water. The phase equilibria were studied with X-ray powder diffraction. The isothermal section at 597 °C (870 K) constructed by [1999Sol] for the $FeSb_{1-x}$-Sb-NdSb region is redrawn in Fig. 2. The ternary phases τ_3 ($NdFe_{1-x}Sb_2$) and τ_5

Table 1 Fe-Nd-Sb crystal structure and lattice parameter data [2007Zen]

Phase	Composition, at.%	Pearson symbol	Space group	Prototype	Lattice parameter, nm
$Nd_6Fe_{13}Sb$ (τ_1 or A)	65 Fe 30 Nd 5 Sb	…	$I4/mcm$	$Co_{11}Ga_3La_6$	a = 0.80903 c = 2.31923
$\sim NdFe_{2.5}Sb_2$ (τ_2 or B)	45.4 Fe 18.2 Nd 36.4 Sb	…	…	…	…
$NdFe_{1-x}Sb_2$ (τ_3 or C)	Fe ~ 18 Nd ~ 27 Sb ~ 55	$tP8$	$P4/nmm$	$CuSi_2Zr$	a = 0.43514 c = 0.96518
$NdFeSb_3$ (τ_4 or D)	20 Fe 20 Nd 60 Sb	…	$Pbcm$	$CeNiSb_3$	a = 1.26823 b = 0.61670 c = 1.81850
$NdFe_4Sb_{12}$ (τ_5 or E)	23.5 Fe 5.9 Nd 70.6 Sb	$cI34$	$Im\bar{3}$	Fe_4LaP_{12}	a = 0.9130

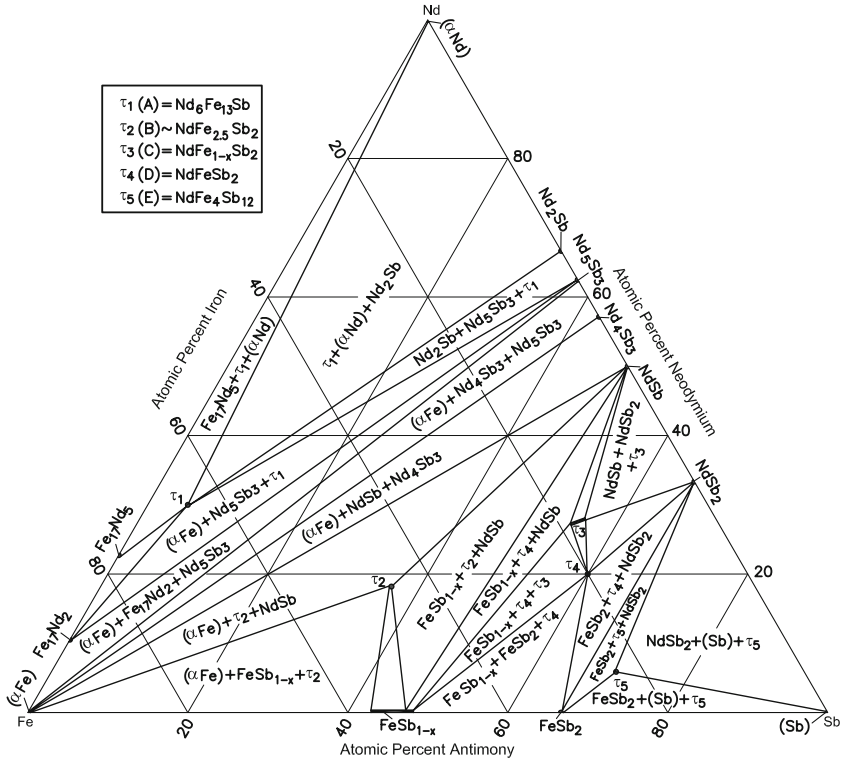

Fig. 1 Fe-Nd-Sb isothermal section at 500 °C [2007Zen]. Narrow two-phase regions are omitted

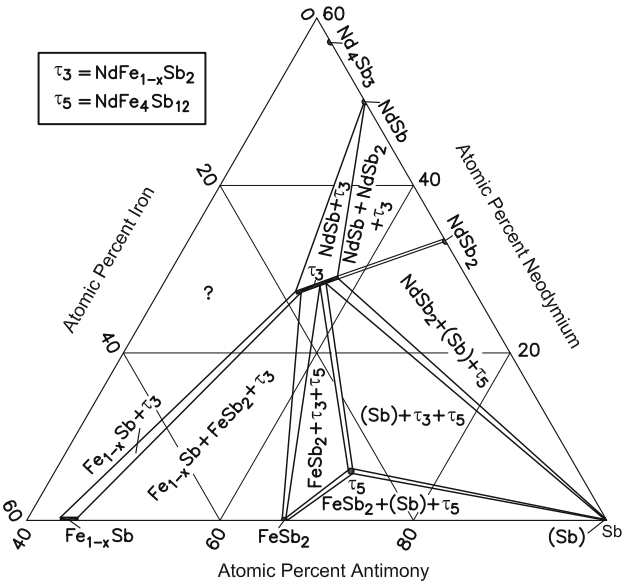

Fig. 2 Fe-Nd-Sb isothermal section at 597 °C [1999Sol]

($NdFe_4Sb_{12}$) are present. The ternary compound τ_4 ($NdFeSb_3$), which falls within this region, was not found at 597 °C by [1999Sol]. The triangulations are different in Fig. 2, as compared with Fig. 1.

References

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