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Fe-Pr-Sb (Iron-Praseodymium-Antimony)

V. Raghavan

Recently, [2008Liu] determined an isothermal section at 500 °C, which depicts five ternary compounds. This section shows some differences from the isothermal section at 600 °C reported by [2006Chy] and reviewed by [2008Rag].

Binary Systems

The Fe-Pr phase diagram has only one stable compound: $Fe_{17}Pr_2$ (Th_2Zn_{17}-type rhombohedral). Both the reported *C*14 and *C*15 forms of Fe_2Pr are metastable. The Fe-Sb phase diagram [Massalski2] has two intermediate phases: $FeSb_{1-x}$ (40-48 at.% Sb; $B8_1$, NiAs-type hexagonal) and $FeSb_2$ (*C*18, marcasite-type orthorhombic). The Pr-Sb phase diagram [Massalski2, 2008Liu] shows the following intermediate compounds: Pr_2Sb (La_2Sb-type tetragonal), Pr_5Sb_3 ($D8_8$, Mn_5Si_3-type hexagonal), Pr_4Sb_3 ($D7_3$, Th_3P_4-type cubic), PrSb (*B*1, NaCl-type cubic), and $PrSb_2$ (Sb_2Sm-type orthorhombic).

Ternary Compounds

Five ternary compounds $PrFe_4Sb_{12}$ (τ_1), $PrFeSb_3$ (τ_2), $PrFeSb_2$ (τ_3), Pr_5Fe_2Sb (τ_4), and $Pr_6Fe_{13}Sb$ (τ_5) found by [2006Chy] at 600 °C are shown in Table 1. At 500 °C, [2008Liu] confirmed only four of these compounds and did not find Pr_5Fe_2Sb (τ_4). The compounds τ_1, τ_2, τ_3 and τ_5 were denoted as M, Q, P and L respectively by [2008Liu]. The new compound found at 500 °C by [2008Liu] is $PrFe_2Sb_2$ (labeled τ_6 here and as N by [2008Liu]). It was tentatively indexed as Ga_2S_3-type with monoclinic symmetry [2008Liu], see Table 1.

Isothermal Section

With starting metals of 99.9% Fe, 99.9% Pr, and 99.99% Sb, [2008Liu] arc-melted 73 alloys under Ar atm. The final anneal was at 500 °C for 300 h, followed by quenching in liquid nitrogen. The phase equilibria were studied by metallography and x-ray powder diffraction. The isothermal section at 500 °C constructed by [2008Liu] is shown in Fig. 1. The five ternary compounds τ_1, τ_2, τ_3, τ_5, and τ_6 are present. No ternary solubility in the binary compounds was indicated by [2008Liu].

Table 1 Fe-Pr-Sb crystal structure and lattice parameter data [2008Liu, 2006Chy]

Phase	Composition, at.%	Pearson symbol	Space group	Prototype	Lattice parameter, nm
$PrFe_4Sb_{12}$ (τ_1 or M)	23.5 Fe 5.9 Pr 70.6 Sb	*cI*34	$Im\bar{3}$	$LaFe_4P_{12}$	a = 0.91351
$PrFeSb_3$ (τ_2 or Q)	20 Fe 20 Pr 60 Sb	*oP*?	*Pbcm*	$CeNiSb_3$	a = 1.2518 b = 0.6064 c = 1.8489
$PrFeSb_2$ (τ_3 or P)	25 Fe 25 Pr 50 Sb	*tP*8	*P*4/*nmm*	$ZrCuSi_2$	a = 0.43616 c = 0.97552
Pr_5Fe_2Sb (τ_4)	25 Fe 62.5 Pr 12.5 Sb	*tI*32	*I*4/*mcm*	Mo_5B_2Si	a = 0.7541 c = 1.4161
$Pr_6Fe_{13}Sb$ (τ_5 or L)	65 Fe 30 Pr 5 Sb	*tI*?	*I*4/*mcm*	$La_6Co_{11}Ga_3$	a = 0.8108 c = 2.3303
$PrFe_2Sb_2$ (τ_6 or N)	40 Fe 20 Pr 40 Sb	*mC*20	*Cc*	Ga_2S_3	a = 0.60719 b = 0.60867 c = 1.33051 β = 103.1°

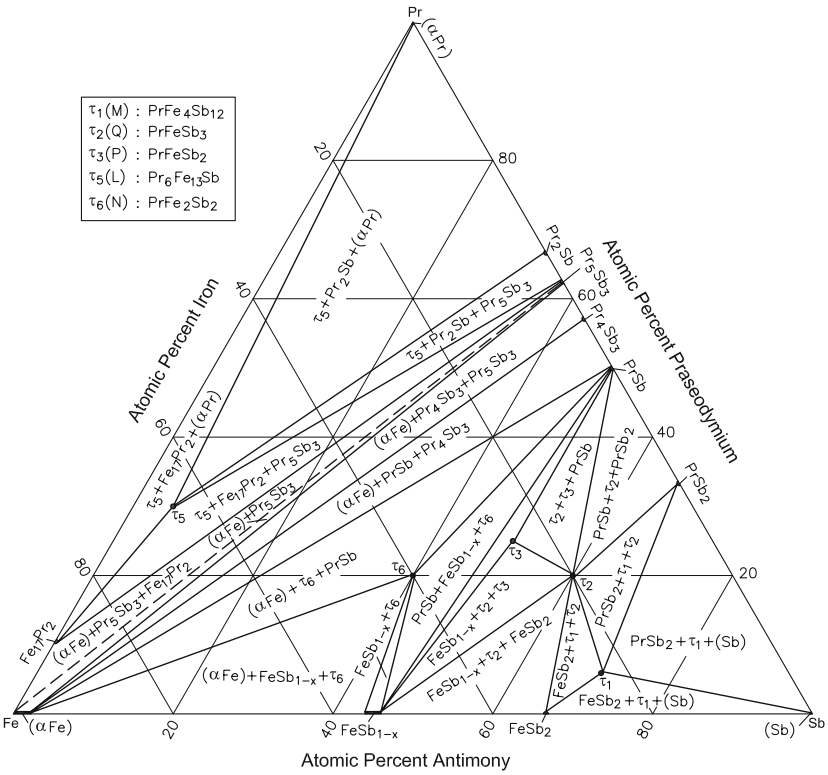

Fig. 1 Fe-Pr-Sb isothermal section at 500 °C [2008Liu]. Narrow two-phase regions are omitted

References

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