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

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Recently, [2006Chy] determined an isothermal section at 600 °C for this ternary system, which depicts five ternary compounds.

Binary Systems

The Fe-Pr phase diagram [1999Zha] 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 [1997Ric] has two intermediate phases: $FeSb_{1-x}$ (41-49 at.% Sb; $B8_1$, NiAs-type hexagonal) and $FeSb_2$ (*C*18, marcasite-type orthorhombic). The Pr-Sb phase diagram [Massalski2, 2006Chy] 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 $PrSb_2$ ($LaSb_2$-type orthorhombic).

Ternary Compounds

Table 1 lists the structural details of the five ternary compounds identified by [2006Chy] at 600 °C. They are denoted as I, II, III, IV and V by [2006Chy] and are redesignated here as τ_1, τ_2, τ_3, τ_4, and τ_5, respectively. $PrFeSb_3$ (τ_2, II) and Pr_5Fe_2Sb (τ_4, IV) were identified by [2006Chy] for the first time. The composition of the earlier known compound $PrFe_4Sb_{12}$ (τ_1, I) was refined by [2006Chy] as $Pr_{1-x}Fe_4Sb_{12}$ (x = 0.14).

Isothermal Section

With starting metals of 99.99% Fe, 99.8% Pr and 99.98% Sb, [2006Chy] melted 34 alloy samples in an arc furnace or in sealed silica tubes. The samples were annealed at 600 °C for 500-1000 h, followed by water quenching. The phase equilibria were studied with x-ray powder diffraction. The isothermal section at 600 °C constructed by [2006Chy] is redrawn in Fig. 1 to agree with the accepted binary data. The metastable compound Fe_2Pr is omitted and the phase equilibria near this location are shown tentatively in Fig. 1. The five ternary compounds τ_1 through τ_5 (I through V) are present at 600 °C.

References

1997Ric: K.W. Richter and H. Ipser, Reinvestigation of the Binary Fe-Sb Phase Diagram, *J. Alloys Compd.*, 1997, **247**, p 247-249

1999Zha: W. Zhang, C. Li, and X. Su, The Fe-Pr (Iron-Praseodymium) System, *J. Phase Equilib.*, 1999, **20**(2), p 158-162

2006Chy: S.L. Chykhrij and V.B. Smetana, Phase Relations in the Pr-Fe-Sb and Pr-Co-Sb Systems, *Neorg. Materialy*, 2006, **42**(5), p 563-567, in Russian; TR: *Inorg. Mater.*, 2006, **42**(5), p 503-507

Table 1 Fe-Pr-Sb Crystal Structure and Lattice Parameter Data [2006Chy]

Phase	Composition, at.%	Pearson symbol	Space group	Prototype	Lattice parameter, nm
$Pr_{0.86}Fe_4Sb_{12}$ (τ_1 or I)	23.7 Fe 5.1 Pr 71.2 Sb	*cI*34	$Im\bar{3}$	$LaFe_4P_{12}$	a = 0.91327
$PrFeSb_3$ (τ_2 or II)	20 Fe 20 Pr 60 Sb	*oP*?	*Pbcm*	$CeNiSb_3$	a = 1.2518 b = 0.6064 c = 1.8489
$PrFeSb_2$ (τ_3 or III)	25 Fe 25 Pr 50 Sb	*tP*8	*P*4/*nmm*	$ZrCuSi_2$	a = 0.43641 c = 0.97584
Pr_5Fe_2Sb (τ_4 or IV)	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 V)	65 Fe 30 Pr 5 Sb	*tI*?	*I*4/*mcm*	$La_6Co_{11}Ga_3$	a = 0.8121 c = 2.3343

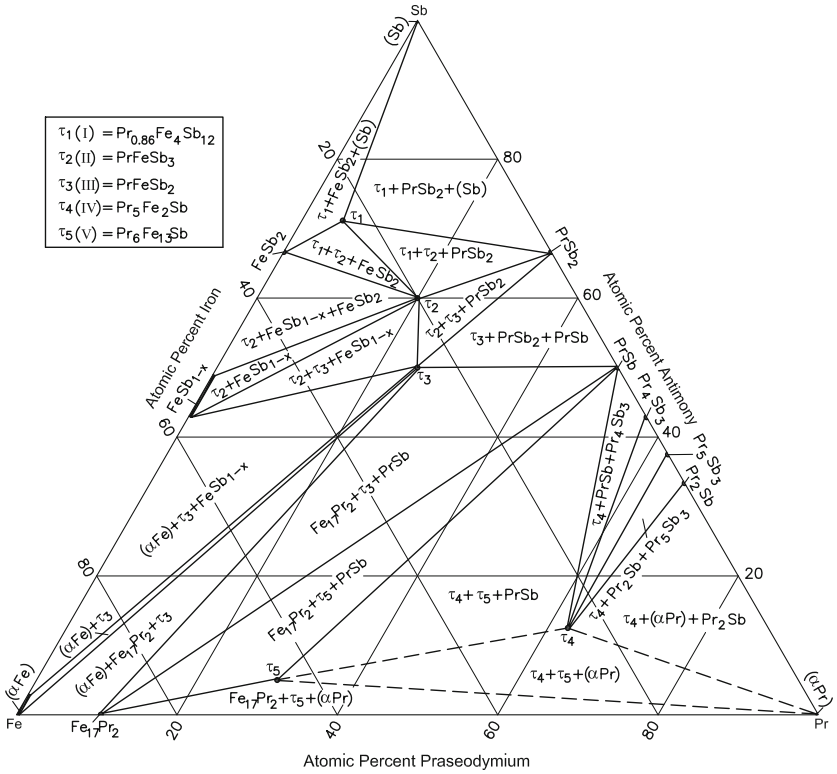

Fig. 1 Fe-Pr-Sb isothermal section at 600 °C [2006Chy]. Narrow two-phase regions are omitted