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Fe-Sb-Ti (Iron-Antimony-Titanium)

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An isothermal section for this system was determined recently by Melnyk et al. [2003Mel], which depicts four ternary compounds.

Binary Systems

The Fe-Sb phase diagram [1993Oka] has two intermediate phases. The ε phase with the NiAs type hexagonal structure, has a homogeneity range of 40-47 at.% Sb. $FeSb_2$ is a line compound with orthorhombic symmetry. The Fe-Ti system has two intermediate phases: Fe_2Ti (*C*14, hexagonal) and FeTi (*B*2, cubic). [1998Dum] presented a comparison of the recent Fe-Ti assessments. A schematic and partial phase diagram of the Sb-Ti system is given in [Massalski2], which depicts seven intermediate compounds: Ti_4Sb, Ti_3Sb, $Ti_{2.5}Sb$, Ti_5Sb_3, Ti_6Sb_5, TiSb and $TiSb_2$. Among these, only the following four were found by [2003Mel]: Ti_3Sb, Ti_5Sb_3, TiSb, and $TiSb_2$. The crystallogaphic data on the intermediate phases of these binary systems are summarized by [2003Mel].

Ternary Compounds

Four ternary compounds are known in this system [1998Sko, 2000Mel, 2003Mel]. The crystallographic data on these phases are summarized in Table 1 from the results of [2003Mel]. $TiFe_{1-x}Sb$ (τ_1) ($0.64 \leq x \leq 0.70$) has the Co_2Si (TiNiSi) type of orthorhombic structure. $Ti_{1.18}Fe_{0.57}Sb$ (τ_2) has the Ni_2In type hexagonal structure. $Ti_{1+x}FeSb$ (τ_3) ($-0.20 \leq x \leq 0.25$) has the AlLiSi type of face centered cubic structure. $Ti_5Fe_xSb_{3-x}$ (τ_4) ($0.45 \leq x \leq 1.0$) has the W_5Si_3 type tetragonal structure.

Table 1 also lists the structural data for the ternary solid solutions based on the binary compounds of Ti_3Sb and Fe_2Ti.

Ternary Isothermal Section

With starting metals of purity ≥99.9%, [2003Mel] melted 138 alloys in an arc furnace under Ar atm. The alloys were annealed for 350 h at 797 °C for compositions in the Fe-$FeSb_2$-$TiSb_2$-Ti region and at 597 °C for compositions in the $FeSb_2$-Sb-$TiSb_2$ region. The samples were quenched in water after the anneal. The phase equilibria were studied by x-ray powder diffraction. The isothermal section redrawn in Fig. 1 corresponds to 597 °C for the Sb-rich region and 797 °C for the lower region. The four ternary compounds τ_1, τ_2, τ_3, and τ_4 are present at 797 °C. The binary compound Fe_2Ti

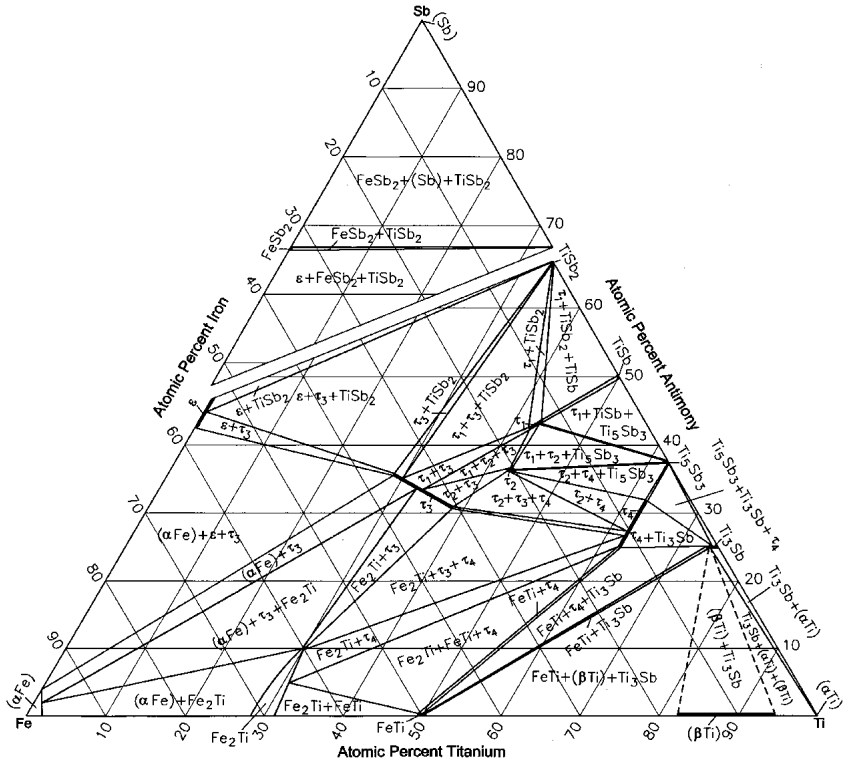

Fig. 1 Fe-Sb-Ti isothermal sections at 797 °C (lower part) and 597 °C (upper part) [2003Mel]

Table 1 Fe-Sb-Ti Crystal Structure and Lattice Parameter Data

Phase	Composition at:%	Pearson Symbol	Space Group	Structurbericht Designation	Prototype	Lattice parameter, nm
$TiFe_{1-x}Sb$	42.4–43.5 Ti	*oP*12	*Pnma*	*C*23	Co_2Si	a = 0.64272 to 0.63758
(τ_1)	42.4–43.5 Sb					b = 0.40501 – 0.40258
						c = 0.70918 – 0.70209
$Ti_{1.18}Fe_{0.57}Sb$	42.9 Ti	*hP*6	$P6_3/mmc$	$B8_2$	Ni_2In	a = 0.41653
(τ_2)	36.4 Sb					c = 0.62594
$Ti_{1+x}FeSb$	28.6–38.5 Ti	*cF*12	$F\bar{4}3m$		AlLiSi	a = 0.59429 to 0.60182
(τ_3)	35.7–30.8 Sb					
$Ti_5Fe_xSb_{1-x}$	62.5 Ti	*tI*32	*I*4/*mcm*	$D8_m$	W_5Si_3	a = 1.04638 to 1.04423
(τ_4)	31.9–25.0 Sb					c = 0.52836 to 0.52131
$(Ti_{1-x}Fe_x)_5Sb$	75–73.6 Ti	*cP*8	$Pm\bar{3}n$	*A*15	Cr_3Si	a = 0.52183 to 0.52028
	25 Sb					
$(Fe_{1-x}Sb_x)_{2+y}Ti$		*hP*12	$P6_3/mmc$	*C*14	$MgZn_2$	a = 0.48213 (a)
						c = 0.78432 (a)

(a) at 30Ti-10Sb

dissolves up to 10 at.% Sb. Ti_3Sb dissolves up to 1.4 at.% Fe at constant Sb content. Other binary phases show insignificant solubility for the third component. Both polymorphic forms of Ti, (βTi) (bcc) and (αTi) (cph), are stable at 797 °C and are shown in Fig. 1.

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