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Al-Ti (Aluminum-Titanium)

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Recently, [1990Sch], [2000Ohn], [2001Bra], and [2001Ste] reported new results on the phase equilibria of this binary system. Crystal structure data on the binary phases are summarized in Table 1 [2001Bra]. The complete phase diagram is shown in Fig. 1.

On the Al-rich side, $TiAl_3$ has two crystal modifications: $TiAl_3$ (HT) ($D0_{22}$-type tetragonal) forms peritectically at 1387 °C [1990Sch] and decomposes eutectoidally at 735 °C [2001Bra]. $TiAl_3$ (LT) forms at ~950 °C and is stable at low temperatures. A metastable form of $TiAl_3$ ($AuCu_3$-type cubic) also has been reported [2001Bra]. Ti_5Al_{11} is a superstructure based on the AuCu-type tetragonal phase, with the subcell parameters of $a = 0.3953$ nm and $c = 0.4104$ nm at 66 at.% Al and $a = 0.3918$ nm and $c = 0.4154$ nm at 71 at.% Al. It forms peritectically at 1416 °C and decomposes eutectoidally at 995 °C to $TiAl_2$ and $TiAl_3$ (HT). $TiAl_2$ ($HfGa_2$-type tetragonal) forms congruently at 1215 °C from Ti_5Al_{11} and is stable at low temperatures. A metastable form of $TiAl_2$ ($ZrGa_2$-type, orthorhombic) was found by [2001Bra] in the as-cast alloys. $Ti_{1-x}Al_{1+x}$ (AuCu-type tetragonal) is stable between 1445 and 1170 °C. Ti_3Al_5 is a low-temperature phase forming below 810 °C. TiAl, often designated γ, has the $L1_0$, AuCu-type tetragonal structure with $a = 0.4000$ nm and $c = 0.4075$ nm at 50 at.% Al and $a = 0.3984$ nm and $c = 0.4060$ nm at 62 at.% Al [2001Bra].

On the Ti-rich side, the updated diagram is quite different from the version in [Massalski2] and shows that (βTi) [body-centered cubic (bcc), often denoted β] and liquid undergo a peritectic reaction to yield (αTi) [hexagonal close-packed (hcp), also denoted α] at a high temperature of ~1490 °C. [2000Ohn] found that (βTi) undergoes the $A2$ (bcc) → $B2$ (CsCl-type ordered bcc) transition in the temperature range of ~1425 to 1125 °C. The Ti-rich intermediate phase Ti_3Al, commonly called α_2, has the $D0_{19}$, Ni_3Sn-type hexagonal structure.

References

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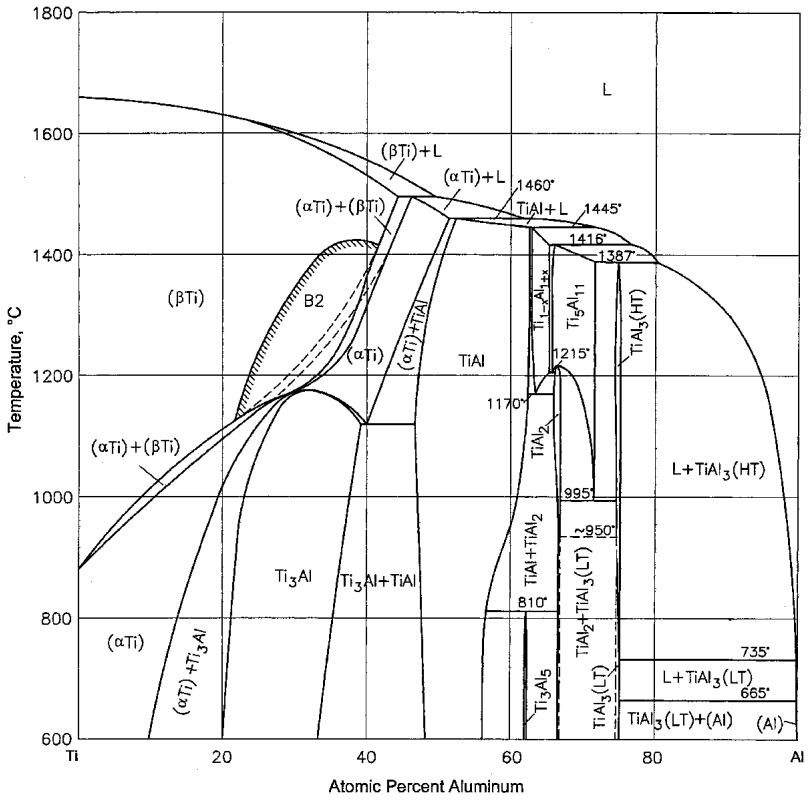

Fig. 1 Al-Ti binary phase diagram [2000Ohn, 2001Bra]

Table 1 Al-Ti crystal structure and lattice parameter data

Phase	Composition, at.% Al	Pearson symbol	Space group	Prototype	Lattice parameter, nm
$TiAl_3$ (HT)	74.5-75.0	*tI*8	*I*4/*mmm*	$TiAl_3$	$a = 0.3849$ $c = 0.8609$
$TiAl_3$ (LT)	~75	*tI*32	*I*4/*mmm*	…	$a = 0.3877$ $c = 3.3828$
Ti_5Al_{11}	66-71	(a)	…	…	$a = 0.3953$ $c = 0.4104$(b)
$TiAl_2$	66-67	*tI*24	$I4_1/amd$	$HfGa_2$	$a = 0.3970$ $c = 2.4309$
$Ti_{1-x}Al_{1+x}$	63-65	*tP*4	*P*4/*mmm*	AuCu	$a = 0.4030$ $c = 0.3955$
Ti_3Al_5	62	*tP*32	*P*4/*mbm*	Ti_3Al_5	$a = 1.1293$ $c = 0.4038$
TiAl(γ)	50-62	*tP*4	*P*4/*mmm*	AuCu	$a = 0.4000$ $c = 0.4075$(c)
$Ti_3Al(\alpha_2)$	~20-39	*hP*8	$P6_3/mmc$	Ni_3Sn	$a = 0.5782$ $c = 0.4629$

(a) Tetragonal. (b) Subcell parameters at 66 at.% Al. (c) At 50 at.% Al