Al-Fe-La (Aluminum-Iron-Lanthanum)

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The previous review of this system by [1992Rag] presented an isothermal section at 500 °C, which depicts six ternary compounds. Recently, [1995Tan] determined an isothermal section at ~25 °C with five ternary compounds. The known crystal structures of three of these compounds are in agreement in the two studies. However, the homogeneity ranges of the compounds differ significantly.

Binary Systems

The Al-Fe phase diagram reviewed by [1993Kat] shows that the fcc solid solution based on Fe is restricted by a γloop. The bcc solid solution α exists in both ordered and disordered forms. Apart from the high-temperature phase ε, there are three intermediate phases in the system with restricted ranges of homogeneity: $FeAl_2$, Fe_2Al_5, and $FeAl_3$. The Al-La phase diagram reviewed by [1988Gsc] shows six intermediate phases: $Al_{11}La_3$, Al_3La, Al_xLa, Al_2La, AlLa, and $AlLa_3$. Recently, [1996Sac] studied the La-rich region and reported that $AlLa_3$ decomposes at 400 °C to AlLa and (βLa). The Fe-La phase diagram reviewed by [1982Kub] shows no intermediate phases. For crystal structure data on the above binary compounds, see [Pearson3].

Ternary Compounds

A phase of unknown structure τ_1 is present at 500 °C on the 33.3 at.% La line between 20 and 33.3 at.% Al [1992Rag]. [1995Tan] found a phase of unknown structure at 36 at.% La and 20 at.% Al at ~25 °C. This phase is denoted τ_1 here. $La_2Fe_7Al_{10}$ (τ_2) has the Th_2Zn_{17}-type rhombohedral structure [1995Tan]. The same phase at 500 °C [1992Rag] extends from 52.6 to 57.9 at.% Al at constant La content. $LaFe_{1.2}Al_{7.8}$ (τ_3) is of unknown structure [1992Rag, 1995Tan]. The $ThMn_{12}$-type tetragonal structure $LaFe_4Al_8$ (τ_4) (the 1:12 phase) occurs at the same composition both at 500 and 25 °C. The $NaZn_{13}$-type cubic structure $La(Fe,Al)_{13}$ (τ_5) has a much wider range of Al content at 25 °C than at 500 °C. $LaFe_2Al_{10}$ found at 500 °C [1992Rag] is not present at 25 °C. $La(Al,Fe)_2$ is an $MgCu_2$-type Laves phase extending from Al_2La into the ternary region at 25 °C (not at 500 °C). The structural details of these compounds determined by [1995Tan] are listed in Table 1.

Ternary Isothermal Section

With starting metals of purity 99.9%, [1995Tan] melted 105 alloy compositions in an arc furnace under Ar atm. The alloys were homogenized between 900 and 500 °C and furnace cooled to room temperature. It is assumed here that the phase equilibria correspond to room temperature (~25 °C). The phase identification was carried out by x-ray powder diffraction analysis. [1995Tan]'s isothermal section is redrawn in Fig. 1 to agree with the accepted binary data. All

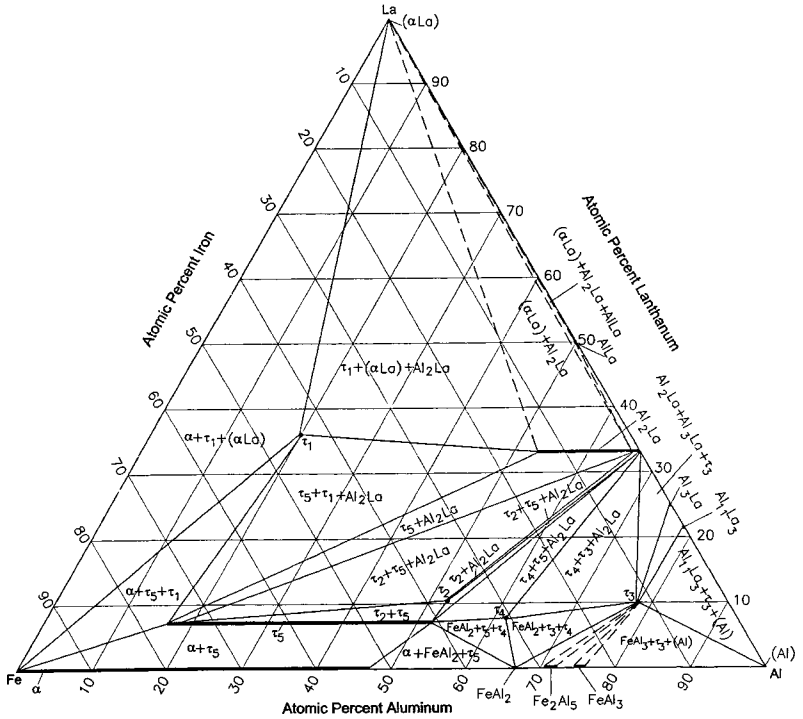

Fig. 1 Al-Fe-La isothermal section at ~ 25 °C [1995Tan]. The thin two-phase fields around tie-triangles are omitted

Table 1 Al-Fe-La crystal structure and lattice parameter data

Phase	Composition, at.% La	Composition, at.% Al	Pearson symbol	Space group	Strukturbericht designation	Prototype	Lattice parameter, nm
$La_9Fe_{11}Al_5$ (τ_1)	36.0	20.0					
$La_2Fe_7Al_{10}$ (τ_2)	10.5	52.6	*hR*19	$R\bar{3}m$		Th_2Zn_{17}	a = 0.8962 c = 1.298
$LaFe_{1.2}Al_{7.8}$ (τ_3)	10.0	78.0					
$LaFe_4Al_8$ (τ_4) (1:12)	7.7	61.5	*tI*26	*I*4/*mmm*	$D2_b$	$ThMn_{12}$	a = 0.8900 c = 0.5075
$La(Fe,Al)_{13}$ (τ_5)	7.1	16.7–52	*cF*112	$Fm\bar{3}c$	$D2_3$	$NaZn_{13}$	a = 1.1668–1.1983
$La(Al,Fe)_2$	33.3	66.7–53.3	*cF*24	$Fd\bar{3}m$	*C*15	$MgCu_2$	a = 0.8147–0.8111

the ternary phases listed in Table 1 are present. Due to lack of data in the ternary region, the ordered and disordered forms of bcc α are not shown separately in Fig. 1. With the exception of Al_2La, none of the Al-La or Fe-Al compounds show any solubility for the third component. $AlLa_3$ (shown by [1995Tan]) is omitted in Fig. 1, in line with the findings of [1996Sac].

References

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