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Fe-La-P (Iron-Lanthanum-Phosphorus)

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Recently, Chikhrii et al. [1997Chi] determined isothermal sections for this system at ~800 °C for 0-30 at.% La and at ~600 °C for 30-70 at.% La.

Binary Systems

The Fe-La phase diagram has no intermediate phases [Massalski2]. A partial phase diagram is known for the Fe-P system [1982Kub]. The intermediate compound Fe_3P forms through a peritectic reaction at 1166 °C between liquid and Fe_2P. Fe_2P forms congruently at 1370 °C. Fe_3P is body-centered tetragonal with the Ni_3P-type structure. Fe_2P has the hexagonal *C*22 structure. The other intermediate phases at higher P contents are FeP (orthorhombic MnP type), FeP_2 [orthorhombic FeS_2 (marcasite) type], and FeP_4 (monoclinic). The La-P phase diagram is not known. Four intermediate phases are known: LaP (cubic NaCl type), LaP_2, (monoclinic and orthorhombic forms), LaP_5 (monoclinic) and LaP_7 (monoclinic). See [1997Chi] and [Pearson3] for more details.

Ternary Compounds

Three ternary compounds are known in this system. $LaFe_2P_2$ (τ_1) has the Al_4Ba type tetragonal structure [1990Ree]. $La_2Fe_{25}P_{12}$ (τ_2) has orthorhombic symmetry [1994Zim]. $LaFe_4P_{12}$ (τ_3) has cubic symmetry (space group $Im\bar{3}$) [1977Jei]. Table 1 lists the structural details of these compounds.

Table 1 Fe-La-P Crystal Structure and Lattice Parameter Data

Phase	Composition, at.%	Pearson Symbol	Space Group	Prototype	Lattice Parameter, nm	Reference
$LaFe_2P_2$	20 La	*tI*10	*I*4/*mmm*	Al_4Ba	$a = 0.3838$	1990Ree
(τ_1)	40 P				$c = 1.1006$	
$La_2Fe_{25}P_{12}$	5.1 La	*oP*78	*Pbam*	$La_2Fe_{25}P_{12}$	$a = 1.4756$	1994Zim
(τ_2)	30.8 P				$b = 1.8149$	
					$c = 0.3636$	
$LaFe_4P_{12}$	5.9 La	*cI*34	$Im\bar{3}$	$LaFe_4P_{12}$	$a = 0.7832$	1977Jei
(τ_3)	70.6 P					

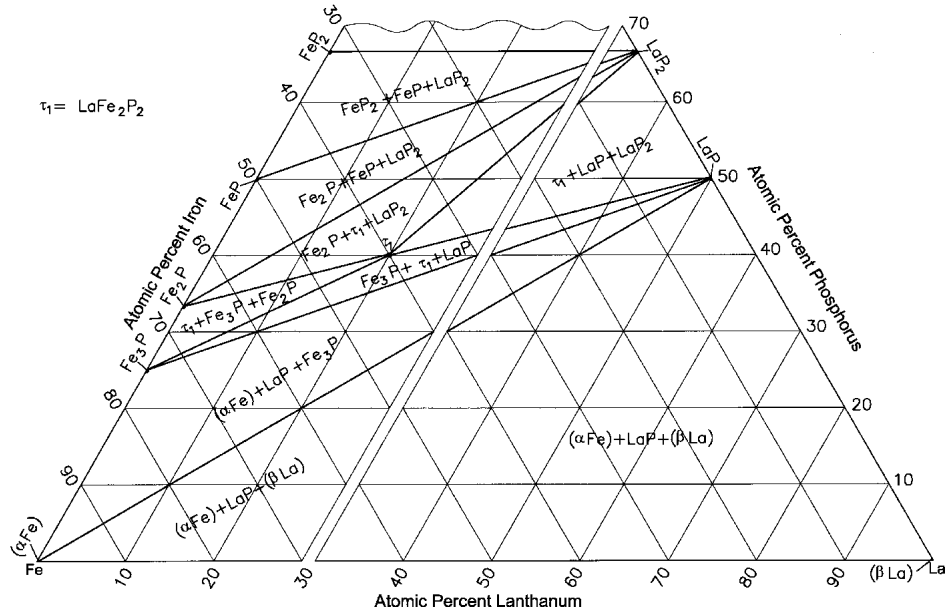

Fig. 1 Fe-La-P isothermal sections at 797 °C (0-30 at.% La) and at 597 °C (30-70 at.% La) [1997Chi]; narrow two-phase regions around tie-triangles are omitted.

Ternary Isothermal Section

With starting materials of purity 99.9% La, 99.99% Fe, and 99.89% P, [1997Chi] prepared 28 alloy compositions. For compositions up to 33.3 at.% P, the alloys were melted in an arc furnace. For higher P contents, the powder mixtures were sintered by slow heating up to 800 °C. The samples were then annealed for 500 h at 1070 K for compositions with ≤30 at.% La and at 870 K for compositions with 30-70 at.% La and quenched in water. The phase equilibria were studied by x-ray powder diffraction. The isothermal sections determined by [1997Chi] at 797 °C (1070 K) for 0-30 at.% La and at 597 °C (870 K) for 30-70 at.% La are presented as a composite section in Fig. 1. The ternary compound τ_1 is present at 797 °C. The compound τ_2 was not found. The composition of τ_3 falls outside the range investigated by [1997Chi]. No homogeneity ranges were found for the ternary compounds. The third component solubility in the binary compounds is negligible.

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