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Ce-Fe-P (Cerium-Iron-Phosphorus)

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Recently, Chikhrii et al. [1997Chi] determined isothermal sections for this system at ~800 °C for 0-30 at.% Ce and at ~590 °C for 30-70 at.% Ce.

Binary Systems

The Ce-Fe phase diagram [1993Zha] depicts two stoichiometric compounds, Ce_2Fe_{17} and $CeFe_2$, both forming peritectically. Ce_2Fe_{17} has two crystal modifications (hexagonal and rhombohedral). $CeFe_2$ has the cubic $MgCu_2$ type structure. The Ce-P phase diagram is not known. Three intermediate compounds are known: CeP (cubic, NaCl type), CeP_2 (monoclinic), and CeP_5 (monoclinic). 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 of 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).

Ternary Compounds

Three ternary compounds are known in this system. $CeFe_2P_2$ (τ_1) has the Al_4Ba-type tetragonal structure [1985Jei]. $Ce_2Fe_{12}P_7$ (τ_2) has the $Zr_2Fe_{12}P_7$-type hexagonal structure [1984Jei]. $CeFe_4P_{12}$ (τ_3) has the $LaFe_4P_{12}$-type cubic structure [1977Jei]. Table 1 lists the structural details of these compounds.

Ternary Isothermal Section

With starting materials of purity of 99.9% Ce, 99.99% Fe, and 99.89% P, [1997Chi] prepared 36 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 finally annealed for 500 h at 1070 K for compositions with ≤30 at.% Ce and at 870 K for compositions with 30-70 at.% Ce 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.% Ce and at ~590 °C for 30-70 at.% Ce are presented as a composite section in Fig. 1. The temperature of anneal for the higher Ce content alloys is assumed here to be just below the eutectic temperature (592 °C) of the Fe-Ce system, as no liquid phase is indicated by [1997Chi]. The ternary compounds τ_1 and τ_2 are present at 797 °C. The composition of the ternary compound 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.

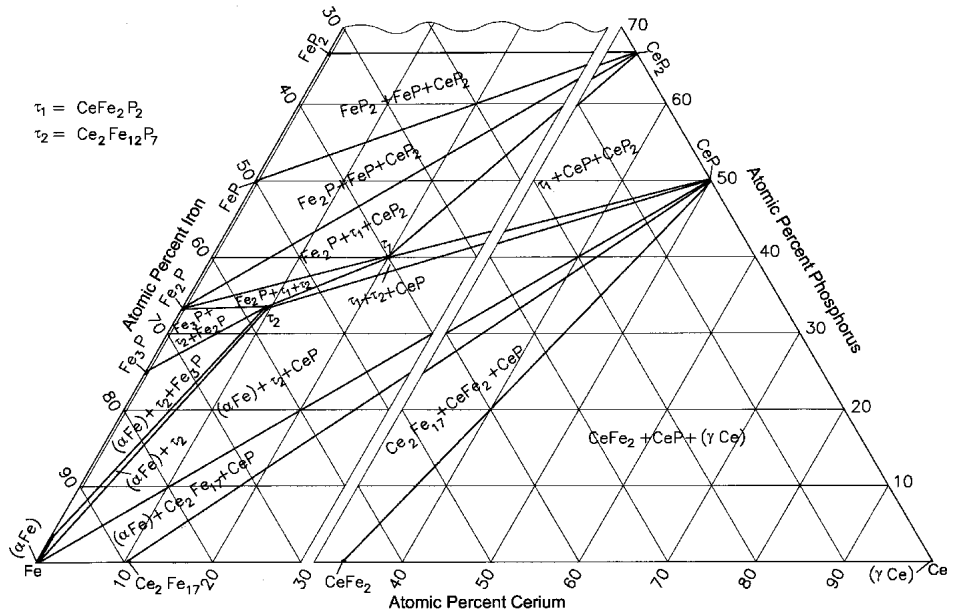

Fig. 1 Ce-Fe-P isothermal section at 797 °C (0-30 at.% Ce) and at ~590 °C (30-70 at.% Ce) [1997Chi]. Narrow two-phase regions around tie-triangles are omitted.

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

Phase	Composition, at.%	Pearson Symbol	Space Group	Prototype	Lattice Parameter, nm	Reference
$CeFe_2P_2$	20 Ce	*tI*10	*I*4/*mmm*	Al_4Ba	$a = 0.3852$	1985Jei
(τ_1)	40 P				$c = 1.0314$	
$Ce_2Fe_{12}P_7$	9.5 Ce	*hP*21	$P\bar{6}$	$Zr_2Fe_{12}P_7$	$a = 0.9135$	1984Jei
(τ_2)	33.3 P				$c = 0.3677$	
$CeFe_4P_{12}$	5.9 Ce	*cI*34	$Im\bar{3}$	$LaFe_4P_{12}$	$a = 0.7792$	1977Jei
(τ_3)	70.6 P				…	

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