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Al-Ir-Pd (Aluminum-Iridium-Palladium)

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Recently, [2008Pav] determined the phase relationships in the Al-rich part of this ternary system and presented partial isothermal sections at 1100, 1000, 900, and 790 °C.

Binary Systems

The Al-Ir phase diagram has the following intermediate phases [2008Pav]: Ir_2Al_9 (Co_2Al_9-type monoclinic), $Ir_{13}Al_{45}$ (ϕ) (orthorhombic, space group *Pnma*), Ir_9Al_{28} (χ) (hexagonal, space group *P*31*c*), $IrAl_3$ (*D*0$_{18}$, Na_3As-type hexagonal), $IrAl_{2.7}$ (cubic, space group *P*23, denoted C), and IrAl (*B*2, CsCl-type cubic, denoted β). The Al-Pd phase diagram [2001Yur] shows the following intermediate phases: $PdAl_4$ (hexagonal, space group *P*6$_3$22, denoted λ), $PdAl_3$ (denoted ε_6, orthorhombic), ε_{28} (~$PdAl_3$, orthorhombic), Pd_8Al_{21} (Pt_8Al_{21}-type tetragonal), Pd_2Al_3 (denoted δ, *D*5$_{13}$, Ni_2Al_3-type hexagonal), PdAl (*B*2, CsCl-type cubic and two low-temperature forms: rhombohedral and *B*20-type cubic), Pd_5Al_3 (Rh_5Ge_3-type orthorhombic), Pd_2Al (*C*23, Co_2Si-type orthorhombic), and Pd_5Al_2 (Pd_5Ga_2-type orthorhombic). In the Ir-Pd system [1991Tri], Ir and Pd form a continuous face centered cubic (fcc) solid solution. Below 1480 °C, a miscibility gap occurs in the solid state.

Ternary Isothermal Sections

[2008Pav] induction-melted Al-rich compositions under Ar atm and annealed them at 1100-790 °C for 24-2610 h, followed by water quenching. The phase equilibria were studied by x-ray powder diffraction and scanning/transmission electron microscopy. Compositions of co-existing phases were determined by energy dispersive x-ray analysis. Single phase compositions were determined by inductively-coupled plasma optical emission spectroscopy. Differential thermal analysis was carried out at heating/cooling rates of 10-50 °C per min. Partial isothermal sections constructed by [2008Pav] at 1100, 1000, 900, and 790 °C are redrawn in Fig. 1 to 4.

At 1100 °C (Fig. 1), all Al-Pd binary phases except PdAl (β) are molten. The maximum Al concentration PdAl was ~55 at.%. On the Al-Ir side, Ir_9Al_{28} (χ) dissolves up to 3.5 at.% Pd. $IrAl_{2.7}$ (C) dissolves up to 14 at.% Pd. Two ternary phases C_2 and C_3 related to the C phase are present. C_2 (cubic) has a lattice parameter a = 1.5482 nm, which is about twice that of the C phase and has a compositional range around ~$Al_{65}Pd_{13}Ir_{22}$. The C_2 composition of $Al_{65}Pd_{11.5}Ir_{23.5}$ melts at ~1500 °C. C_3 is hexagonal and has a composition of $Al_{67}Pd_{11.5}Ir_{21.5}$ at 1100 and 1000 °C and lattice parameters of a = 1.09135 nm and c = 1.3418 nm. The full compositional ranges of C_2 and C_3 were not determined. The ε-related phases were denoted together as ε by [2008Pav]. This phase occurs in the ternary region between $Al_{73}Pd_4Ir_{23}$ and $Al_{73}Pd_{11.5}Ir_{15.5}$. The binary phase $IrAl_3$ was not observed in the ternary region. At 1000 °C (Fig. 2), the phase distribution is the same as at 1100 °C. The solubility of Pd in the χ phase is 5 at.%. The ε-range is now wider and extends from

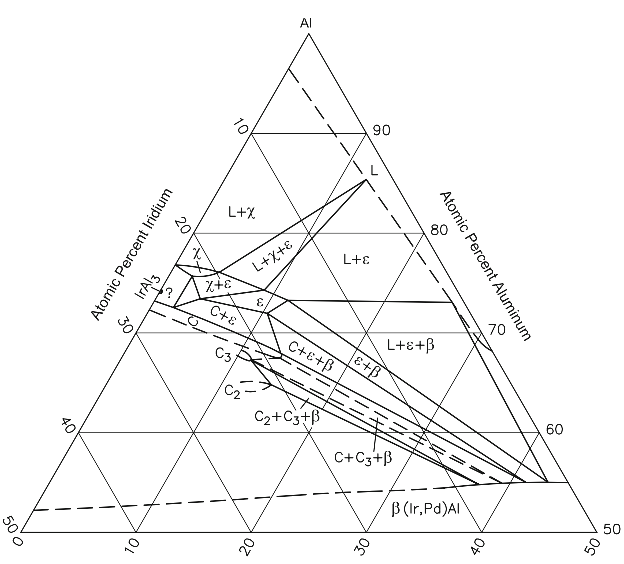

Fig. 1 Al-Ir-Pd partial isothermal section at 1100 °C for Al-rich alloys [2008Pav]

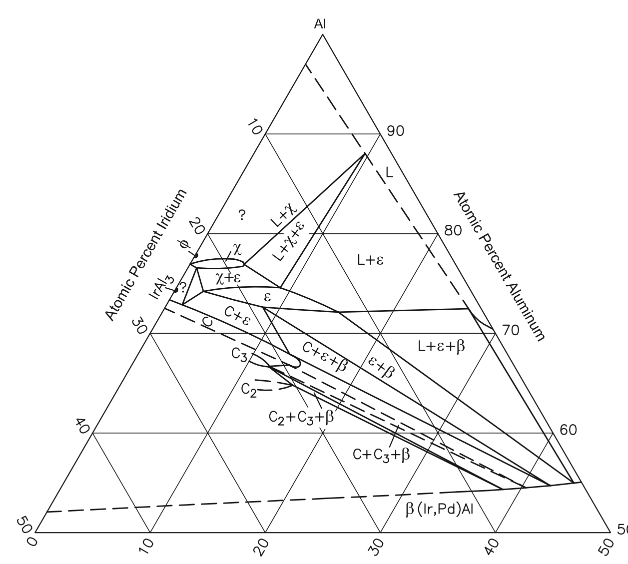

Fig. 2 Al-Ir-Pd partial isothermal section at 1000 °C for Al-rich alloys [2008Pav]

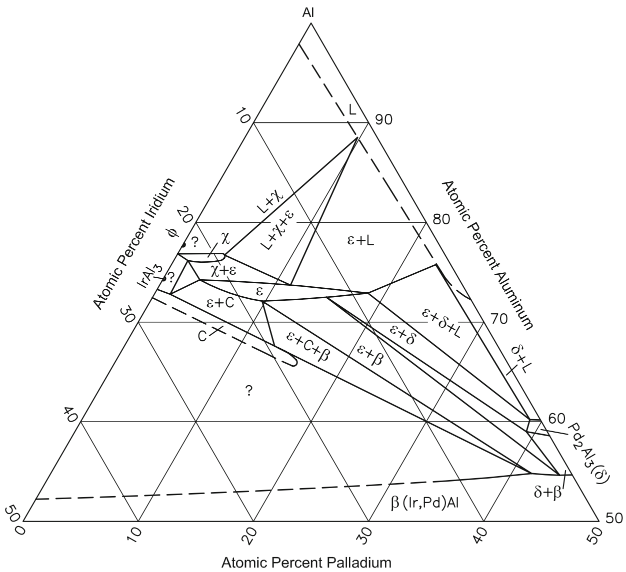

Fig. 3 Al-Ir-Pd partial isothermal section at 900 °C for Al-rich alloys [2008Pav]

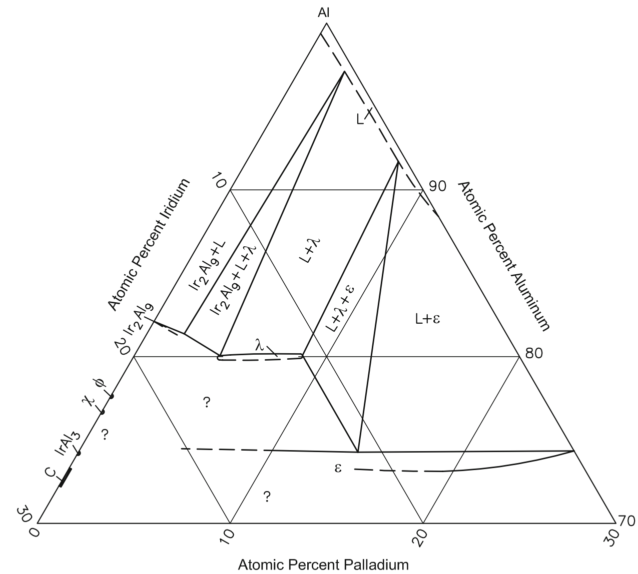

Fig. 4 Al-Ir-Pd partial isothermal section at 790 °C for Al-rich alloys [2008Pav]

$Al_{74}Pd_3Ir_{23}$ to $Al_{73}Pd_{15.5}Ir_{11.5}$. The solubility of Pd in the C phase goes up to 15 at.%. The homogeneity ranges of C_2 and C_3 phases extend up to 15.5 and 12 at.% Pd respectively.

At 900 °C (Fig. 3), in addition to the phases at 1100 and 1000 °C, Pd_2Al_3 (δ) forms and dissolves up to 2 at.% Ir. The binary phases $IrAl_3$ and ϕ were not observed in the ternary region. The solubility of Pd in the χ phase decreases to 3 at.%. The ε-range extends from $Al_{74}Pd_{3.5}Ir_{22.5}$ to $Al_{73}Pd_{18.5}Ir_{8.5}$. The solubility of Pd in the C phase is at least 13 at.%. At 790 °C (Fig. 4), the ε phase extends to the Al-Pd side. The binary phase $PdAl_4$ (λ) appears in the ternary region and has a homogeneity range from $\sim Al_{80}Pd_{4.5}Ir_{15.5}$ and $\sim Al_{80}Pd_{8.5}Ir_{11.5}$. Ir_2Al_9 dissolves about 2 at.% Pd.

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