JPEDAV (2006) 27:497-498
DOI: 10.1361/154770306X136395
1547-7037/$19.00 ©ASM International

Al-Ni-Pt (Aluminum-Nickel-Platinum)

V. Raghavan

The previous study of this system by [1977Jac] presented a schematic isothermal section at 1060 °C. Recently, two isothermal sections have been determined at 1150 °C by [2005Hay] and at 1100 °C by [2004Gle], respectively.

Binary Systems

The Al-Ni phase diagram [1993Oka] shows five intermediate phases: $NiAl_3$ ($D0_{11}$, Fe_3C-type orthorhombic), Ni_2Al_3 ($D5_{13}$-type hexagonal), NiAl (*B*2, CsCl-type cubic, also denoted β), Ni_5Al_3 (Ga_3Pt_5-type orthorhombic), and Ni_3Al ($L1_2$, $AuCu_3$-type cubic; also denoted γ′). The Al-Pt phase diagram [1986Mca] depicts nine intermetallic phases: Pt_5Al_{21} (cubic), Pt_8Al_{21} (tetragonal), $PtAl_2$ (*C*1, CaF_2-type cubic), Pt_2Al_3 (hexagonal), PtAl (*B*20, FeSi-type cubic), β (52 to 56 at.% Pt; *B*2-type cubic), Pt_5Al_3 (Ge_3Rh_5-type orthorhombic), Pt_2Al ($PbCl_2$-type orthorhombic above 1060 °C and Pt_2Ga-type orthorhombic below 1060 °C), and Pt_3Al ($L1_2$, $AuCu_3$-type cubic and low-temperature Pt_3Ga-type tetragonal). The mode and temperature of transition in Pt_3Al have not been established. [1987Oya] found that the low-temperature Pt_3Al forms congruently from the $AuCu_3$-type at ~250 °C through a martensitic transition. The Ni-Pt phase diagram [1989Nas] depicts a large region of the continuous face-centered cubic (fcc) solid solution of Ni and Pt. At low temperatures, two ordered phases appear NiPt ($L1_0$, AuCu-type tetragonal) and Ni_3Pt ($L1_2$, $AuCu_3$-type cubic), with the critical temperatures at 645 and 580 °C, respectively.

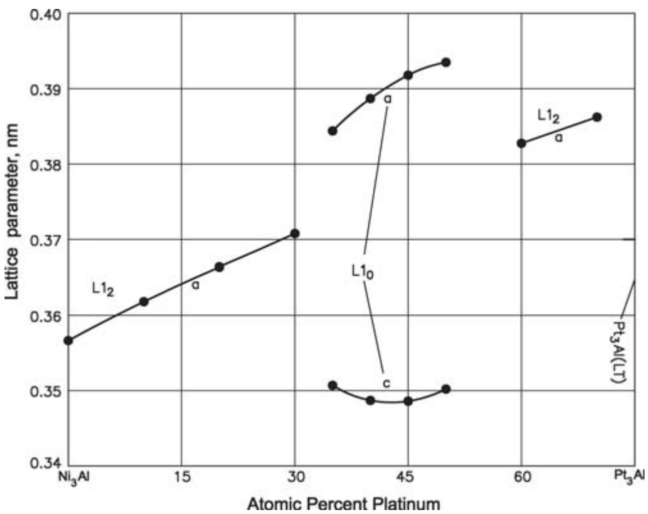

Fig. 1 Al-Ni-Pt lattice parameters of phases along the Ni_3Al-Pt_3Al join [2003Mei]

Ternary Isothermal Sections

In the schematic isothermal section drawn by [1977Jac], no ternary phase is present. [1994Kam] arc melted about ten alloys along the Ni_3Al-Pt_3Al join, using starting metals of 99.99% purity. The alloys were annealed at 1100 °C for 7 d and air cooled. Structural examination with x-ray powder diffraction showed that the Ni_3Al-based $L1_2$ dissolves up to 25 at.% Pt. At 37 and 50 at.% Pt, a ternary phase with the $L1_0$, AuCu-type tetragonal structure is present. [1994Kam] denoted this ternary phase as "$NiPt_2Al$." In view of its range of homogeneity, this phase is labeled here as $L1_0$. Between 26 and 32 at.% Pt, a two-phase mixture of $L1_2$ and $L1_0$ is stable. At compositions close to Pt_3Al, the $L1_2$ phase is

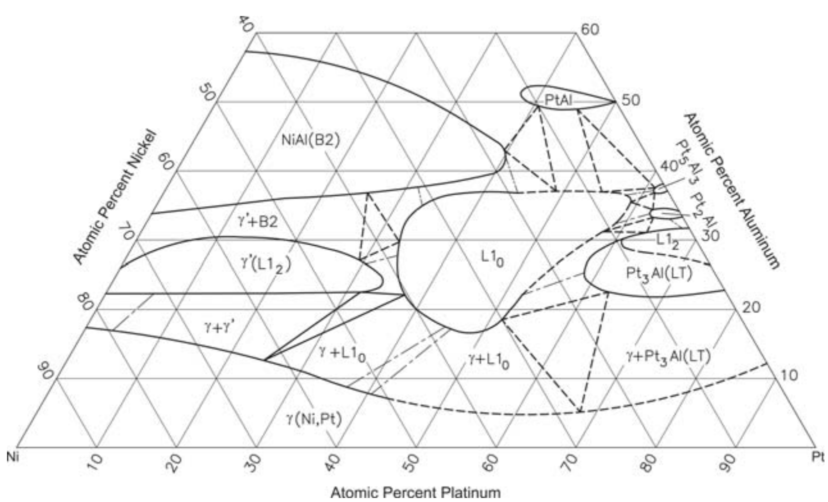

Fig. 2 Al-Ni-Pt tentative isothermal section at 1150 °C [2005Hay]

again stable. [2003Mei] studied the same join (Ni_3Al-Pt_3Al) and found no continuous solution between these phases either in rapid liquid quenching or by heat treatment. The Ni_3Al-based $L1_2$ dissolves up to 30 at.% Pt. Between 35 and 50 at.% Pt, the $L1_0$ phase is stable. The Pt_3Al-based $L1_2$ phase is stable between 60 and 70 at.% Pt. At the Pt-end, the low-temperature Pt_3Ga-type tetragonal phase is stable. The boundaries of the two-phase regions between these phases are not clearly demarcated in the results of [2003Mei]. The lattice parameters determined by [2003Mei] are shown in Fig. 1. The *c/a* ratio of the $L1_0$ phase is less than unity (0.912 to 0.890), in contrast to the ratio for Pt_3Al (LT) of more than unity (1.010 to 1.011).

[2004Gle] determined a partial isothermal section for Al-poor alloys of this ternary system applicable for the temperature range of 1150 to 1100 °C. A more detailed study was carried out by [2005Hay] at 1150 °C. With starting metals of ~99.99 wt.% purity, [2005Hay] arc melted alloy compositions for preparing the diffusion couples, which were annealed at 1150 °C for 50 h and quenched. The phase equilibria were determined by a combination of experimental techniques, including high-temperature synchrotron x-ray diffraction, scanning electron microscopy, and electron probe microanalysis. The partial isothermal section constructed by [2005Hay] at 1150 °C is redrawn in Fig. 2 to agree with the accepted binary data. Except for the ($\gamma + \gamma' + L1_0$) equilibrium, the triangulations shown in Fig. 2 are schematic.

References

1977Jac: M.R. Jackson and M.R. Rairden, The Aluminization of Platinum and Platinum-Coated IN-738, *Metall. Trans. A,* 1977, **8A,** p 1697-1707

1986Mca: A.J. McAlister and D.J. Kahan, The Al-Pt (Aluminum-Platinum) System, *Bull. Alloy Phase Diagrams,* 1986, **7**(1), p 47-51

1987Oya: Y. Oya, Y. Mishima, and T. Suzuki, The Pt-Al and Pt-Ga Phase Diagram with Emphasis on the Polymorphism of Pt_3Al and Pt_3Ga, *Z. Metallkd.,* 1987, **78**(7), p 485-490

1989Nas: P. Nash and M.F. Singleton, The Ni-Pt (Nickel-Platinum) System, *Bull. Alloy Phase Diagrams,* 1989, **10**(3), p 258-262

1993Oka: H. Okamoto, Al-Ni (Aluminum-Nickel), *J. Phase Equilib.,* 1993, **14**(2), p 257-259

1994Kam: J.L. Kamm and W.W. Milligan, Phase Stability in $(Ni,Pt)_3Al$ Alloys, *Scr. Metall. Mater.,* 1994, **31**(11), p 1461-1464

2003Mei: H. Meininger and M. Ellner, Phase Transformation and the Type of Lattice Distortion of Some Platinum-Rich Phases Belonging to the Cu Family, *J. Alloys Compd.,* 2003, **353,** p 207-212

2004Gle: B. Gleeson, W. Wang, S. Hayashi, and D. Sordelet, Effects of Platinum on the Interdiffusion and Oxidation Behavior of Ni-Al Based Alloys, *Mater. Sci. Forum,* 2004, **461-464,** p 213-222

2005Hay: S. Hayashi, S.I. Ford, D.J. Young, D.J. Sordelet, M.F. Besser, and B. Gleeson, α-NiPt(Al) and Phase Equilibria in the Ni-Al-Pt System at 1150 °C, *Acta Mater.,* 2005, **53,** p 3319-3328