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A contribution to the ternary phase diagrams of Al with Co, Rh and Ir

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Abstract

Phase equilibria were studied in Al–Co–Rh above 50 at.% Al at 1100 and 1000 °C and above 70 at.% Al at 900 °C; in Al–Co–Ir above 50 at.% Al at 1100 °C and above 70 at.% Al at 900 °C; in Al–Ir–Rh above 50 at.% Al at 1150 °C and above 70 at.% Al at 900 °C. Wide phase regions extended along about constant Al are common in these ternary alloy systems. A continuous ternary region was observed between isostructural Al_9Co_2, Al_9Rh_2 and Al_9Ir_2 (θ-phase), another region between Al_5Co_2 and Al_5Rh_2 (H-phase), and at elevated temperatures also between $Al_{2.63}Rh$ and $Al_{2.75}Ir$ (C-phase). The binary regions forming around equiatomic AlCo, AlRh and AlIr are probably connected by continuous ternary regions. The C-phase was found to extend up to at least 8 at.% Co in Al–Co–Rh and up to 10 at.% Co in Al–Co–Ir. The H-phase was found to extend up to at least 8 at.% Ir in Al–Co–Ir.

The ternary extensions of m-$Al_{13}Co_4$ achieved ~11 at.% Ir and ~15 at.% Rh, and those of the Al–Co Z-phase up to ~4 at.% Ir and ~10 at.% Rh. O-$Al_{13}Co_4$ was found to dissolve up to ~2 at. % Rh or Ir. M-$Al_{13}Co_4$ was not observed at ternary compositions. The Al–Rh ε-region containing both ε_6 and ε_{16} was found to extend up to ~8.5 at.% Co and up to ~20 at.% Ir, while the Al–Rh V-phase was found to extend up to 5.5 at.% Co and at least 13 at.% Ir. Of the Al–Ir phases, the φ-phase was found to dissolve up to 5 at.% Rh, and the χ-phase up to at least 12 at.% Rh but only ~5 at.% Co. Al_3Ir was found to dissolve up to ~14.5 at.% Co but very little Rh.

No ternary phases were revealed in Al–Ir–Rh. A ternary E-phase (*Pbma*, a = 2.3555, b = 1.6497, c = 2.0035 nm) was exposed around ~$Al_{77}Co_8Rh_{15}$. The same structure was also revealed at ~$Al_{77}Co_{10.5\text{-}16.0}Ir_{12.5\text{-}7.0}$. In addition, Al–Co–Ir contains ternary phases V, ε, W and D. The Al–Co–Ir V-phase and ε-phase are structurally interrelated with the Al–Rh V-phase and ε-phase, respectively. The former is formed at ~$Al_{71}Co_{17.5}Ir_{11.5}$, the latter at $Al_{76}Co_{7.5\text{-}10.5}Ir_{16.5\text{-}13.5}$. The W-phase (*Pmn*$2_1$, a = 2.3736, b = 0.8153, c = 2.0757 nm for $Al_{73}Co_{21}Ir_6$) occupies a region inside ~$Al_{73.0\text{-}71.5}Co_{19.0\text{-}22}Ir_{5.0\text{-}9.0}$ at 1100 °C and decomposes between 1000 and 1100 °C. At 1150 °C the same compositional region belongs to a decagonal D-phase, while at 1100 °C this phase exists at ~$Al_{74.5}Co_{17.5\text{-}21.0}Ir_{8.0\text{-}4.5}$ and at 900 °C around ~$Al_{74.5}Co_{19,5}Ir_{6.0}$.

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