Al-Cr-Ru (Aluminum-Chromium-Ruthenium)

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Recently, [2010Aco] determined two partial isothermal sections at 1500 and 1100 °C for this ternary system in the region around the two-phase equilibrium between RuAl (*B2*) and (Ru) (cph).

Binary Systems

The Al-Cr phase diagram [2008Gru] depicts a number of intermediate phases with significant ranges of homogeneity: CrAl_7 (V_7Al_{45} -type monoclinic), $\text{Cr}_2\text{Al}_{11}$ (CrAl_5 -type monoclinic), CrAl_4 (hexagonal), $\text{Cr}_4\text{Al}_{11}$ (triclinic), $\sim\text{Cr}_3\text{Al}_2$ (or CrAl) (*B2*, CsCl-type cubic) and Cr_2Al (MoSi_2 -type tetragonal). Between 30 and 41 at% Cr, the high-temperature phase denoted γ_1 (Cu_5Zn_8 -type cubic) transforms on cooling via a second-order transition to γ_2 (Cr_5Al_8 -type rhombohedral). The Al-Ru phase diagram [2003Mi] has six intermediate phases: Al_6Ru (orthorhombic, *Cmcm*), $\text{Al}_{13}\text{Ru}_4$ (monoclinic, *C2/m*), Al_5Ru_2 (orthorhombic, *Cmcm*), Al_2Ru (*C54*, TiSi_2 -type orthorhombic), Al_3Ru_2 (Os_2Al_3 -type tetragonal), and AlRu (*B2*, CsCl-type cubic). In the Cr-Ru system [Massalski2], Cr_2Ru ($D8_b$, σCrFe -type tetragonal) forms at 1580 °C and decomposes at ~ 800 °C. Another intermediate phase Cr_3Ru (*A15*, Cr_3Si -type cubic) forms between ~ 1000 and ~ 750 °C.

Fig. 1 Al-Cr-Ru partial isothermal section at 1500 °C in the Al lean region [2010Aco]

Fig. 2 Al-Cr-Ru partial isothermal section at 1100 °C in the Al lean region [2010Aco]

Ternary Isothermal Sections

With target compositions mainly in the RuAl-(Ru) region, [2010Aco] prepared eight alloys by arc-melting and three alloys by directional solidification. The alloys were annealed at 1500 °C for 2.5-6 h or at 1100 °C for 100-200 h. The phase equilibria were studied with x-ray powder diffraction and scanning electron microscope equipped with energy dispersive x-ray analyzer. Orientation relationships between (Ru) matrix and *B2* precipitates were determined by selected area diffraction in a transmission electron microscope. The partial isothermal sections in the Al-lean region at 1500 and 1100 °C constructed by [2010Aco] are shown in Fig. 1-2. At both temperatures, RuAl (*B2*) phase extends deep into the ternary region and forms tie-lines with the cph phase (Ru). The tie-triangles *B2* + (Ru) + σ and *B2* + (Cr) + σ are shown tentatively [2010Aco].

References

- 2003Mi:** S. Mi, S. Balanetsky, and B. Grushko, A Study of the Al-Rich Part of the Al-Ru Alloy System, *Intermetallics*, 2003, **11**, p 643-649
- 2008Gru:** B. Grushko, B. Przepiorzynski, and D. Pavlyuchkov, On the Constitution of the High Al-Region of the Al-Cr Alloy System, *J. Alloys Compd.*, 2008, **454**, p 214-220
- 2010Aco:** M. Acosta, T.D. Reynolds, D.R. Johnson, and E.P. Kvam, Characterization of Two-Phase *B2*-HCP Alloys in the Ru-Al-Cr System, *Intermetallics*, 2010, **18**, p 2281-2288