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Al-C-Cr (Aluminum-Carbon-Chromium)

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Schuster et al. [1980Sch] presented two isothermal sections at 1000 and 800 °C for this system. Recently, [2006Hal] determined the thermodynamic properties of the ternary compound Cr_2AlC and computed a liquidus projection and two isothermal sections at 1400 and 1000 °C.

Binary Systems

In the Al-C system [1991Har], the stoichiometric compound Al_4C_3 ($D7_1$-type rhombohedral) is present. The Al-Cr phase diagram by [2000Mah] includes a thermodynamic assessment and depicts a number of intermediate phases with significant ranges of homogeneity: $CrAl_7$ (V_7Al_{45}-type monoclinic), Cr_2Al_{11} ($CrAl_5$-type monoclinic), $CrAl_4$ (monoclinic), Cr_2Al ($MoSi_2$-type tetragonal), and an unconfirmed low-temperature phase X at 75 at.% Cr. Between 30 and 41 at.% Cr, five phases have been reported: αCr_4Al_9, βCr_4Al_9, γCr_4Al_9, αCr_5Al_8, and βCr_5Al_8, with no clear phase boundaries between them [2000Mah]. The C-Cr phase diagram [1990Ven] depicts three well-established compounds $Cr_{23}C_6$ ($D8_4$-type cubic), Cr_7C_3 ($D10_1$-type orthorhombic), and Cr_3C_2 ($D5_{10}$-type orthorhombic).

Ternary Phase Equilibria

[1980Sch] determined the crystal structure of the ternary compound Cr_2AlC (denoted τ here; hexagonal, $P6_3/mmc$, 8 atoms/cell, a = 0.2866 nm and c = 1.282 nm). Employing ab initio calculations, [2006Hal] estimated the energy of formation of Cr_2AlC. The incongruent melting temperature determined from the not-so-precise DTA measurement was between 1460 and 1495 °C and agrees satisfactorily with the calculated value of 1498 °C. [2006Hal] accepted the binary descriptions of [1995Gro] (Al-C), [1992Lee] (Cr-C)

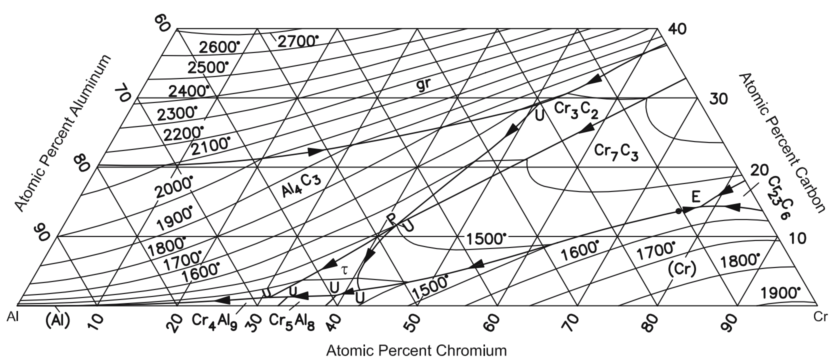

Fig. 1 Al-C-Cr computed liquidus projection [2006Hal]

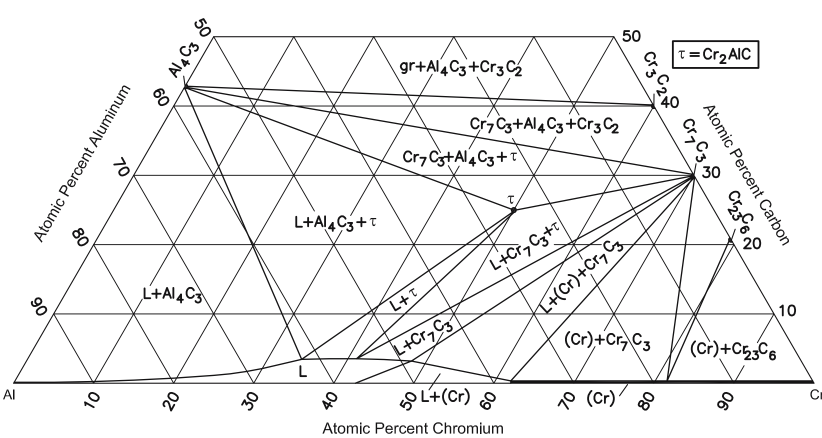

Fig. 2 Al-C-Cr computed isothermal section at 1400 °C [2006Hal]. Narrow two-phase regions are omitted

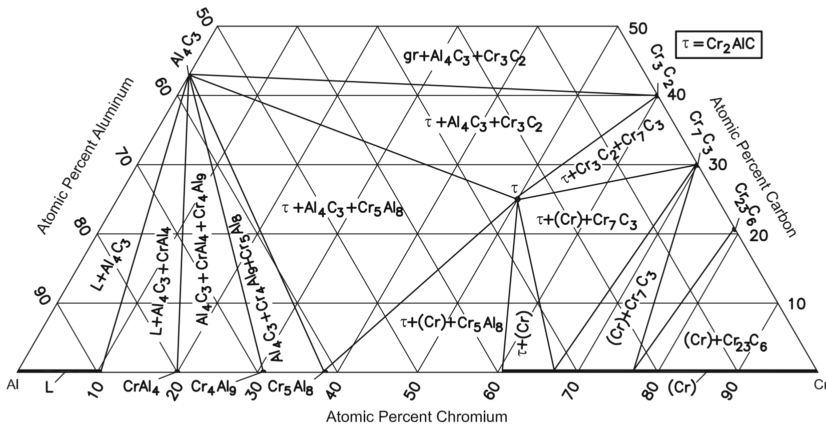

Fig. 3 Al-C-Cr computed isothermal section at 1000 °C [2006Hal]. Narrow two-phase regions are omitted

and [1998Sau] (Al-Cr). All compounds including the Al-Cr phases were treated as stoichiometric.

A liquidus projection and two isothermal sections at 1400 and 1000 °C were computed by [2006Hal], see Fig. 1-3. The invariant reactions on the liquidus surface (Fig. 1), their temperatures and compositions were listed. The primary crystallization regions of (Al), $CrAl_7$, Cr_2Al_{11}, and $CrAl_4$ are very close to the Al-Cr side in Fig. 1. In the isothermal sections (Fig. 2 and 3), the three-phase field of (Al_4C_3 + Cr_3C_2 + gr) extends up to the graphite corner. The triangulation seen at 1000 °C in Fig. 3 agrees with that of [1980Sch]. The tie line between τ and graphite reported by [1980Sch] at 800 °C could not reproduced in the calculations.

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