Cr-Si (Chromium-Silicon)

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The equilibrium phases of the Cr-Si system are: (1) the liquid, L; (2) the terminal solid solution, (Cr), with a maximum solubility of approximately 9.5 at.% at the eutectic temperature of 1705 °C; (3) the terminal solid solution, (Si), with a maximum solid solubility of approximately 8×10^{-6} at.% at the eutectic temperature of 1305 °C; (4) the cubic intermediate phase, Cr_3Si, which melts congruently at 1770 °C; (5) the tetragonal intermediate phase, Cr_5Si_3, which melts congruently at 1680 °C and undergoes a polymorphic transformation at 1505 °C; (6) the cubic intermediate phase, CrSi, which decomposes peritectically at 1413 °C; and (7) the hexagonal intermediate phase, $CrSi_2$, which melts congruently at 1490 °C. The assessed phase diagram is based primarily on the work of [68Cha], with modifications based on the data of [55Par], [61Gol], and [71Koc].

According to the data of [78Ast], [82Ben], and [82End] on magnetic first-order transitions, the Cr-Si system exhibits a triple point at 0.8 to 0.9 at.% Si. For Si concentrations greater than the triple point, the system goes through paramagnetic (P) → commensurate (C) → incommensurate (I) transitions with decreasing temperature, whereas for Si contents less than the triple point, the system exhibits P → I(T) → I(L) transitions with decreasing temperature.

Cr-Si Crystal Structure Data

Phase	Composition, at.% Si	Pearson symbol	Space group	Strukturbericht designation	Prototype
(Cr)	0 to 9.5	*cI*2	*Im*3*m*	*A*2	W
Cr_3Si	22.5 to 26.4	*cP*8	*Pm*3*n*	*A*15	βW
αCr_5Si_3	36 to 41	*tI*38	*I*4/*mcm*	$D8_m$	W_5Si_3
CrSi	50	*cP*8	$P2_13$	*B*20	FeSi
$CrSi_2$	66.67 to 66.99	*hP*9	$P6_222$	*C*40	$CrSi_2$
(Si)	~100	*cF*8	*Fd*3*m*	*A*4	C (diamond)

Cr-Si Monovariant and Invariant Points

Reaction	Composition, at.% Si		Temperature, °C	Reaction type
(Cr) + $Cr_3Si \rightleftarrows$ L 9.5	22.5	15	1705 ± 5	Eutectic
$Cr_3Si \rightleftarrows$ L	25		1770 ± 10	Congruent
$Cr_3Si + Cr_5Si_3 \rightleftarrows$ L 26.4	36	35	1660 ± 10	Eutectic
$Cr_5Si_3 \rightleftarrows$ L	37.5		1680 ± 20	Congruent
$Cr_5Si_3(\alpha) \rightleftarrows Cr_5Si_3(\beta)$	36 to 41		1505 ± 20	Allotropic transformation
Cr_5Si_3 + L $\rightleftarrows$ CrSi 41	51	50	1413 ± 5	Peritectic
Crsi + $CrSi_2 \rightleftarrows$ L 50	66.67	56	1390 ± 10	Eutectic
$CrSi_2 \rightleftarrows$ L	66.67		1490 ± 20	Congruent
$CrSi_2$ + (Si) $\rightleftarrows$ L 66.99	8×10^{-6}	87	1305 ± 10	Eutectic
Cr $\rightleftarrows$ L	0		1860 ± 20	Melting point
Si $\rightleftarrows$ L	100		1414 ± 2	Melting point

55Par: E. Parthe, H. Nowotny, and H. Schmid, *Monatsh. Chem.*, (86), 385-396 (1955) in German.

61Gol: H.J. Goldschmidt and J.A. Brand, *J. Less-Common Met.*, (3), 34-43 (1961).

68Cha: Y.A. Chang, *Trans. AIME*, (242), 1509-1515 (1968).

71Koc: Ju.A. Kocherzhinsky, *Therm. Anal., Proc. 3rd ICTA DAVOS*, (1), 549-559 (1971).

78Ast: H.U. Astrom, G. Benediktsson, and K.V. Rao, *J. Phys.*, *39*(6), 785-787 (1978).

82Ben: G. Benediktsson, L. Hedman, H.U. Astrom, and K.V. Rao, *J. Phys. F. (Met. Phys.)*, *12*, 1439-1452 (1982).

82End: Y. Endoh, J. Mizuki, and Y. Ishikawa, *J. Phys. Soc. Jpn.*, *51*(a), 2826-2832 (1982).

Complete evaluation contains 11 figures, 6 tables, and 35 references.