Si – Zn (Silicon – Zinc)

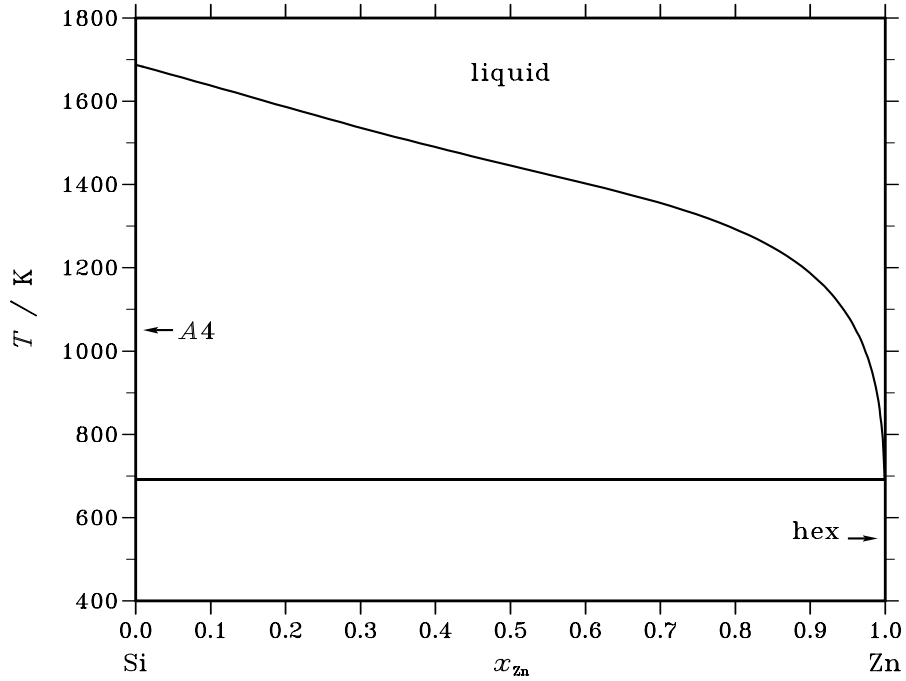

Fig. 1. Calculated phase diagram for the system Si-Zn.

The Si-Zn system is characterised by complete mixing of the components in the liquid phase and negligible solubility in either the diamond form of Si or the hcp form of Zn. The shape of the liquidus surface indicates positive enthalpies of mixing and the possibility of a metastable miscibility gap. While this system seems to have no particular technological importance in its own right, an understanding of the phase diagram and thermodynamic properties are essential in order to model important ternary systems such as the Al-Si-Zn system, key to certain types of aluminium alloys used by industry.
The critically assessed data for this system have been taken from the work of Jacobs and Spencer [96Jac]. This was based entirely on measurements of the liquidus temperatures. The system has also been assessed by an Mey and Hack [86Mey] and Olesinski and Abbaschian [85Ole].

Table I. Phases, structures and models.

Phase	Struktur-bericht	Prototype	Pearson symbol	Space group	SGTE name	Model
liquid					LIQUID	$(Si,Zn)_1$
$A4$	$A4$	C(diamond)	$cF8$	$Fd\overline{3}m$	DIAMOND_A4	$(Si,Zn)_1$
hex	$A3$	Mg	$hP2$	$P6_3/mmc$	HCP_ZN	$(Si,Zn)_1$

Table II. Invariant reactions.

Reaction	Type	T / K	Compositions / x_{Zn}			$\Delta_r H$ / (J/mol)
liquid $\rightleftharpoons A4$ + hex	eutectic	692.2	0.999	0.000	1.000	−7372

Table IIIa. Integral quantities for the liquid phase at 1700 K.

x_{Zn}	ΔG_{m} [J/mol]	ΔH_{m} [J/mol]	ΔS_{m} [J/(mol·K)]	$G_{\mathrm{m}}^{\mathrm{E}}$ [J/mol]	$S_{\mathrm{m}}^{\mathrm{E}}$ [J/(mol·K)]	ΔC_P [J/(mol·K)]
0.000	0	0	0.000	0	0.000	0.000
0.100	−4182	413	2.703	413	0.000	0.000
0.200	−6192	881	4.161	881	0.000	0.000
0.300	−7301	1334	5.079	1334	0.000	0.000
0.400	−7803	1710	5.596	1710	0.000	0.000
0.500	−7840	1957	5.763	1957	0.000	0.000
0.600	−7482	2031	5.596	2031	0.000	0.000
0.700	−6740	1895	5.079	1895	0.000	0.000
0.800	−5551	1522	4.161	1522	0.000	0.000
0.900	−3701	894	2.703	894	0.000	0.000
1.000	0	0	0.000	0	0.000	0.000

Reference states: Si(liquid), Zn(liquid)

Table IIIb. Partial quantities for Si in the liquid phase at 1700 K.

x_{Si}	ΔG_{Si} [J/mol]	ΔH_{Si} [J/mol]	ΔS_{Si} [J/(mol·K)]	$G_{\mathrm{Si}}^{\mathrm{E}}$ [J/mol]	$S_{\mathrm{Si}}^{\mathrm{E}}$ [J/(mol·K)]	a_{Si}	γ_{Si}
1.000	0	0	0.000	0	0.000	1.000	1.000
0.900	−1529	−40	0.876	−40	0.000	0.897	0.997
0.800	−3216	−62	1.855	−62	0.000	0.797	0.996
0.700	−4980	61	2.966	61	0.000	0.703	1.004
0.600	−6790	431	4.247	431	0.000	0.619	1.031
0.500	−8675	1123	5.763	1123	0.000	0.541	1.083
0.400	−10764	2187	7.619	2187	0.000	0.467	1.167
0.300	−13369	3649	10.010	3649	0.000	0.388	1.295
0.200	−17242	5506	13.382	5506	0.000	0.295	1.476
0.100	−24813	7733	19.145	7733	0.000	0.173	1.728
0.000	$-\infty$	10276	∞	10276	0.000	0.000	2.069

Reference state: Si(liquid)

Table IIIc. Partial quantities for Zn in the liquid phase at 1700 K.

x_{Zn}	ΔG_{Zn} [J/mol]	ΔH_{Zn} [J/mol]	ΔS_{Zn} [J/(mol·K)]	$G_{\mathrm{Zn}}^{\mathrm{E}}$ [J/mol]	$S_{\mathrm{Zn}}^{\mathrm{E}}$ [J/(mol·K)]	a_{Zn}	γ_{Zn}
0.000	$-\infty$	3600	∞	3600	0.000	0.000	1.290
0.100	−28058	4488	19.145	4488	0.000	0.137	1.374
0.200	−18097	4652	13.382	4652	0.000	0.278	1.390
0.300	−12715	4303	10.010	4303	0.000	0.407	1.356
0.400	−9322	3629	7.619	3629	0.000	0.517	1.293
0.500	−7006	2792	5.763	2792	0.000	0.609	1.218
0.600	−5294	1926	4.247	1926	0.000	0.688	1.146
0.700	−3899	1143	2.966	1143	0.000	0.759	1.084
0.800	−2628	526	1.855	526	0.000	0.830	1.038
0.900	−1356	134	0.876	134	0.000	0.909	1.010
1.000	0	0	0.000	0	0.000	1.000	1.000

Reference state: Zn(liquid)

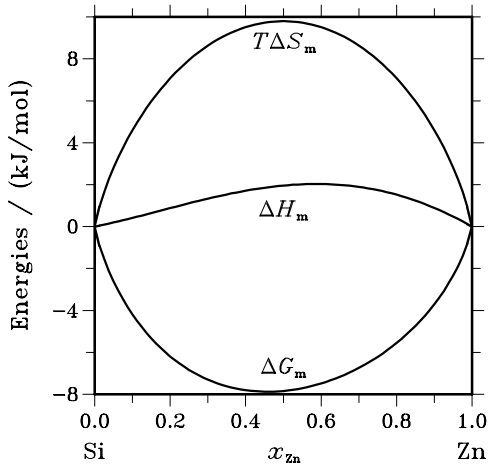

Fig. 2. Integral quantities of the liquid phase at T=1700 K.

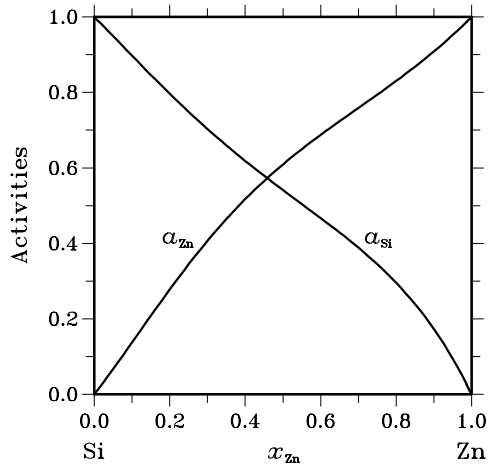

Fig. 3. Activities in the liquid phase at T=1700 K.

References

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