Ga – Zn (Gallium – Zinc)

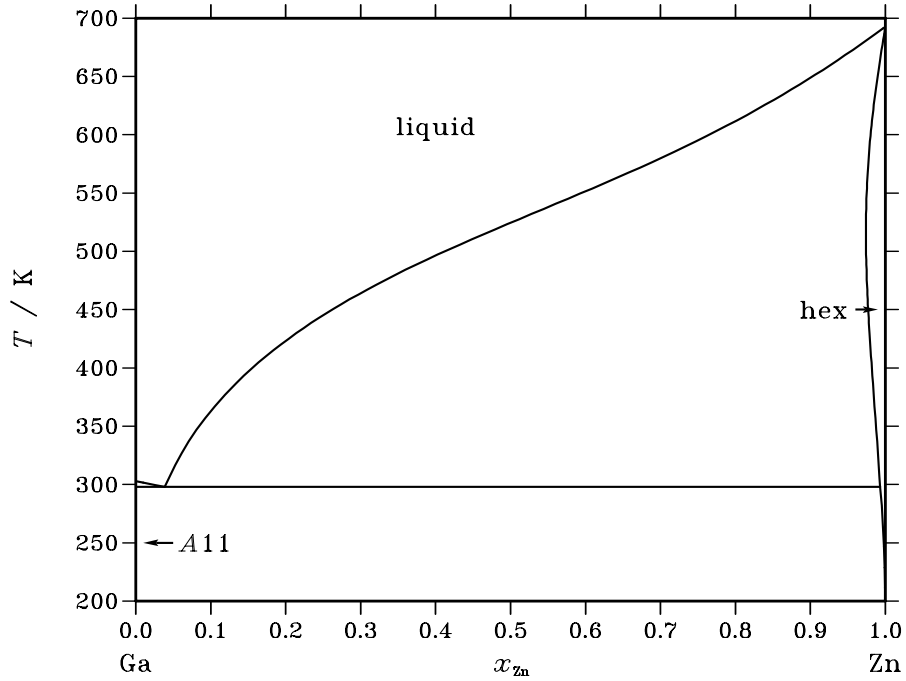

Fig. 1. Calculated phase diagram for the system Ga-Zn.

The phase diagram for the Ga-Zn system is characterised by complete mixing of the pure elements in the liquid phase, small solubility of Ga in hexagonal Zn and low solubility of Zn in orthorhombic Ga. The critically assessed thermodynamic data for this system were taken from the work of Dutkiewicz *et al.* [90Dut] who also reviewed all the experimental data for the system. The liquidus surface is reasonably well defined experimentally and there is a eutectic at 297.82 K corresponding to a composition of 3.87 at.% Zn. The solubility of Ga in hexagonal Zn is retrograde with a maximum solubility of 2.36 at.% Ga at 533 K. There are very few data on the solubility of Zn in orthorhombic Ga but the maximum solubility is likely to be no more than 0.8 at.% Zn. The thermodynamic properties of liquid alloys have been studied by an EMF method, vapour pressure techniques and calorimetry. The critically assessed data [90Dut] are in good agreement with most of the experimental data.

Table I. Phases, structures and models.

Phase	Struktur-bericht	Prototype	Pearson symbol	Space group	SGTE name	Model
liquid					LIQUID	$(Ga,Zn)_1$
$A11$	$A11$	αGa	$oC8$	$Cmca$	ORTHORHOMBIC_CMCA	Ga_1
hex	$A3$	Mg	$hP2$	$P6_3/mmc$	HCP_ZN	$(Ga,Zn)_1$

Table II. Invariant reactions.

Reaction	Type	T / K	Compositions / x_{Zn}			$\Delta_r H$ / (J/mol)
liquid $\rightleftharpoons$ $A11$ + hex	eutectic	297.9	0.039	0.000	0.993	-5803

Table IIIa. Integral quantities for the liquid phase at 723 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	−1682	570	3.114	273	0.411	0.378
0.200	−2509	1027	4.891	499	0.730	0.672
0.300	−2997	1368	6.037	675	0.958	0.882
0.400	−3252	1586	6.691	794	1.095	1.008
0.500	−3317	1675	6.904	850	1.141	1.050
0.600	−3208	1630	6.691	838	1.095	1.008
0.700	−2919	1446	6.037	753	0.958	0.882
0.800	−2420	1116	4.891	589	0.730	0.672
0.900	−1615	636	3.114	339	0.411	0.378
1.000	0	0	0.000	0	0.000	0.000

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

Table IIIb. Partial quantities for Ga in the liquid phase at 723 K.

x_{Ga}	ΔG_{Ga} [J/mol]	ΔH_{Ga} [J/mol]	ΔS_{Ga} [J/(mol·K)]	$G_{\mathrm{Ga}}^{\mathrm{E}}$ [J/mol]	$S_{\mathrm{Ga}}^{\mathrm{E}}$ [J/(mol·K)]	a_{Ga}	γ_{Ga}
1.000	0	0	0.000	0	0.000	1.000	1.000
0.900	−611	55	0.922	22	0.046	0.903	1.004
0.800	−1246	227	2.038	95	0.183	0.813	1.016
0.700	−1913	528	3.376	231	0.411	0.727	1.039
0.600	−2631	968	4.978	440	0.730	0.646	1.076
0.500	−3433	1559	6.904	734	1.141	0.565	1.130
0.400	−4385	2312	9.262	1124	1.643	0.482	1.206
0.300	−5617	3237	12.247	1620	2.236	0.393	1.309
0.200	−7440	4347	16.303	2235	2.921	0.290	1.450
0.100	−10863	5652	22.842	2979	3.697	0.164	1.641
0.000	$-\infty$	7164	∞	3864	4.564	0.000	1.902

Reference state: Ga(liquid)

Table IIIc. Partial quantities for Zn in the liquid phase at 723 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	$-\infty$	6235	∞	2935	4.564	0.000	1.630
0.100	−11314	5201	22.842	2528	3.697	0.152	1.523
0.200	−7559	4228	16.303	2116	2.921	0.284	1.422
0.300	−5526	3328	12.247	1711	2.236	0.399	1.329
0.400	−4184	2512	9.262	1324	1.643	0.499	1.246
0.500	−3201	1791	6.904	966	1.141	0.587	1.174
0.600	−2423	1176	4.978	648	0.730	0.668	1.114
0.700	−1763	678	3.376	381	0.411	0.746	1.065
0.800	−1165	309	2.038	177	0.183	0.824	1.030
0.900	−587	79	0.922	46	0.046	0.907	1.008
1.000	0	0	0.000	0	0.000	1.000	1.000

Reference state: Zn(liquid)

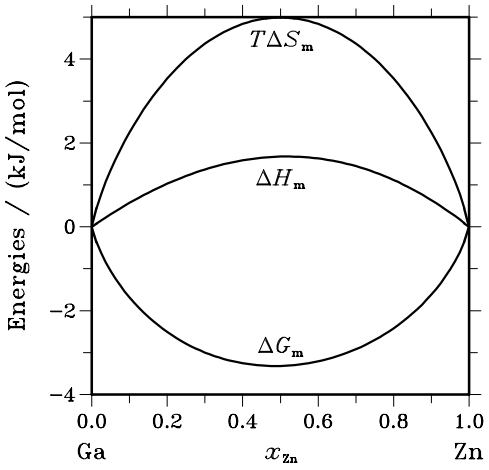

Fig. 2. Integral quantities of the liquid phase at T=723 K.

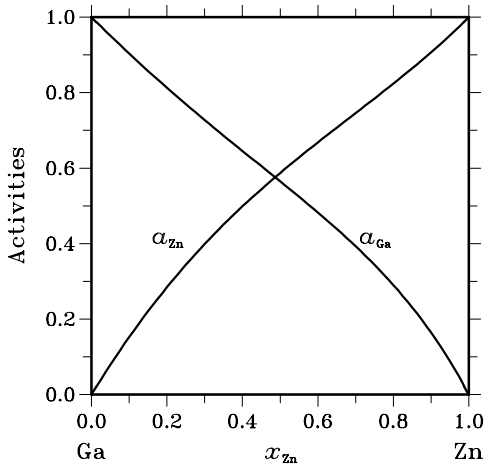

Fig. 3. Activities in the liquid phase at T=723 K.

References

[90Dut] J. Dutkiewicz, Z. Moser, L. Zabdyr, D.D. Gohil, T.G. Chart, I. Ansara, C. Girard: Bull. Alloy Phase Diagrams **11** (1990) 77–82.