Ga – Sn (Gallium – Tin)

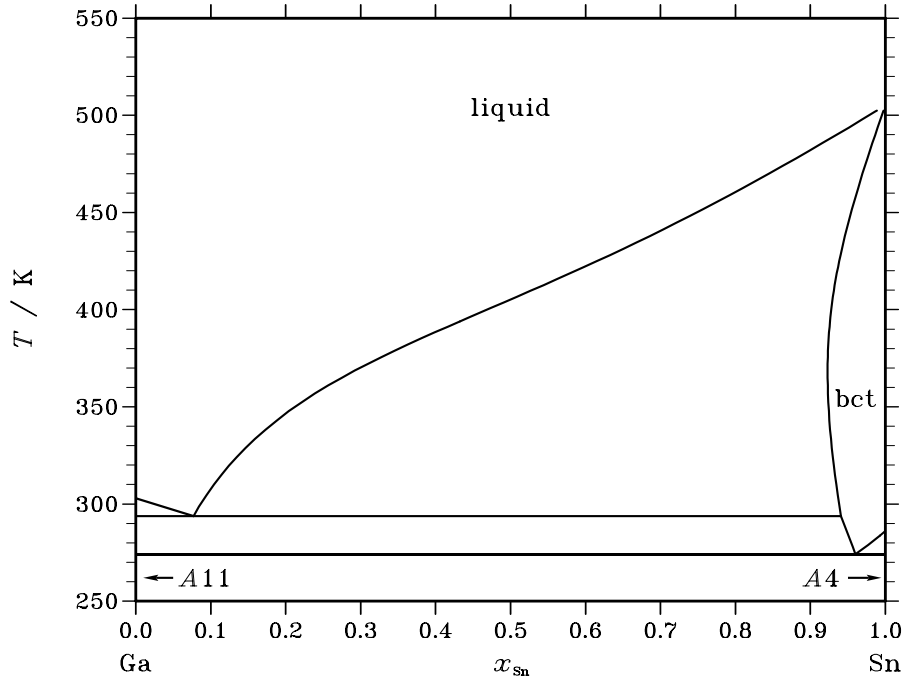

Fig. 1. Calculated phase diagram for the system Ga-Sn.

The Ga-Sn system is interesting for the electronic industry. It has been assessed by [92And]. It is a simple eutectic type at 293.8 K on the Ga rich side. The solubility of tin in Ga is very small (0.016 at.%), but on the Sn rich side at the eutectic temperature the solubility of Ga in tin is about 6.4 at.%. A metastable eutectic reaction may occur between γGa and Sn at 249.77 K with 3 at.% of Sn. No experimental data are reported for equilibria including cubic αSn. The enthalpies of mixing in the liquid are slightly endothermic and show a very small temperature dependence.

Table I. Phases, structures and models.

Phase	Struktur-bericht	Prototype	Pearson symbol	Space group	SGTE name	Model
liquid					LIQUID	$(Ga,Sn)_1$
$A11$	$A11$	αGa	$oC8$	$Cmca$	ORTHORHOMBIC_CMCA	Ga_1
bct	$A5$	βSn	$tI4$	$I4_1/amd$	BCT_A5	$(Ga,Sn)_1$
$A4$	$A4$	C(diamond)	$cF8$	$Fd\overline{3}m$	DIAMOND_A4	Sn_1

Table II. Invariant reactions.

Reaction	Type	T / K	Compositions / x_{Sn}			$\Delta_{\mathrm{r}}H$ / (J/mol)
liquid $\rightleftharpoons$ $A11$ + bct	eutectic	293.8	0.077	0.000	0.940	-5911
bct $\rightleftharpoons$ $A11$ + $A4$	eutectoid	274.2	0.960	0.000	1.000	-2287

Table IIIa. Integral quantities for the liquid phase at 723 K.

x_{Sn}	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	−1616	341	2.708	338	0.005	0.000
0.200	−2422	590	4.165	586	0.005	0.000
0.300	−2921	752	5.081	751	0.002	0.000
0.400	−3209	834	5.592	837	−0.004	0.000
0.500	−3317	842	5.754	849	−0.010	0.000
0.600	−3252	783	5.581	794	−0.015	0.000
0.700	−2996	663	5.061	676	−0.018	0.000
0.800	−2507	488	4.143	501	−0.017	0.000
0.900	−1681	265	2.691	274	−0.012	0.000
1.000	0	0	0.000	0	0.000	0.000

Reference states: Ga(liquid), Sn(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	−588	47	0.879	46	0.003	0.907	1.008
0.800	−1166	181	1.864	175	0.009	0.824	1.030
0.700	−1766	389	2.981	378	0.015	0.745	1.065
0.600	−2427	658	4.267	644	0.019	0.668	1.113
0.500	−3206	975	5.782	961	0.019	0.587	1.173
0.400	−4189	1327	7.629	1319	0.011	0.498	1.245
0.300	−5529	1703	10.003	1709	−0.008	0.399	1.329
0.200	−7558	2089	13.342	2117	−0.039	0.284	1.422
0.100	−11307	2472	19.058	2535	−0.087	0.152	1.525
0.000	$-\infty$	2841	∞	2951	−0.153	0.000	1.634

Reference state: Ga(liquid)

Table IIIc. Partial quantities for Sn in the liquid phase at 723 K.

x_{Sn}	ΔG_{Sn} [J/mol]	ΔH_{Sn} [J/mol]	ΔS_{Sn} [J/(mol·K)]	$G_{\mathrm{Sn}}^{\mathrm{E}}$ [J/mol]	$S_{\mathrm{Sn}}^{\mathrm{E}}$ [J/(mol·K)]	a_{Sn}	γ_{Sn}
0.000	$-\infty$	3899	∞	3844	0.076	0.000	1.895
0.100	−10873	2987	19.169	2969	0.024	0.164	1.639
0.200	−7443	2224	13.372	2232	−0.010	0.290	1.449
0.300	−5616	1599	9.980	1621	−0.030	0.393	1.310
0.400	−4381	1099	7.580	1127	−0.039	0.482	1.206
0.500	−3429	710	5.725	738	−0.038	0.565	1.131
0.600	−2627	421	4.215	444	−0.032	0.646	1.077
0.700	−1911	218	2.944	234	−0.022	0.728	1.040
0.800	−1245	88	1.844	97	−0.012	0.813	1.016
0.900	−611	20	0.873	22	−0.003	0.903	1.004
1.000	0	0	0.000	0	0.000	1.000	1.000

Reference state: Sn(liquid)

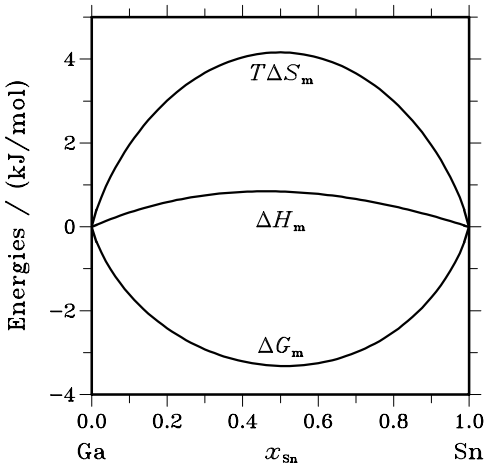

Fig. 2. Integral quantities of the liquid phase at T=723 K.

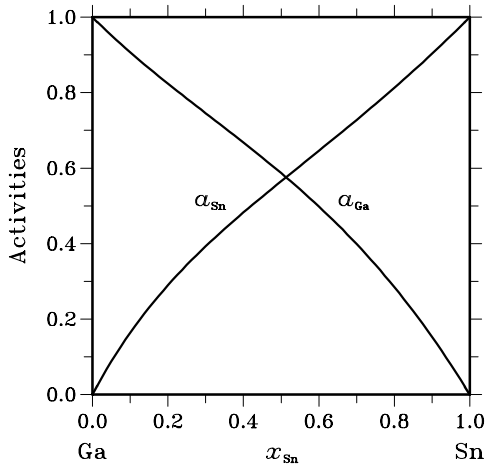

Fig. 3. Activities in the liquid phase at T=723 K.

References

[92And] T. Anderson, I. Ansara: J. Phase Equilibria **13** (1992) 181–189.