Cu – Tl (Copper – Thallium)

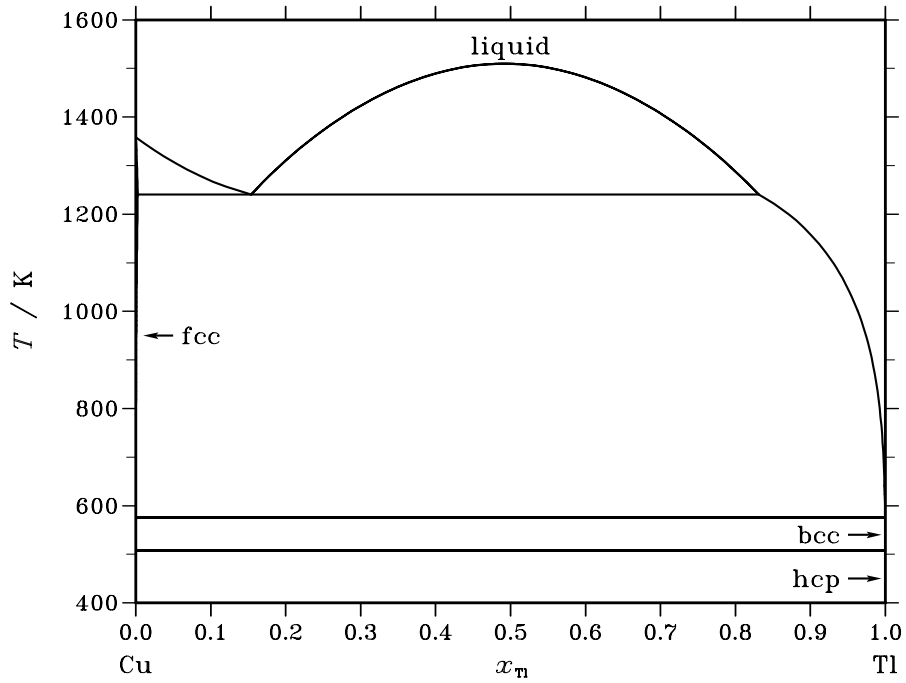

Fig. 1. Calculated phase diagram for the system Cu-Tl.

A thermodynamic assessment for the Cu-Tl system has been provided by Chevalier [89Che] and updated later [03Che]. The phase diagram is of monotectic type, with a miscibility gap in the liquid state, a very limited solid solubility of Tl in the cubic fcc-Cu terminal solid solution [46Rau], and an unknown but negligible solubility of Cu in hexagonal thallium as well as in bcc-Tl. There is no compound in the system and the solution phases were modelled with a simple substitutional model, using a second-order Redlich-Kister polynomial for the liquid and a regular model for the solid solution. The miscibility gap in the liquid and the liquidus have been determined in several investigations [06Doe, 52Kle, 55Sei, 69Pre]. The activity of thallium in the melt has been obtained from vapour pressure measurements [66Yaz] and the enthalpy of mixing of liquid alloys has been measured by direct high temperature calorimetry [69Pre].

Table I. Phases, structures and models.

Phase	Struktur-bericht	Prototype	Pearson symbol	Space group	SGTE name	Model
liquid					LIQUID	$(Cu,Tl)_1$
fcc	$A1$	Cu	$cF4$	$Fm\overline{3}m$	FCC_A1	$(Cu,Tl)_1$
bcc	$A2$	W	$cI2$	$Im\overline{3}m$	BCC_A2	$(Cu,Tl)_1$
hcp	$A3$	Mg	$hP2$	$P6_3/mmc$	HCP_A3	$(Cu,Tl)_1$

Table II. Invariant reactions.

Reaction	Type	T / K	Compositions / x_{Tl}			$\Delta_r H$ / (J/mol)
liquid $\rightleftharpoons$ liquid′ + liquid″	critical	1516.1	0.498	0.498	0.498	0
liquid′ $\rightleftharpoons$ fcc + liquid″	monotectic	1243.4	0.149	0.003	0.829	−14388
liquid″ $\rightleftharpoons$ fcc + bcc	eutectic	576.5	0.999	0.000	1.000	−4173
bcc $\rightleftharpoons$ fcc + hcp	degenerate	507.0	1.000	0.000	1.000	−360

Table IIIa. Integral quantities for the liquid phase at 1573 K.

x_{Tl}	ΔG_{m} [J/mol]	ΔH_{m} [J/mol]	ΔS_{m} [J/(mol·K)]	$G^{\mathrm{E}}_{\mathrm{m}}$ [J/mol]	$S^{\mathrm{E}}_{\mathrm{m}}$ [J/(mol·K)]	ΔC_P [J/(mol·K)]
0.000	0	0	0.000	0	0.000	0.000
0.100	−2277	3185	3.473	1975	0.770	0.000
0.200	−2957	5505	5.380	3587	1.219	0.000
0.300	−3213	7066	6.535	4776	1.456	0.000
0.400	−3305	7950	7.155	5497	1.559	0.000
0.500	−3338	8208	7.340	5727	1.577	0.000
0.600	−3341	7865	7.124	5461	1.529	0.000
0.700	−3277	6918	6.481	4712	1.402	0.000
0.800	−3030	5335	5.318	3515	1.157	0.000
0.900	−2332	3058	3.426	1920	0.723	0.000
1.000	0	0	0.000	0	0.000	0.000

Reference states: Cu(liquid), Tl(liquid)

Table IIIb. Partial quantities for Cu in the liquid phase at 1573 K.

x_{Cu}	ΔG_{Cu} [J/mol]	ΔH_{Cu} [J/mol]	ΔS_{Cu} [J/(mol·K)]	$G^{\mathrm{E}}_{\mathrm{Cu}}$ [J/mol]	$S^{\mathrm{E}}_{\mathrm{Cu}}$ [J/(mol·K)]	a_{Cu}	γ_{Cu}
1.000	0	0	0.000	0	0.000	1.000	1.000
0.900	−1209	453	1.057	169	0.181	0.912	1.013
0.800	−2150	1655	2.419	769	0.563	0.848	1.061
0.700	−2770	3432	3.943	1894	0.977	0.809	1.156
0.600	−3096	5692	5.587	3585	1.339	0.789	1.315
0.500	−3244	8429	7.421	5822	1.658	0.780	1.561
0.400	−3455	11719	9.647	8529	2.028	0.768	1.920
0.300	−4173	15721	12.647	11574	2.637	0.727	2.423
0.200	−6284	20678	17.140	14766	3.759	0.619	3.093
0.100	−12258	26915	24.903	17857	5.758	0.392	3.917
0.000	$-\infty$	34842	∞	20545	9.089	0.000	4.811

Reference state: Cu(liquid)

Table IIIc. Partial quantities for Tl in the liquid phase at 1573 K.

x_{Tl}	ΔG_{Tl} [J/mol]	ΔH_{Tl} [J/mol]	ΔS_{Tl} [J/(mol·K)]	$G^{\mathrm{E}}_{\mathrm{Tl}}$ [J/mol]	$S^{\mathrm{E}}_{\mathrm{Tl}}$ [J/(mol·K)]	a_{Tl}	γ_{Tl}
0.000	$-\infty$	36610	∞	21302	9.732	0.000	5.098
0.100	−11889	27774	25.215	18226	6.070	0.403	4.029
0.200	−6187	20904	17.222	14863	3.841	0.623	3.116
0.300	−4247	15548	12.584	11500	2.574	0.723	2.409
0.400	−3618	11337	9.508	8365	1.889	0.758	1.896
0.500	−3433	7987	7.260	5632	1.497	0.769	1.538
0.600	−3266	5296	5.443	3415	1.196	0.779	1.298
0.700	−2893	3145	3.839	1772	0.873	0.802	1.145
0.800	−2217	1499	2.362	702	0.507	0.844	1.055
0.900	−1229	407	1.040	149	0.164	0.910	1.011
1.000	0	0	0.000	0	0.000	1.000	1.000

Reference state: Tl(liquid)

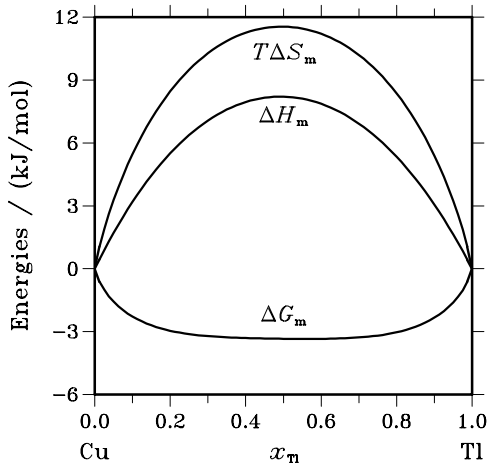

Fig. 2. Integral quantities of the liquid phase at T=1573 K.

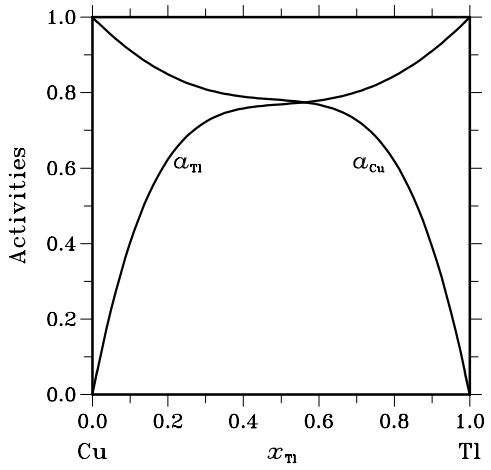

Fig. 3. Activities in the liquid phase at T=1573 K.

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