Cu – Nb (Copper – Niobium)

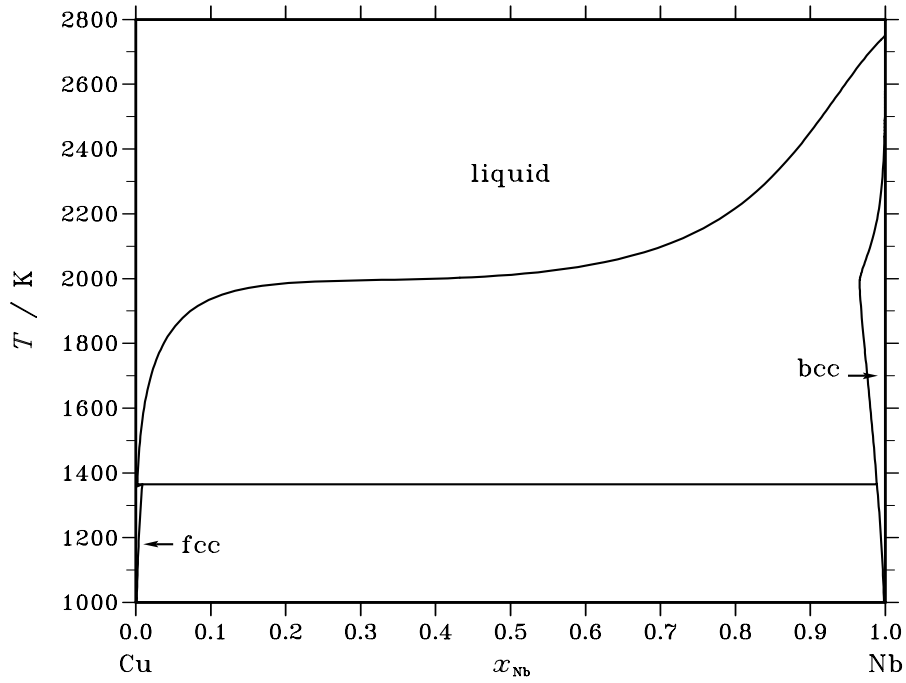

Fig. 1. Calculated phase diagram for the system Cu-Nb.

There is still some uncertainty about the phase diagram for the Cu-Nb system and particular whether there is a miscibility gap in the liquid on the Cu rich side of the system. The dataset adopted by SGTE is from the work of Hämäläinen *et al.* [90Ham] who concluded that, although the liquidus curve was indeed flat, the miscibility gap was metastable ie below the liquidus surface. This conclusion has since been confirmed experimentally by Li *et al.* [00Li]. In the assessment of Hämäläinen *et al.* there is appreciable solubility of Cu in bcc Nb although this is not well established experimentally. There is also a large degree of uncertainty about the phase equilibria close to pure Cu and it is not unambiguously clear whether there is a eutectic or a peritectic reaction. The data of Hämäläinen *et al.* indicate a peritectic reaction. The experimental studies on the thermodynamic properties are limited to measurement of copper activities in the liquid phase close to pure Cu.

Table I. Phases, structures and models.

Phase	Struktur-bericht	Prototype	Pearson symbol	Space group	SGTE name	Model
liquid					LIQUID	$(Cu,Nb)_1$
fcc	$A1$	Cu	$cF4$	$Fm\overline{3}m$	FCC_A1	$(Cu,Nb)_1$
bcc	$A2$	W	$cI2$	$Im\overline{3}m$	BCC_A2	$(Cu,Nb)_1$

Table II. Invariant reactions.

Reaction	Type	T / K	Compositions / x_{Nb}			$\Delta_{\mathrm{r}}H$ / (J/mol)
liquid + bcc $\rightleftharpoons$ fcc	peritectic	1365.3	0.002	0.989	0.009	−12908

Table IIIa. Integral quantities for the liquid phase at 2773 K.

x_{Nb}	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	−7574	10822	6.634	−79	3.931	0.000
0.200	−13443	22604	12.999	−1906	8.839	0.000
0.300	−18903	34083	19.108	−4819	14.029	0.000
0.400	−23673	44000	24.404	−8156	18.808	0.000
0.500	−27236	51090	28.246	−11255	22.483	0.000
0.600	−28970	54094	29.955	−13453	24.359	0.000
0.700	−28173	51748	28.821	−14089	23.742	0.000
0.800	−24037	42792	24.100	−12500	19.939	0.000
0.900	−15520	25963	14.960	−8024	12.257	0.000
1.000	0	0	0.000	0	0.000	0.000

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

Table IIIb. Partial quantities for Cu in the liquid phase at 2773 K.

x_{Cu}	ΔG_{Cu} [J/mol]	ΔH_{Cu} [J/mol]	ΔS_{Cu} [J/(mol·K)]	$G_{\mathrm{Cu}}^{\mathrm{E}}$ [J/mol]	$S_{\mathrm{Cu}}^{\mathrm{E}}$ [J/(mol·K)]	a_{Cu}	γ_{Cu}
1.000	0	0	0.000	0	0.000	1.000	1.000
0.900	−1445	−690	0.272	984	−0.604	0.939	1.044
0.800	−2090	−1079	0.365	3055	−1.491	0.913	1.142
0.700	−3337	1359	1.693	4887	−1.272	0.865	1.236
0.600	−6621	9145	5.685	5157	1.438	0.750	1.251
0.500	−13442	24803	13.792	2540	8.029	0.558	1.116
0.400	−25415	50858	27.505	−4288	19.887	0.332	0.830
0.300	−44411	89833	48.411	−16652	38.400	0.146	0.486
0.200	−72982	144250	78.338	−35875	64.957	0.042	0.211
0.100	−116370	216635	120.088	−63281	100.943	0.006	0.064
0.000	$-\infty$	309509	∞	−100196	147.748	0.000	0.013

Reference state: Cu(liquid)

Table IIIc. Partial quantities for Nb in the liquid phase at 2773 K.

x_{Nb}	ΔG_{Nb} [J/mol]	ΔH_{Nb} [J/mol]	ΔS_{Nb} [J/(mol·K)]	$G_{\mathrm{Nb}}^{\mathrm{E}}$ [J/mol]	$S_{\mathrm{Nb}}^{\mathrm{E}}$ [J/(mol·K)]	a_{Nb}	γ_{Nb}
0.000	$-\infty$	99213	∞	10159	32.115	0.000	1.554
0.100	−62738	114431	63.890	−9649	44.746	0.066	0.658
0.200	−58857	117332	63.537	−21749	50.156	0.078	0.389
0.300	−55225	110442	59.743	−27467	49.732	0.091	0.304
0.400	−49251	96282	52.482	−28125	44.864	0.118	0.295
0.500	−41030	77377	42.700	−25049	36.937	0.169	0.337
0.600	−31340	56251	31.587	−19563	27.340	0.257	0.428
0.700	−21214	35427	20.426	−12990	17.460	0.398	0.569
0.800	−11801	17428	10.540	−6656	8.685	0.599	0.749
0.900	−4314	4777	3.279	−1885	2.403	0.829	0.922
1.000	0	0	0.000	0	0.000	1.000	1.000

Reference state: Nb(liquid)

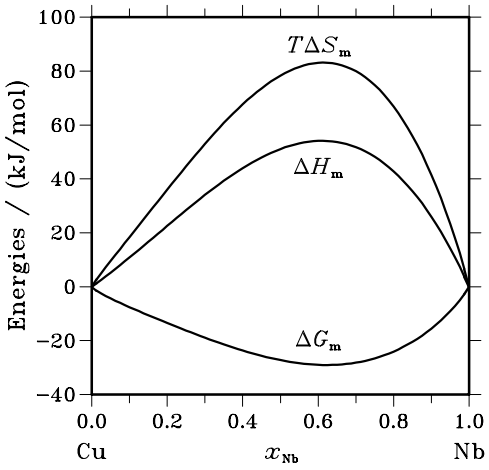

Fig. 2. Integral quantities of the liquid phase at T=2773 K.

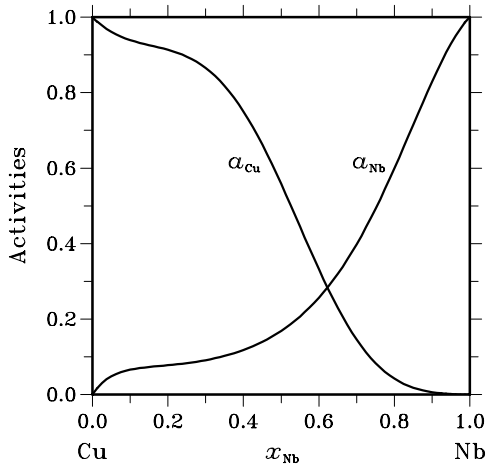

Fig. 3. Activities in the liquid phase at T=2773 K.

References

[90Ham] M. Hämäläinen, K. Jääskeläinen, R. Luoma, M. Nuotio, P. Taskinen, O. Teppo: Calphad **14** (1990) 125–137.

[00Li] D. Li, M.B. Robinson, T.J. Rathz: J. Phase Equilibria **21** (2000) 136–140.