Ag – Cu (Silver – Copper)

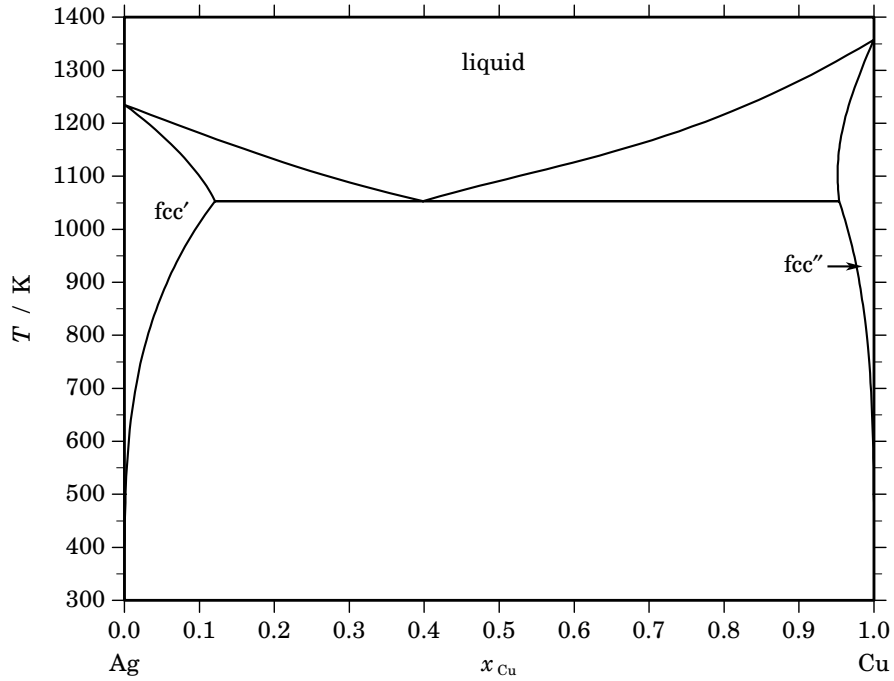

Fig. 1. Calculated phase diagram for the system Ag-Cu.

The combination of silver and copper is encountered in gold alloys for dental applications, jewelry and coinage. Copper-Silver alloys with high contents of phosphorus are used for brazing. The thermodynamics of the binary Ag-Cu system has been re-assessed recently in [2004Wit] in the course of the optimisation of the ternary Ag-Al-Cu system. The phase diagram of the Ag-Cu binary is a simple eutectic with appreciable solid solubilities of the metallic elements. The evaluation takes into account literature data for the phase boundaries in the phase diagram from many experimental investigations. For the description of the liquid phase, several experimental studies of the mixing enthalpy have been taken into account. The evaluated dataset of [2004Wit] is preferred over that of [2002Kus] because more recent calorimetric data for the mixing properties of the liquid [1999Fit] have been included.

Table I. Phases, structures and models.

Phase	Struktur-bericht	Prototype	Pearson symbol	Space group	SGTE name	Model
liquid					LIQUID	$(Ag,Cu)_1$
fcc	$A1$	Cu	$cF4$	$Fm\overline{3}m$	FCC_A1	$(Ag,Cu)_1$

Table II. Invariant reactions.

Reaction	Type	T / K	Compositions / x_{Cu}			$\Delta_r H$ / (J/mol)
liquid $\rightleftharpoons$ fcc′ + fcc″	eutectic	1053.4	0.398	0.121	0.953	−12438

Table IIIa. Integral quantities for the liquid phase at 1373 K.

x_{Cu}	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	−2632	1234	2.816	1079	0.113	0.000
0.200	−3779	2224	4.373	1933	0.212	0.000
0.300	−4415	2959	5.371	2558	0.292	0.000
0.400	−4735	3426	5.944	2948	0.349	0.000
0.500	−4817	3616	6.142	3095	0.379	0.000
0.600	−4688	3516	5.975	2995	0.379	0.000
0.700	−4332	3116	5.424	2642	0.345	0.000
0.800	−3684	2404	4.434	2029	0.273	0.000
0.900	−2561	1369	2.862	1150	0.159	0.000
1.000	0	0	0.000	0	0.000	0.000

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

Table IIIb. Partial quantities for Ag in the liquid phase at 1373 K.

x_{Ag}	ΔG_{Ag} [J/mol]	ΔH_{Ag} [J/mol]	ΔS_{Ag} [J/(mol·K)]	$G_{\mathrm{Ag}}^{\mathrm{E}}$ [J/mol]	$S_{\mathrm{Ag}}^{\mathrm{E}}$ [J/(mol·K)]	a_{Ag}	γ_{Ag}
1.000	0	0	0.000	0	0.000	1.000	1.000
0.900	−1092	120	0.883	111	0.007	0.909	1.010
0.800	−2096	496	1.888	452	0.033	0.832	1.040
0.700	−3038	1150	3.050	1034	0.085	0.766	1.095
0.600	−3962	2105	4.418	1870	0.171	0.707	1.178
0.500	−4941	3382	6.062	2971	0.299	0.649	1.297
0.400	−6110	5005	8.095	4350	0.477	0.586	1.464
0.300	−7726	6995	10.722	6018	0.712	0.508	1.694
0.200	−10385	9376	14.393	7988	1.011	0.403	2.013
0.100	−16016	12169	20.528	10270	1.383	0.246	2.459
0.000	$-\infty$	15397	∞	12878	1.835	0.000	3.090

Reference state: Ag(liquid)

Table IIIc. Partial quantities for Cu in the liquid phase at 1373 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}
0.000	$-\infty$	13529	∞	11886	1.197	0.000	2.832
0.100	−16498	11261	20.218	9788	1.073	0.236	2.357
0.200	−10512	9137	14.311	7861	0.929	0.398	1.991
0.300	−7629	7178	10.785	6116	0.774	0.513	1.709
0.400	−5896	5408	8.233	4564	0.615	0.597	1.492
0.500	−4693	3849	6.222	3219	0.459	0.663	1.326
0.600	−3739	2523	4.561	2092	0.314	0.721	1.201
0.700	−2877	1453	3.154	1195	0.188	0.777	1.110
0.800	−2008	661	1.944	539	0.089	0.839	1.048
0.900	−1066	169	0.899	137	0.023	0.911	1.012
1.000	0	0	0.000	0	0.000	1.000	1.000

Reference state: Cu(liquid)

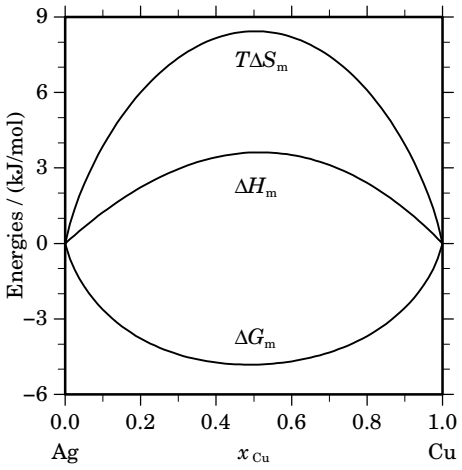

Fig. 2. Integral quantities of the liquid phase at T=1373 K.

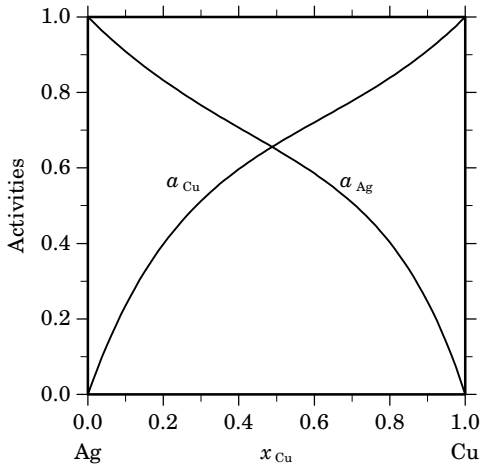

Fig. 3. Activities in the liquid phase at T=1373 K.

References

[1999Fit] K. Fitzner, Q. Guo, J. Wang, O.J. Kleppa: J. Alloys Comp. **291** (1999) 190–200.
[2002Kus] A. Kusoffsky: Acta Mater. **50** (2002) 5139–5145.
[2004Wit] V.T. Witusiewicz, U. Hecht, S.G. Fries, S. Rex: J. Alloys Comp. **385** (2004) 133–143.