Co – Zn (Cobalt – Zinc)

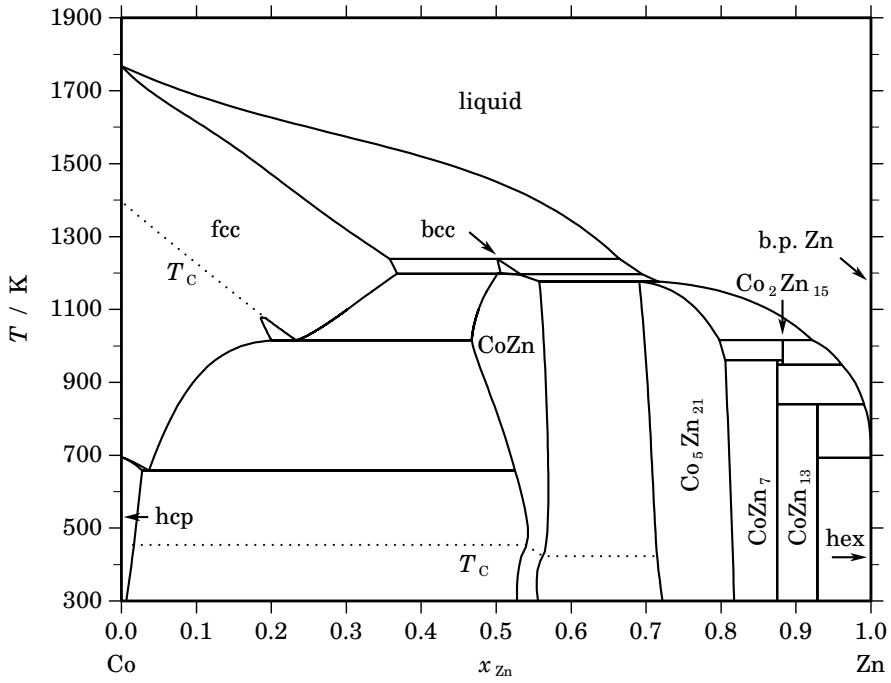

Fig. 1. Calculated phase diagram for the system Co-Zn.

The Co-Zn system has been reviewed and a thermodynamic dataset has been optimised in [2004Vas]. The Co-Zn system has been studied thoroughly by Schramm using metallographic and thermal analyses, x-ray diffraction and magnetic methods [1938Sch1, 1938Sch2, 1938Sch3, 1938Sch4, 1941Sch]. Later, various parts of the phase diagram have been re-investigated [1955Kös, 1955Lih, 1976Bud1, 1995Tak]. Thermodynamic properties of Co-Zn solutions have been reported for solid alloys [1976Bud2, 1977Bud, 1981Ali, 1982Cöm] as well as more limited data for the melt [1982Cöm]. The assessed dataset which is shown here [2004Vas] provides a good representation of the experimental data. The dataset should not be used at too high temperatures because an artificial inverse miscibility gap opens in the liquid above 2600 K. Another assessment for Co-Zn has been reported by [2004Iso] but here the phase diagram has been modelled with less detail.

Table I. Phases, structures and models.

Phase	Struktur-bericht	Prototype	Pearson symbol	Space group	SGTE name	Model
liquid					LIQUID	$(Co,Zn)_1$
fcc	$A1$	Cu	$cF4$	$Fm\overline{3}m$	FCC_A1	$(Co,Zn)_1$
hcp	$A3$	Mg	$hP2$	$P6_3/mmc$	HCP_A3	$(Co,Zn)_1$
bcc	$A2$	W	$cI2$	$Im\overline{3}m$	COZN_A2	$(Co,Zn)_1$
CoZn	$A13$	βMn	$cP20$	$P4_132$	COZN_A13	$(Co,Zn)_1$
Co_5Zn_{21}	$D8_3$	Al_4Cu_9	$cP52$	$P4\overline{3}m$	CO5ZN21	$(Co,Zn)_1$
$CoZn_7$	···	···	$c*^*$	···	COZN7	Co_1Zn_7
Co_2Zn_{15}	···	···	···	···	CO2ZN15	Co_2Zn_{15}
$CoZn_{13}$	···	···	$mC28$	$C2/m$	COZN13	Co_1Zn_{13}
hex	$A3$	Mg	$hP2$	$P6_3/mmc$	HCP_ZN	Zn_1

Table II. Invariant reactions.

Reaction	Type	T / K	Compositions / x_{Zn}			$\Delta_{\mathrm{r}}H$ / (J/mol)
fcc + liquid ⇌ bcc	peritectic	1239.0	0.358	0.664	0.501	−3900
fcc + bcc ⇌ CoZn	peritectoid	1198.0	0.368	0.506	0.502	−6720
bcc ⇌ CoZn + liquid	metatectic	1197.0	0.532	0.529	0.694	−6865
CoZn + liquid ⇌ Co_5Zn_{21}	peritectic	1176.8	0.558	0.716	0.691	−14659
fcc ⇌ fcc′ + fcc″	critical	1089.0	0.184	0.184	0.184	0
Co_5Zn_{21} + liquid ⇌ Co_2Zn_{15}	peritectic	1016.4	0.798	0.921	0.882	−5328
fcc″ ⇌ fcc′ + CoZn	monotectoid	1014.7	0.234	0.200	0.467	−1182
Co_5Zn_{21} + Co_2Zn_{15} ⇌ $CoZn_7$	peritectoid	961.1	0.806	0.882	0.875	−3846
Co_2Zn_{15} ⇌ $CoZn_7$ + liquid	eutectic	948.1	0.882	0.875	0.961	−3068
$CoZn_7$ + liquid ⇌ $CoZn_{13}$	peritectic	840.2	0.875	0.991	0.929	−3437
liquid ⇌ $CoZn_{13}$ + hex	eutectic	692.6	1.000	0.929	1.000	−7327
fcc′ ⇌ hcp + CoZn	eutectoid	658.0	0.037	0.028	0.525	−685

Table IIIa. Integral quantities for the liquid phase at 1800 K.

x_{Zn}	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	−4283	2375	3.699	582	0.996	0.000
0.200	−6397	2566	4.979	1093	0.819	0.000
0.300	−7633	1194	4.904	1509	−0.175	0.000
0.400	−8261	−1120	3.967	1811	−1.628	0.000
0.500	−8397	−3754	2.579	1977	−3.184	0.000
0.600	−8089	−6088	1.111	1984	−4.484	0.000
0.700	−7331	−7501	−0.094	1811	−5.174	0.000
0.800	−6052	−7371	−0.733	1437	−4.894	0.000
0.900	−4024	−5078	−0.585	841	−3.288	0.000
1.000	0	0	0.000	0	0.000	0.000

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

Table IIIb. Partial quantities for Co in the liquid phase at 1800 K.

x_{Co}	ΔG_{Co} [J/mol]	ΔH_{Co} [J/mol]	ΔS_{Co} [J/(mol·K)]	$G^{\mathrm{E}}_{\mathrm{Co}}$ [J/mol]	$S^{\mathrm{E}}_{\mathrm{Co}}$ [J/(mol·K)]	a_{Co}	γ_{Co}
1.000	0	0	0.000	0	0.000	1.000	1.000
0.900	−1544	1196	1.522	32	0.646	0.902	1.002
0.800	−3181	3954	3.964	158	2.109	0.809	1.011
0.700	−4917	7033	6.639	421	3.674	0.720	1.029
0.600	−6782	9191	8.874	863	4.627	0.636	1.059
0.500	−8846	9185	10.017	1528	4.254	0.554	1.107
0.400	−11255	5774	9.460	2458	1.842	0.471	1.179
0.300	−14321	−2286	6.686	3698	−3.324	0.384	1.280
0.200	−18797	−16236	1.423	5290	−11.959	0.285	1.424
0.100	−27184	−37318	−5.630	7277	−24.775	0.163	1.626
0.000	−∞	−66775	∞	9702	−42.487	0.000	1.912

Reference state: Co(liquid)

Table IIIc. Partial quantities for Zn in the liquid phase at 1800 K.

x_{Zn}	ΔG_{Zn} [J/mol]	ΔH_{Zn} [J/mol]	ΔS_{Zn} [J/(mol·K)]	$G^{\mathrm{E}}_{\mathrm{Zn}}$ [J/mol]	$S^{\mathrm{E}}_{\mathrm{Zn}}$ [J/(mol·K)]	a_{Zn}	γ_{Zn}
0.000	$-\infty$	36741	∞	6110	17.017	0.000	1.504
0.100	−28930	12991	23.289	5531	4.144	0.145	1.447
0.200	−19257	−2986	9.040	4830	−4.342	0.276	1.381
0.300	−13969	−12431	0.855	4050	−9.156	0.393	1.311
0.400	−10479	−16586	−3.393	3234	−11.011	0.496	1.241
0.500	−7948	−16694	−4.859	2425	−10.622	0.588	1.176
0.600	−5978	−13997	−4.455	1667	−8.702	0.671	1.118
0.700	−4336	−9736	−3.000	1002	−5.966	0.748	1.069
0.800	−2865	−5155	−1.272	474	−3.128	0.826	1.032
0.900	−1451	−1496	−0.025	126	−0.901	0.908	1.008
1.000	0	0	0.000	0	0.000	1.000	1.000

Reference state: Zn(liquid)

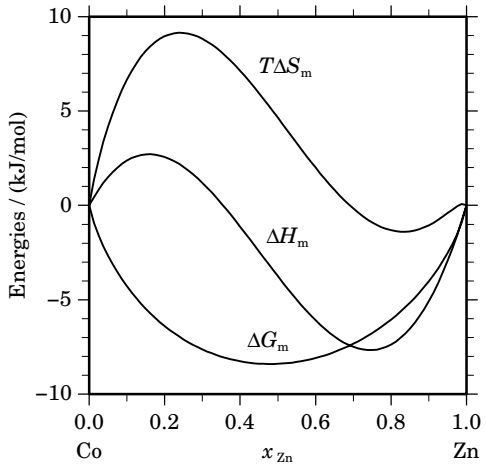

Fig. 2. Integral quantities of the liquid phase at T=1800 K.

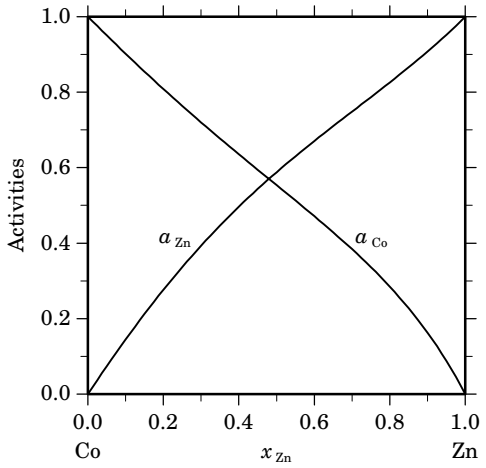

Fig. 3. Activities in the liquid phase at T=1800 K.

Table IV. Standard reaction quantities at 298.15 K for the compounds per mole of atoms.

Compound	x_{Zn}	$\Delta_{\mathrm{f}}G^{\circ}$ / (J/mol)	$\Delta_{\mathrm{f}}H^{\circ}$ / (J/mol)	$\Delta_{\mathrm{f}}S^{\circ}$ / (J/(mol·K))	$\Delta_{\mathrm{f}}C^{\circ}_{P}$ / (J/(mol·K))
Co_1Zn_7	0.875	−9901	−10986	−3.638	−0.018
Co_2Zn_{15}	0.882	−6739	−6491	0.830	−0.017
Co_1Zn_{13}	0.929	−5795	−6101	−1.029	−0.010

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