Mn – Pb (Manganese – Lead)

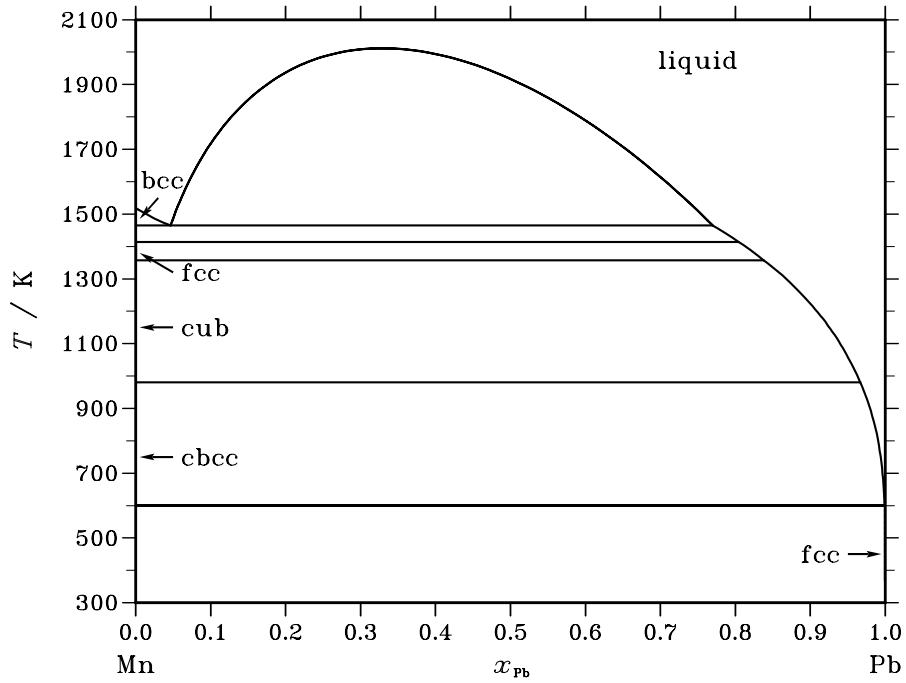

Fig. 1. Calculated phase diagram for the system Mn-Pb.

Information about the thermodynamic properties and the phase diagram for the Mn-Pb system are extremely limited. Pelzel [56Pel] measured the solubility of Mn in liquid Pb up to 1273 K. Hansen [58Han] reported a monotectic temperature of 1744 K from the work of Williams [07Wil] using rather impure materials. The Pb solubility in the Mn rich liquid was determined to be 3 at.%. The composition of the Pb rich liquid is less certain but was thought to be less than 70 at.% Pb. The SGTE data for the system were taken from a critical assessment by Dinsdale [03Din] and is in good agreement with the limited information available.

Table I. Phases, structures and models.

Phase	Struktur-bericht	Prototype	Pearson symbol	Space group	SGTE name	Model
liquid					LIQUID	$(Mn,Pb)_1$
fcc	$A1$	Cu	$cF4$	$Fm\overline{3}m$	FCC_A1	$(Mn,Pb)_1$
bcc	$A2$	W	$cI2$	$Im\overline{3}m$	BCC_A2	Mn_1
cbcc	$A12$	αMn	$cI58$	$I\overline{4}3m$	CBCC_A12	Mn_1
cub	$A13$	βMn	$cP20$	$P4_132$	CUB_A13	Mn_1

Table II. Invariant reactions.

Reaction	Type	T / K	Compositions / x_{Pb}			$\Delta_r H$ / (J/mol)
liquid $\rightleftharpoons$ liquid′ + liquid″	critical	2010.9	0.329	0.329	0.329	0
liquid′ $\rightleftharpoons$ bcc + liquid″	monotectic	1465.1	0.047	0.000	0.770	−13731
bcc + liquid″ $\rightleftharpoons$ fcc	degenerate	1411.0	0.000	0.805	0.000	−1908
fcc $\rightleftharpoons$ cub + liquid″	degenerate	1360.0	0.000	0.000	0.838	−2166
cub $\rightleftharpoons$ cbcc + liquid″	degenerate	980.0	0.000	0.000	0.967	−2254
liquid″ $\rightleftharpoons$ cbcc + fcc	eutectic	600.3	0.999	0.000	1.000	−4812

Table IIIa. Integral quantities for the liquid phase at 1273 K.

x_{Pb}	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)]
0.880	−1110	5023	4.818	2774	1.767	0.387
0.900	−1118	4208	4.183	2323	1.480	0.323
0.950	−928	2129	2.401	1173	0.751	0.161
1.000	0	0	0.000	0	0.000	0.000

Reference states: Mn(cub), Pb(liquid)

Table IIIb. Partial quantities for Mn in the liquid phase at 1273 K.

x_{Mn}	ΔG_{Mn} [J/mol]	ΔH_{Mn} [J/mol]	ΔS_{Mn} [J/(mol·K)]	$G_{\mathrm{Mn}}^{\mathrm{E}}$ [J/mol]	$S_{\mathrm{Mn}}^{\mathrm{E}}$ [J/(mol·K)]	a_{Mn}	γ_{Mn}
0.120	0	40604	31.896	22439	14.269	1.000	8.331
0.100	−1643	41086	33.566	22728	14.421	0.856	8.562
0.050	−8421	42147	39.724	23287	14.816	0.451	9.026
0.000	$-\infty$	42979	∞	23589	15.231	0.000	9.288

Reference state: Mn(cub)

Table IIIc. Partial quantities for Pb in the liquid phase at 1273 K.

x_{Pb}	ΔG_{Pb} [J/mol]	ΔH_{Pb} [J/mol]	ΔS_{Pb} [J/(mol·K)]	$G_{\mathrm{Pb}}^{\mathrm{E}}$ [J/mol]	$S_{\mathrm{Pb}}^{\mathrm{E}}$ [J/(mol·K)]	a_{Pb}	γ_{Pb}
0.880	−1262	170	1.125	91	0.061	0.888	1.009
0.900	−1060	110	0.919	56	0.043	0.905	1.005
0.950	−534	23	0.437	9	0.011	0.951	1.001
1.000	0	0	0.000	0	0.000	1.000	1.000

Reference state: Pb(liquid)

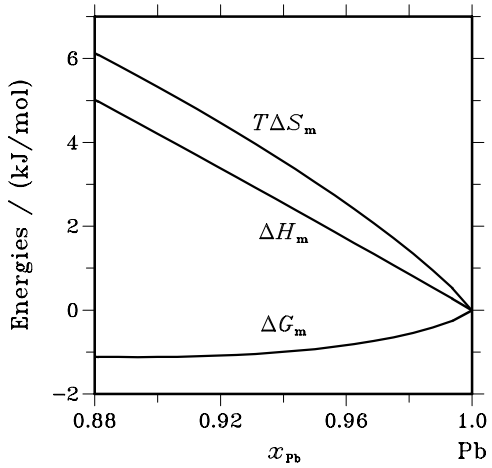

Fig. 2. Integral quantities of the liquid phase at T=1273 K.

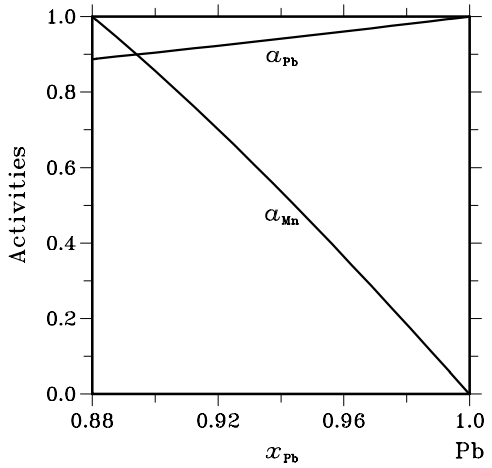

Fig. 3. Activities in the liquid phase at T=1273 K.

References

[07Wil] R.S. Williams: Z. Anorg. Chem. **55** (1907) 31–33.
[56Pel] E. Pelzel: Metall **10** (1956) 717–718.
[03Din] A.T. Dinsdale, unpublished work 2003.