Ge – Sn (Germanium – Tin)

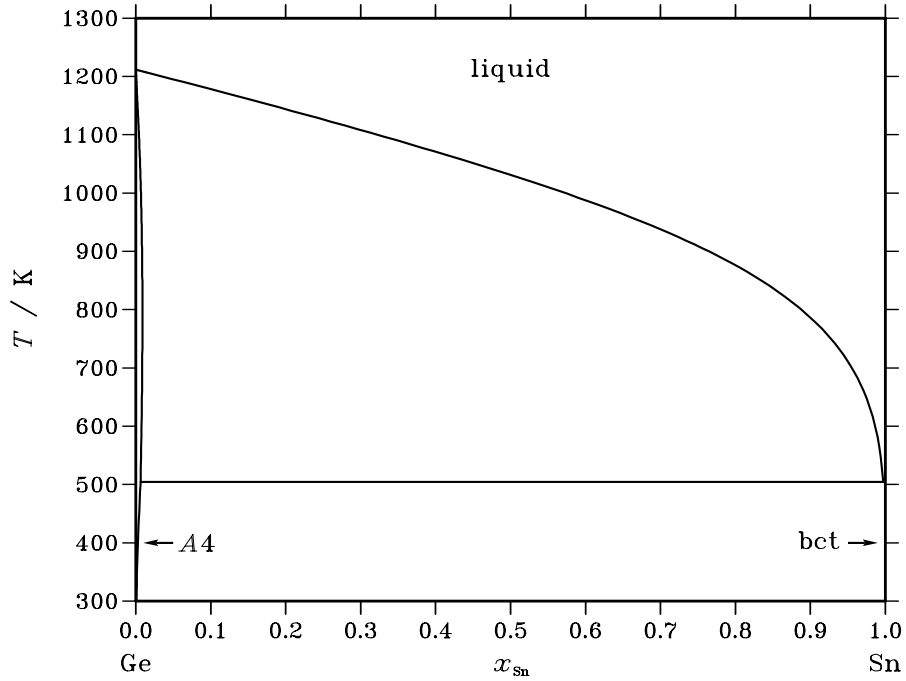

Fig. 1. Calculated phase diagram for the system Ge-Sn.

Thin films based on tellurium, germanium and tin are materials used for phase change type re-writable disk media. This system presents a degenerated eutectic on the Sn rich side at 504.21 K. Thermodynamic quantities have been optimised by [96Feu] for the liquid and the solution of tin in germanium. As there are no experimental data for the solution of germanium in tin, this phase has not been included in the optimisation. For the liquid and the Ge-diamond phases, the excess Gibbs energies are described by Redlich-Kister polynomials.

Table I. Phases, structures and models.

Phase	Struktur-bericht	Prototype	Pearson symbol	Space group	SGTE name	Model
liquid					LIQUID	$(Ge,Sn)_1$
$A4$	$A4$	C(diamond)	$cF8$	$Fd\overline{3}m$	DIAMOND_A4	$(Ge,Sn)_1$
bct	$A5$	βSn	$tI4$	$I4_1/amd$	BCT_A5	Sn_1

Table II. Invariant reactions.

Reaction	Type	T / K	Compositions / x_{Sn}			$\Delta_r H$ / (J/mol)
liquid $\rightleftharpoons$ $A4$ + bct	eutectic	504.2	0.997	0.006	1.000	−7126

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

x_{Sn}	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	−3312	212	2.768	129	0.065	0.000
0.200	−5052	393	4.277	245	0.116	0.000
0.300	−6125	535	5.232	341	0.153	0.000
0.400	−6711	635	5.770	412	0.175	0.000
0.500	−6884	685	5.945	453	0.182	0.000
0.600	−6666	680	5.770	458	0.175	0.000
0.700	−6045	615	5.232	420	0.153	0.000
0.800	−4961	484	4.277	335	0.116	0.000
0.900	−3244	280	2.768	197	0.065	0.000
1.000	0	0	0.000	0	0.000	0.000

Reference states: Ge(liquid), Sn(liquid)

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

x_{Ge}	ΔG_{Ge} [J/mol]	ΔH_{Ge} [J/mol]	ΔS_{Ge} [J/(mol·K)]	$G_{\mathrm{Ge}}^{\mathrm{E}}$ [J/mol]	$S_{\mathrm{Ge}}^{\mathrm{E}}$ [J/(mol·K)]	a_{Ge}	γ_{Ge}
1.000	0	0	0.000	0	0.000	1.000	1.000
0.900	−1109	15	0.883	6	0.007	0.900	1.001
0.800	−2331	68	1.884	31	0.029	0.802	1.003
0.700	−3689	170	3.031	87	0.065	0.706	1.008
0.600	−5223	332	4.364	184	0.116	0.611	1.018
0.500	−7002	567	5.945	335	0.182	0.516	1.032
0.400	−9148	884	7.881	550	0.262	0.421	1.053
0.300	−11902	1296	10.367	842	0.357	0.325	1.083
0.200	−15815	1813	13.847	1220	0.466	0.224	1.122
0.100	−22674	2448	19.734	1697	0.589	0.117	1.174
0.000	$-\infty$	3211	∞	2284	0.728	0.000	1.241

Reference state: Ge(liquid)

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

x_{Sn}	ΔG_{Sn} [J/mol]	ΔH_{Sn} [J/mol]	ΔS_{Sn} [J/(mol·K)]	$G_{\mathrm{Sn}}^{\mathrm{E}}$ [J/mol]	$S_{\mathrm{Sn}}^{\mathrm{E}}$ [J/(mol·K)]	a_{Sn}	γ_{Sn}
0.000	$-\infty$	2266	∞	1340	0.728	0.000	1.135
0.100	−23133	1989	19.734	1238	0.589	0.112	1.124
0.200	−15936	1692	13.847	1099	0.466	0.222	1.109
0.300	−11809	1388	10.367	934	0.357	0.328	1.092
0.400	−8944	1088	7.881	754	0.262	0.430	1.074
0.500	−6765	803	5.945	571	0.182	0.528	1.055
0.600	−5011	544	4.364	396	0.116	0.623	1.038
0.700	−3536	323	3.031	240	0.065	0.716	1.023
0.800	−2248	151	1.884	114	0.029	0.809	1.011
0.900	−1085	40	0.883	30	0.007	0.903	1.003
1.000	0	0	0.000	0	0.000	1.000	1.000

Reference state: Sn(liquid)

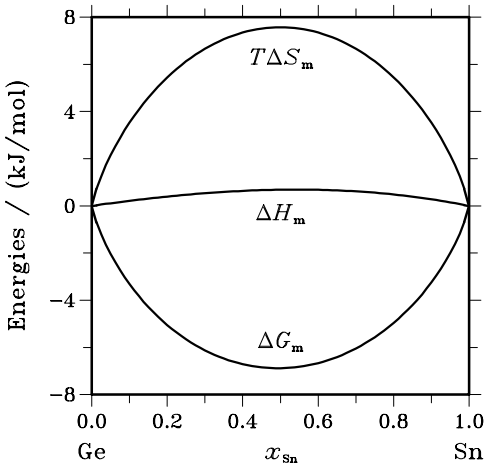

Fig. 2. Integral quantities of the liquid phase at T=1273 K.

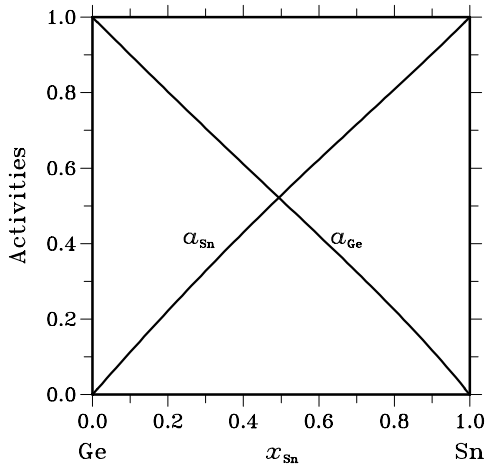

Fig. 3. Activities in the liquid phase at T=1273 K.

References

[96Feu] Y. Feutelais, B. Legendre, S. Fries: Calphad **20** (1996) 109–123.