Nd – Pr (Neodymium – Praseodymium)

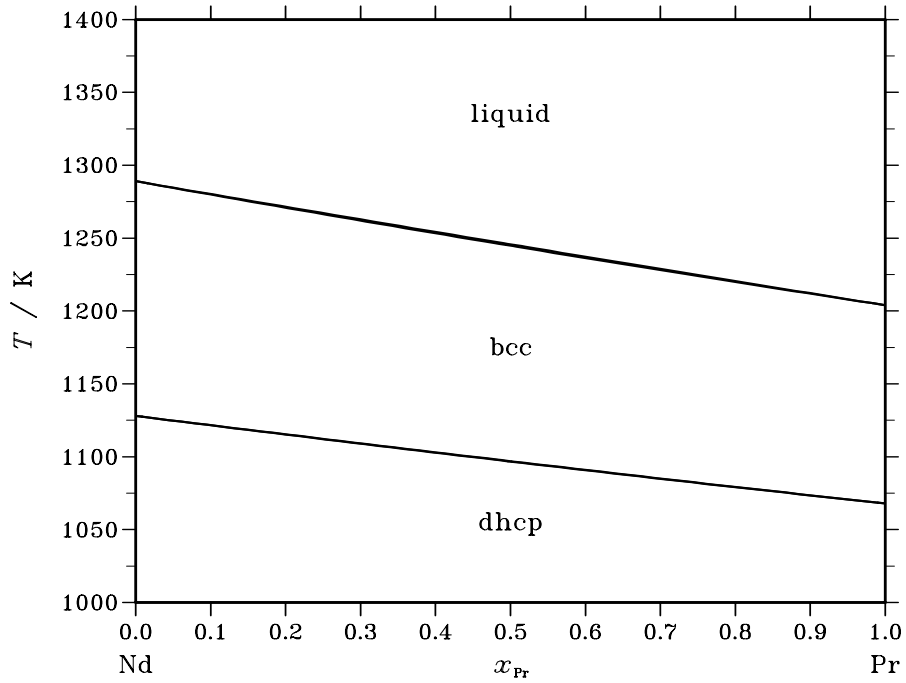

Fig. 1. Calculated phase diagram for the system Nd-Pr.

The literature on the thermodynamic properties of Nd-Pr alloys has been reviewed by Gschneidner and Calderwood [82Gsc]. They concluded, that within the experimental uncertainty range, Nd and Pr form ideal solutions in the liquid state and in bcc as well as in dhcp solid solutions. In [79Shi] a small positive deviation from ideal behaviour was proposed for all three phases due to broader 2-phase fields which have been found experimentally. However, [82Gsc] attribute the broader 2-phase fields to impurities in the used materials.

Table I. Phases, structures and models.

Phase	Struktur-bericht	Prototype	Pearson symbol	Space group	SGTE name	Model
liquid					LIQUID	$(Nd,Pr)_1$
bcc	$A2$	W	$cI2$	$Im\overline{3}m$	BCC_A2	$(Nd,Pr)_1$
dhcp	$A3'$	αLa	$hP4$	$P6_3/mmc$	DHCP	$(Nd,Pr)_1$

Table IIa. Integral quantities for the liquid phase at 1300 K.

x_{Pr}	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	−3514	0	2.703	0	0.000	0.000
0.200	−5409	0	4.161	0	0.000	0.000
0.300	−6603	0	5.079	0	0.000	0.000
0.400	−7274	0	5.596	0	0.000	0.000
0.500	−7492	0	5.763	0	0.000	0.000
0.600	−7274	0	5.596	0	0.000	0.000
0.700	−6603	0	5.079	0	0.000	0.000
0.800	−5409	0	4.161	0	0.000	0.000
0.900	−3514	0	2.703	0	0.000	0.000
1.000	0	0	0.000	0	0.000	0.000

Reference states: Nd(liquid), Pr(liquid)

Table IIb. Partial quantities for Nd in the liquid phase at 1300 K.

x_{Nd}	ΔG_{Nd} [J/mol]	ΔH_{Nd} [J/mol]	ΔS_{Nd} [J/(mol·K)]	$G_{\mathrm{Nd}}^{\mathrm{E}}$ [J/mol]	$S_{\mathrm{Nd}}^{\mathrm{E}}$ [J/(mol·K)]	a_{Nd}	γ_{Nd}
1.000	0	0	0.000	0	0.000	1.000	1.000
0.900	−1139	0	0.876	0	0.000	0.900	1.000
0.800	−2412	0	1.855	0	0.000	0.800	1.000
0.700	−3855	0	2.966	0	0.000	0.700	1.000
0.600	−5521	0	4.247	0	0.000	0.600	1.000
0.500	−7492	0	5.763	0	0.000	0.500	1.000
0.400	−9904	0	7.619	0	0.000	0.400	1.000
0.300	−13014	0	10.010	0	0.000	0.300	1.000
0.200	−17396	0	13.382	0	0.000	0.200	1.000
0.100	−24888	0	19.145	0	0.000	0.100	1.000
0.000	$-\infty$	0	∞	0	0.000	0.000	1.000

Reference state: Nd(liquid)

Table IIc. Partial quantities for Pr in the liquid phase at 1300 K.

x_{Pr}	ΔG_{Pr} [J/mol]	ΔH_{Pr} [J/mol]	ΔS_{Pr} [J/(mol·K)]	$G_{\mathrm{Pr}}^{\mathrm{E}}$ [J/mol]	$S_{\mathrm{Pr}}^{\mathrm{E}}$ [J/(mol·K)]	a_{Pr}	γ_{Pr}
0.000	$-\infty$	0	∞	0	0.000	0.000	1.000
0.100	−24888	0	19.145	0	0.000	0.100	1.000
0.200	−17396	0	13.382	0	0.000	0.200	1.000
0.300	−13014	0	10.010	0	0.000	0.300	1.000
0.400	−9904	0	7.619	0	0.000	0.400	1.000
0.500	−7492	0	5.763	0	0.000	0.500	1.000
0.600	−5521	0	4.247	0	0.000	0.600	1.000
0.700	−3855	0	2.966	0	0.000	0.700	1.000
0.800	−2412	0	1.855	0	0.000	0.800	1.000
0.900	−1139	0	0.876	0	0.000	0.900	1.000
1.000	0	0	0.000	0	0.000	1.000	1.000

Reference state: Pr(liquid)

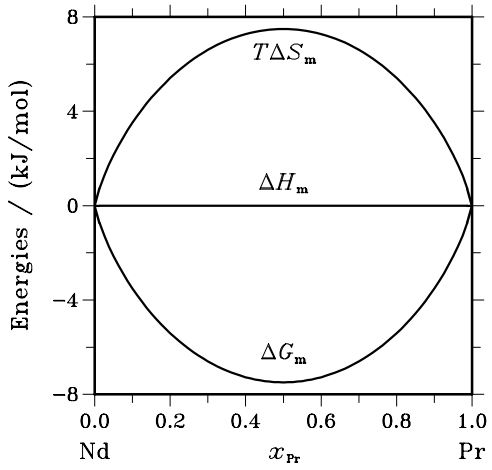

Fig. 2. Integral quantities of the liquid phase at T=1300 K.

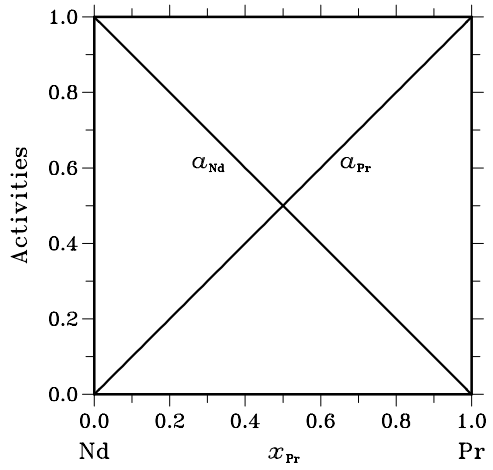

Fig. 3. Activities in the liquid phase at T=1300 K.

Table IIIa. Integral quantities for the stable phases at 1173 K.

Phase	x_{Pr}	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)]
bcc	0.000	0	0	0.000	0	0.000	0.000
	0.100	−3171	0	2.703	0	0.000	0.000
	0.200	−4880	0	4.161	0	0.000	0.000
	0.300	−5958	0	5.079	0	0.000	0.000
	0.400	−6564	0	5.596	0	0.000	0.000
	0.500	−6760	0	5.763	0	0.000	0.000
	0.600	−6564	0	5.596	0	0.000	0.000
	0.700	−5958	0	5.079	0	0.000	0.000
	0.800	−4880	0	4.161	0	0.000	0.000
	0.900	−3171	0	2.703	0	0.000	0.000
	1.000	0	0	0.000	0	0.000	0.000

Reference states: Nd(bcc), Pr(bcc)

Table IIIb. Partial quantities for Nd in the stable phases at 1173 K.

Phase	x_{Nd}	ΔG_{Nd} [J/mol]	ΔH_{Nd} [J/mol]	ΔS_{Nd} [J/(mol·K)]	$G_{\mathrm{Nd}}^{\mathrm{E}}$ [J/mol]	$S_{\mathrm{Nd}}^{\mathrm{E}}$ [J/(mol·K)]	a_{Nd}	γ_{Nd}
bcc	1.000	0	0	0.000	0	0.000	1.000	1.000
	0.900	−1028	0	0.876	0	0.000	0.900	1.000
	0.800	−2176	0	1.855	0	0.000	0.800	1.000
	0.700	−3479	0	2.966	0	0.000	0.700	1.000
	0.600	−4982	0	4.247	0	0.000	0.600	1.000
	0.500	−6760	0	5.763	0	0.000	0.500	1.000
	0.400	−8937	0	7.619	0	0.000	0.400	1.000
	0.300	−11742	0	10.010	0	0.000	0.300	1.000
	0.200	−15697	0	13.382	0	0.000	0.200	1.000
	0.100	−22457	0	19.145	0	0.000	0.100	1.000
	0.000	$-\infty$	0	∞	0	0.000	0.000	1.000

Reference state: Nd(bcc)

Table IIIc. Partial quantities for Pr in the stable phases at 1173 K.

Phase	x_{Pr}	ΔG_{Pr} [J/mol]	ΔH_{Pr} [J/mol]	ΔS_{Pr} [J/(mol·K)]	$G^{\mathrm{E}}_{\mathrm{Pr}}$ [J/mol]	$S^{\mathrm{E}}_{\mathrm{Pr}}$ [J/(mol·K)]	a_{Pr}	γ_{Pr}
bcc	0.000	$-\infty$	0	∞	0	0.000	0.000	1.000
	0.100	−22457	0	19.145	0	0.000	0.100	1.000
	0.200	−15697	0	13.382	0	0.000	0.200	1.000
	0.300	−11742	0	10.010	0	0.000	0.300	1.000
	0.400	−8937	0	7.619	0	0.000	0.400	1.000
	0.500	−6760	0	5.763	0	0.000	0.500	1.000
	0.600	−4982	0	4.247	0	0.000	0.600	1.000
	0.700	−3479	0	2.966	0	0.000	0.700	1.000
	0.800	−2176	0	1.855	0	0.000	0.800	1.000
	0.900	−1028	0	0.876	0	0.000	0.900	1.000
	1.000	0	0	0.000	0	0.000	1.000	1.000

Reference state: Pr(bcc)

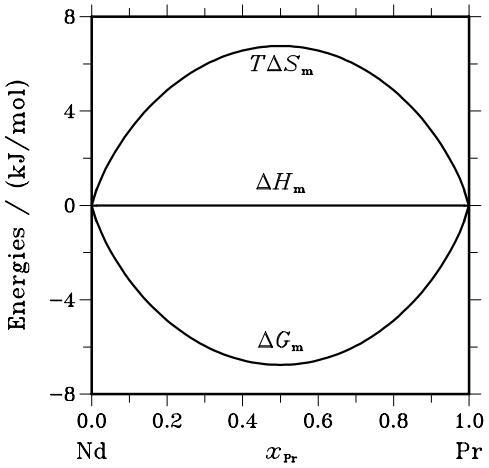

Fig. 4. Integral quantities of the stable phases at T=1173 K.

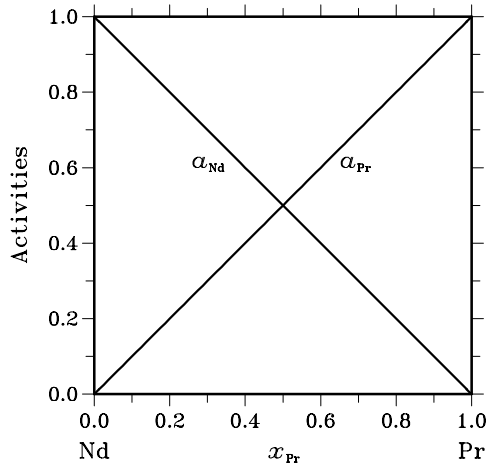

Fig. 5. Activities in the stable phases at T=1173 K.

References

[79Shi] G.J. Shiflet, J.K. Lee, H.I. Aaronson: Calphad **3** (1979) 129–137.
[82Gsc] K.A. Gschneidner, F.W. Calderwood: Bull. Alloy Phase Diagrams **3** (1982) 196–198.