Ni – Y (Nickel – Yttrium)

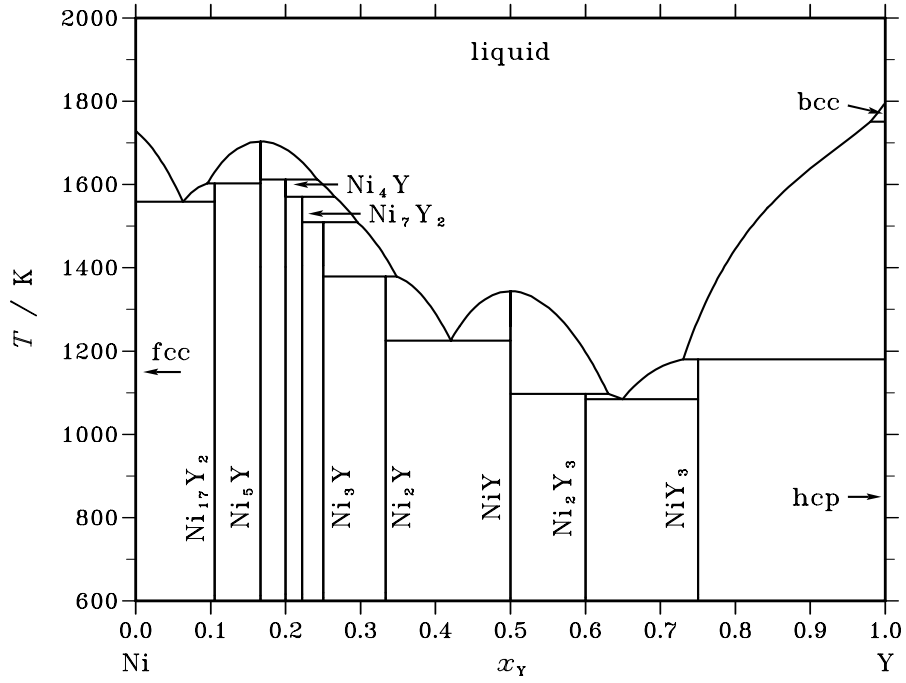

Fig. 1. Calculated phase diagram for the system Ni-Y.

The diagram has many intermetallic phases most of which are formed peritectically. There is no mutual solubility in the pure elements and the compounds are all modelled as stoichiometric. A thermodynamic assessment of the Ni-Y system has been reported in [96Du].

Table I. Phases, structures and models.

Phase	Struktur-bericht	Prototype	Pearson symbol	Space group	SGTE name	Model
liquid					LIQUID	$(Ni,Y)_1$
fcc	$A1$	Cu	$cF4$	$Fm\overline{3}m$	FCC_A1	$(Ni,Y)_1$
$Ni_{17}Y_2$	···	$Ni_{17}Th_2$	$hP*$	$P6_3/mmc$	NI17Y2	$Ni_{17}Y_2$
Ni_5Y	$D2_d$	$CaCu_5$	$hP6$	$P6/mmm$	D2D_NI5Y	Ni_5Y_1
Ni_4Y	···	···	···	···	NI4Y	Ni_4Y_1
Ni_7Y_2	···	Co_7Gd_2	$hR*$	$R\overline{3}m$	NI7Y2	Ni_7Y_2
Ni_3Y	···	Ni_3Pu	$hR*$	$R\overline{3}m$	NI3Y	Ni_3Y_1
Ni_2Y	$C15$	Cu_2Mg	$cF24$	$Fd\overline{3}m$	C15_NI2Y	Ni_2Y_1
NiY	$B27$	FeB	$oP8$	$Pnma$	B27_NIY	Ni_1Y_1
Ni_2Y_3	···	···	$t*$	$P4_12_12$	NI2Y3	Ni_2Y_3
NiY_3	$D0_{11}$	Fe_3C	$oP16$	$Pnma$	D011_NIY3	Ni_1Y_3
bcc	$A2$	W	$cI2$	$Im\overline{3}m$	BCC_A2	$(Ni,Y)_1$
hcp	$A3$	Mg	$hP2$	$P6_3/mmc$	HCP_A3	$(Ni,Y)_1$

Table II. Invariant reactions.

Reaction	Type	T / K	Compositions / x_{Y}			$\Delta_{\mathrm{r}}H$ / (J/mol)
bcc $\rightleftharpoons$ liquid + hcp	degenerate	1751.1	1.000	0.980	1.000	−4886
liquid $\rightleftharpoons$ Ni_5Y	congruent	1703.9	0.167	0.167		−21727
Ni_5Y + liquid $\rightleftharpoons$ Ni_4Y	peritectic	1612.3	0.167	0.242	0.200	−7234
liquid + Ni_5Y $\rightleftharpoons$ $Ni_{17}Y_2$	peritectic	1602.6	0.096	0.167	0.105	−15440
Ni_4Y + liquid $\rightleftharpoons$ Ni_7Y_2	peritectic	1570.5	0.200	0.265	0.222	−5197
liquid $\rightleftharpoons$ fcc + $Ni_{17}Y_2$	eutectic	1558.5	0.063	0.000	0.105	−16815
Ni_7Y_2 + liquid $\rightleftharpoons$ Ni_3Y	peritectic	1509.6	0.222	0.296	0.250	−5406
Ni_3Y + liquid $\rightleftharpoons$ Ni_2Y	peritectic	1379.0	0.250	0.348	0.333	−8648
liquid $\rightleftharpoons$ NiY	congruent	1343.9	0.500	0.500		−10469
liquid $\rightleftharpoons$ Ni_2Y + NiY	eutectic	1225.3	0.420	0.333	0.500	−8907
liquid + hcp $\rightleftharpoons$ NiY_3	peritectic	1180.0	0.730	1.000	0.750	−9797
NiY + liquid $\rightleftharpoons$ Ni_2Y_3	peritectic	1097.1	0.500	0.631	0.600	−10915
liquid $\rightleftharpoons$ Ni_2Y_3 + NiY_3	eutectic	1084.8	0.649	0.600	0.750	−11339

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

x_{Y}	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	−15483	−17804	−1.289	−10617	−3.992	0.000
0.200	−25062	−29958	−2.720	−17573	−6.880	0.000
0.300	−30498	−37098	−3.667	−21356	−8.746	0.000
0.400	−32526	−39858	−4.074	−22454	−9.669	0.000
0.500	−31728	−38874	−3.970	−21355	−9.733	0.000
0.600	−28620	−34780	−3.422	−18547	−9.018	0.000
0.700	−23662	−28210	−2.527	−14520	−7.606	0.000
0.800	−17250	−19801	−1.417	−9761	−5.578	0.000
0.900	−9623	−10186	−0.312	−4758	−3.015	0.000
1.000	0	0	0.000	0	0.000	0.000

Reference states: Ni(liquid), Y(liquid)

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

x_{Ni}	ΔG_{Ni} [J/mol]	ΔH_{Ni} [J/mol]	ΔS_{Ni} [J/(mol·K)]	$G_{\mathrm{Ni}}^{\mathrm{E}}$ [J/mol]	$S_{\mathrm{Ni}}^{\mathrm{E}}$ [J/(mol·K)]	a_{Ni}	γ_{Ni}
1.000	0	0	0.000	0	0.000	1.000	1.000
0.900	−3489	−2930	0.310	−1912	−0.566	0.792	0.880
0.800	−10337	−10875	−0.299	−6998	−2.154	0.501	0.627
0.700	−19618	−22565	−1.637	−14280	−4.603	0.270	0.385
0.600	−30427	−36730	−3.502	−22782	−7.749	0.131	0.218
0.500	−41901	−52100	−5.666	−31527	−11.429	0.061	0.122
0.400	−53253	−67406	−7.863	−39540	−15.481	0.028	0.071
0.300	−63862	−81378	−9.731	−45843	−19.742	0.014	0.047
0.200	−73546	−92746	−10.666	−49459	−24.048	0.007	0.037
0.100	−83874	−100240	−9.093	−49413	−28.237	0.004	0.037
0.000	$-\infty$	−102592	∞	−44727	−32.147	0.000	0.050

Reference state: Ni(liquid)

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

x_Y	ΔG_Y [J/mol]	ΔH_Y [J/mol]	ΔS_Y [J/(mol·K)]	G_Y^E [J/mol]	S_Y^E [J/(mol·K)]	a_Y	γ_Y
0.000	$-\infty$	−208400	∞	−126109	−45.717	0.000	0.000
0.100	−123425	−151663	−15.688	−88965	−34.832	0.000	0.003
0.200	−83963	−106289	−12.403	−59876	−25.785	0.004	0.018
0.300	−55886	−71008	−8.401	−37867	−18.412	0.024	0.080
0.400	−35675	−44551	−4.931	−21961	−12.550	0.092	0.231
0.500	−21556	−25648	−2.274	−11182	−8.037	0.237	0.474
0.600	−12197	−13029	−0.462	−4552	−4.709	0.443	0.738
0.700	−6434	−5424	0.561	−1096	−2.405	0.651	0.929
0.800	−3176	−1564	0.895	164	−0.960	0.809	1.011
0.900	−1373	−179	0.663	204	−0.213	0.912	1.014
1.000	0	0	0.000	0	0.000	1.000	1.000

Reference state: Y(liquid)

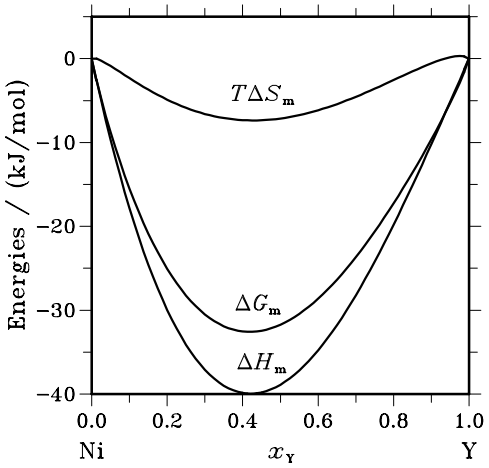

Fig. 2. Integral quantities of the liquid phase at T=1800 K.

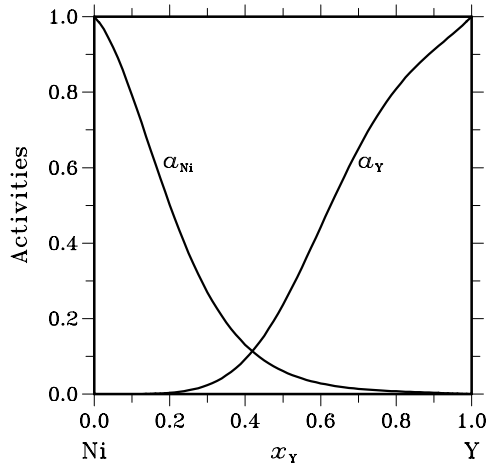

Fig. 3. Activities in the liquid phase at T=1800 K.

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

Compound	x_Y	$\Delta_f G^\circ$ / (J/mol)	$\Delta_f H^\circ$ / (J/mol)	$\Delta_f S^\circ$ / (J/(mol·K))	$\Delta_f C_P^\circ$ / (J/(mol·K))
$Ni_{17}Y_2$	0.105	−18235	−18266	−0.104	−0.684
Ni_5Y_1	0.167	−28851	−29598	−2.508	−0.637
Ni_4Y_1	0.200	−30018	−30613	−1.996	−0.612
Ni_7Y_2	0.222	−30772	−31299	−1.768	−0.595
Ni_3Y_1	0.250	−31704	−32210	−1.699	−0.573
Ni_2Y_1	0.333	−32090	−32247	−0.525	−0.510
Ni_1Y_1	0.500	−32844	−33342	−1.671	−0.382
Ni_2Y_3	0.600	−31134	−32984	−6.206	−0.306
Ni_1Y_3	0.750	−19845	−20652	−2.706	−0.191

References

[96Du] Z. Du, W. Zhang: J. Alloys Comp. **245** (1996) 164–167.