Mg – Ni (Magnesium – Nickel)

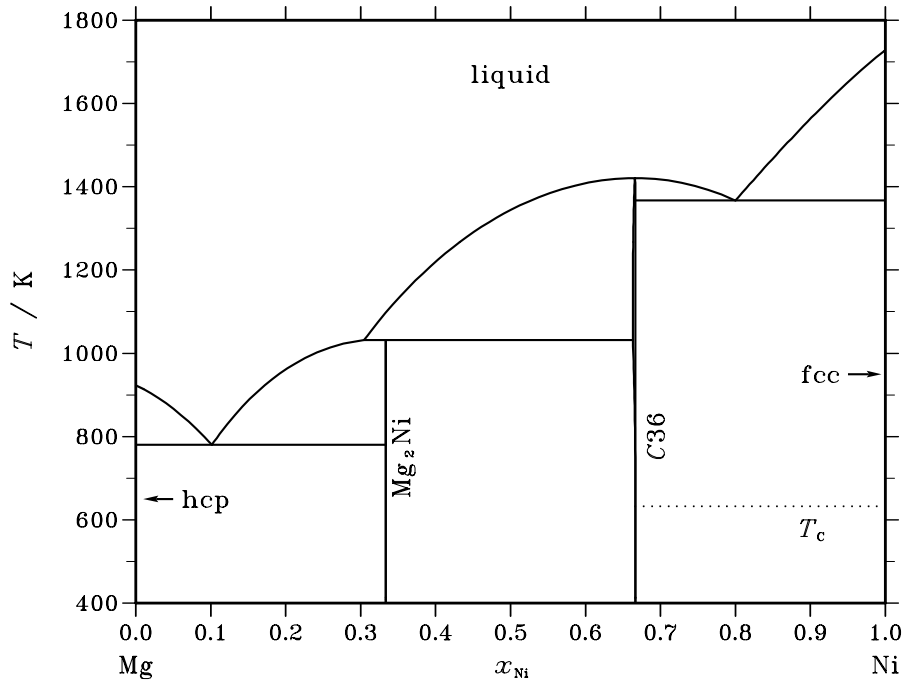

Fig. 1. Calculated phase diagram for the system Mg-Ni.

The dominant feature of the Mg-Ni system is the $MgNi_2$ Laves phase ($C36$) forming congruently from the melt at a temperature of about 1420 K. A further compound phase, Mg_2Ni, forms peritectically from $MgNi_2$ and the liquid at 1032 K. There is negligible solid solubility of either component in the other [86Mas]. The system has been assessed by Jacobs and Spencer [98Jac1] using published thermodynamic and phase boundary information. A revised dataset is given in [98Jac2]. The phase diagram calculated using their assessed parameters reproduces the reported invariants within very close limits. Enthalpies of mixing and activities of the components in the liquid phase show moderate negative departures from ideality. The two solid compound phases also display moderately exothermic enthalpies of formation.

Table I. Phases, structures and models.

Phase	Struktur-bericht	Prototype	Pearson symbol	Space group	SGTE name	Model
liquid					LIQUID	$(Mg,Ni)_1$
hcp	$A3$	Mg	$hP2$	$P6_3/mmc$	HCP_A3	$(Mg,Ni)_1$
Mg_2Ni	···	···	$hP18$	$P6_222$	MG2NI	Mg_2Ni_1
$C36$	$C36$	$MgNi_2$	$hP24$	$P6_3/mmc$	C36_LAVES	$(Mg,Ni)_2(Mg,Ni)_1$
fcc	$A1$	Cu	$cF4$	$Fm\overline{3}m$	FCC_A1	$(Mg,Ni)_1$

Table II. Invariant reactions.

Reaction	Type	T / K	Compositions / x_{Ni}			$\Delta_r H$ / (J/mol)
liquid $\rightleftharpoons$ $C36$	congruent	1420.6	0.666	0.666		−27630
liquid $\rightleftharpoons$ $C36$ + fcc	eutectic	1366.6	0.800	0.667	1.000	−22718
liquid + $C36$ $\rightleftharpoons$ Mg_2Ni	peritectic	1032.1	0.305	0.663	0.333	−15287
liquid $\rightleftharpoons$ hcp + Mg_2Ni	eutectic	780.0	0.101	0.000	0.333	−9082

Table IIIa. Integral quantities for the liquid phase at 1750 K.

x_{Ni}	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	−7338	−4931	1.375	−2608	−1.328	0.000
0.200	−11929	−8267	2.092	−4648	−2.069	0.000
0.300	−15003	−10195	2.747	−6114	−2.332	0.000
0.400	−16797	−10902	3.368	−7005	−2.227	0.000
0.500	−17399	−10576	3.899	−7314	−1.864	0.000
0.600	−16830	−9404	4.244	−7038	−1.352	0.000
0.700	−15061	−7573	4.279	−6173	−0.800	0.000
0.800	−11995	−5270	3.843	−4714	−0.318	0.000
0.900	−7388	−2683	2.688	−2658	−0.015	0.000
1.000	0	0	0.000	0	0.000	0.000

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

Table IIIb. Partial quantities for Mg in the liquid phase at 1750 K.

x_{Mg}	ΔG_{Mg} [J/mol]	ΔH_{Mg} [J/mol]	ΔS_{Mg} [J/(mol·K)]	$G_{\mathrm{Mg}}^{\mathrm{E}}$ [J/mol]	$S_{\mathrm{Mg}}^{\mathrm{E}}$ [J/(mol·K)]	a_{Mg}	γ_{Mg}
1.000	0	0	0.000	0	0.000	1.000	1.000
0.900	−1817	−829	0.564	−284	−0.312	0.883	0.981
0.800	−4387	−3066	0.755	−1140	−1.101	0.740	0.925
0.700	−7767	−6336	0.817	−2577	−2.148	0.586	0.838
0.600	−12036	−10266	1.012	−4603	−3.236	0.437	0.729
0.500	−17313	−14479	1.619	−7227	−4.144	0.304	0.609
0.400	−23789	−18602	2.964	−10457	−4.654	0.195	0.487
0.300	−31819	−22259	5.463	−14301	−4.548	0.112	0.374
0.200	−42185	−25077	9.776	−18767	−3.605	0.055	0.275
0.100	−57368	−26679	17.536	−23865	−1.608	0.019	0.194
0.000	$-\infty$	−26693	∞	−29601	1.662	0.000	0.131

Reference state: Mg(liquid)

Table IIIc. Partial quantities for Ni in the liquid phase at 1750 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}
0.000	$-\infty$	−57916	∞	−28908	−16.576	0.000	0.137
0.100	−57032	−41854	8.673	−23528	−10.472	0.020	0.198
0.200	−42097	−29073	7.442	−18679	−5.940	0.055	0.277
0.300	−31887	−19199	7.250	−14369	−2.760	0.112	0.373
0.400	−23939	−11858	6.904	−10607	−0.715	0.193	0.482
0.500	−17486	−6673	6.179	−7400	0.415	0.301	0.601
0.600	−12191	−3272	5.097	−4758	0.849	0.433	0.721
0.700	−7879	−1278	3.772	−2689	0.806	0.582	0.831
0.800	−4447	−318	2.360	−1201	0.504	0.737	0.921
0.900	−1835	−17	1.039	−302	0.163	0.882	0.979
1.000	0	0	0.000	0	0.000	1.000	1.000

Reference state: Ni(liquid)

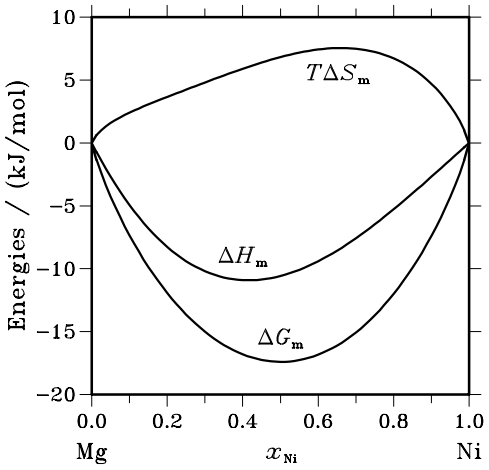

Fig. 2. Integral quantities of the liquid phase at T=1750 K.

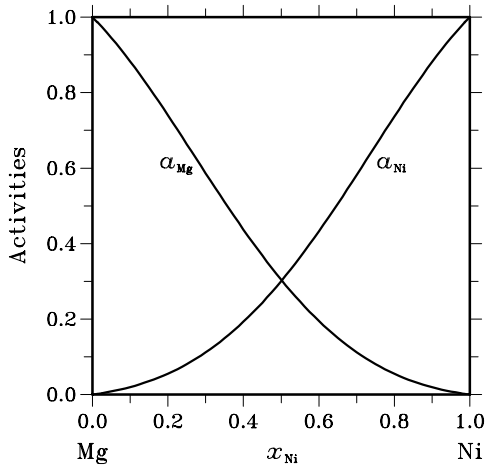

Fig. 3. Activities in the liquid phase at T=1750 K.

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

Compound	x_{Ni}	$\Delta_{\mathrm{f}}G^{\circ}$ / (J/mol)	$\Delta_{\mathrm{f}}H^{\circ}$ / (J/mol)	$\Delta_{\mathrm{f}}S^{\circ}$ / (J/(mol·K))	$\Delta_{\mathrm{f}}C_P^{\circ}$ / (J/(mol·K))
Mg_2Ni_1	0.333	−15554	−17864	−7.747	6.840
$C36$	0.667	−18051	−18414	−1.220	−1.629

References

[86Mas] T.B. Massalski, Ed., “Binary Alloy Phase Diagrams” ASM, Metals Park, OH, 1986.
[98Jac1] M.H.G. Jacobs, P.J. Spencer: Calphad **22** (1998) 513–525.
[98Jac2] M.H.G. Jacobs, P.J. Spencer, I. Ansara in: I. Ansara, A.T. Dinsdale, M.H. Rand (eds.): COST 507, “Thermochemical database for light metal alloys”, Vol. 2, EUR 18499, 1998, 218–220.