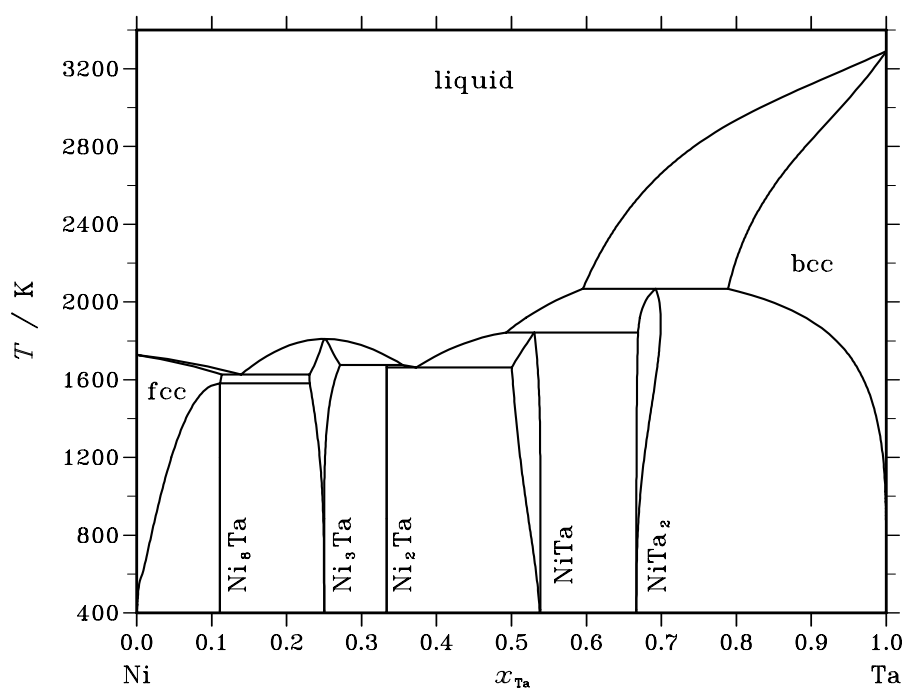


Ni – Ta (Nickel – Tantalum)**Fig. 1.** Calculated phase diagram for the system Ni-Ta.

Ni-Ta are both alloying elements in steels and other alloys. There are several intermetallic phases with small solubility ranges. Ta is a strong carbide former and also promotes the ordered Ni_3Al phase in Ni-based superalloys. A thermodynamic assessment of the Ni-Ta system has been prepared by [99Cui].

Table I. Phases, structures and models.

Phase	Strukturbericht	Prototype	Pearson symbol	Space group	SGTE name	Model
liquid					LIQUID	$(\text{Ni,Ta})_1$
fcc	A1	Cu	$cF4$	$Fm\bar{3}m$	FCC_A1	$(\text{Ni,Ta})_1$
Ni_8Ta	...	NbNi_8	$tI36$...	NI8TA	Ni_8Ta_1
Ni_3Ta	$D0_a$	$\beta\text{Cu}_3\text{Ti}$	$oP8$	$Pm\bar{3}n$	D0A_NI3X	$(\text{Ni,Ta})_3(\text{Ni,Ta})_1$
Ni_2Ta	$C11_b$	MoSi_2	$tI6$	$I4/mmm$	C11B_NI2TA	Ni_2Ta_1
NiTa	$D8_5$	Fe_7W_6	$hR13$	$R\bar{3}m$	D05_NITA	$(\text{Ni,Ta})_1\text{Ta}_4(\text{Ni,Ta})_2\text{Ni}_6$
NiTa_2	$C16$	Al_2Cu	$tI12$	$I4/mcm$	C16_NITA2	$(\text{Ni,Ta})_1\text{Ta}_2$
bcc	A2	W	$cI2$	$Im\bar{3}m$	BCC_A2	$(\text{Ni,Ta})_1$

Table II. Invariant reactions.

Reaction	Type	T / K	Compositions / x_{Ta}			$\Delta_r H / (\text{J/mol})$
liquid + bcc \rightleftharpoons NiTa ₂	peritectic	2067.1	0.595	0.789	0.692	–27603
liquid + NiTa ₂ \rightleftharpoons NiTa	peritectic	1842.8	0.493	0.669	0.531	–28660
liquid \rightleftharpoons Ni ₃ Ta	congruent	1810.9	0.251	0.251		–23308
Ni ₃ Ta + liquid \rightleftharpoons Ni ₂ Ta	peritectic	1676.3	0.271	0.355	0.333	–19756
liquid \rightleftharpoons Ni ₂ Ta + NiTa	eutectic	1663.3	0.373	0.333	0.500	–26000
liquid \rightleftharpoons fcc + Ni ₃ Ta	eutectic	1627.4	0.139	0.114	0.230	–19186
fcc \rightleftharpoons Ni ₈ Ta	congruent	1580.6	0.111	0.111		–5112
fcc \rightleftharpoons Ni ₈ Ta + Ni ₃ Ta	eutectoid	1580.6	0.111	0.111	0.231	–5110

Table IIIa. Integral quantities for the stable phases at 2073 K.

Phase	x_{Ta}	ΔG_{m} [J/mol]	ΔH_{m} [J/mol]	ΔS_{m} [J/(mol·K)]	G_{m}^{E} [J/mol]	S_{m}^{E} [J/(mol·K)]	ΔC_P [J/(mol·K)]
liquid	0.000	0	0	0.000	0	0.000	0.000
	0.100	–17233	–4434	6.174	–11630	3.471	0.556
	0.200	–27664	–8836	9.083	–19039	4.922	1.112
	0.300	–33236	–11947	10.270	–22707	5.191	1.667
	0.400	–34729	–12874	10.543	–23129	4.947	2.223
	0.500	–32761	–11081	10.458	–20814	4.695	2.779
	0.596	–28144	–6649	10.369	–16515	4.760	3.311
bcc	0.789	–16442	–5937	5.068	–7566	0.786	–0.146
	0.800	–15784	–5732	4.849	–7159	0.689	–0.138
	0.900	–9002	–3350	2.726	–3399	0.023	–0.069
	1.000	0	0	0.000	0	0.000	0.000

Reference states: Ni(liquid), Ta(bcc)

Table IIIb. Partial quantities for Ni in the stable phases at 2073 K.

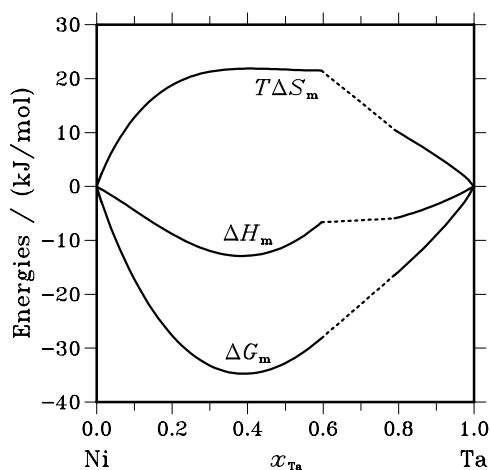
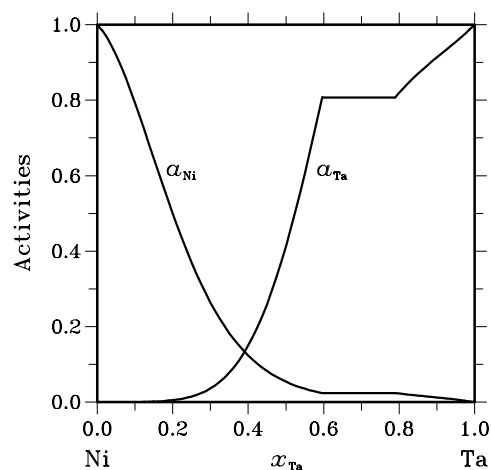
Phase	x_{Ni}	ΔG_{Ni} [J/mol]	ΔH_{Ni} [J/mol]	ΔS_{Ni} [J/(mol·K)]	G_{Ni}^{E} [J/mol]	S_{Ni}^{E} [J/(mol·K)]	a_{Ni}	γ_{Ni}
liquid	1.000	0	0	0.000	0	0.000	1.000	1.000
	0.900	–4004	223	2.039	–2188	1.163	0.793	0.881
	0.800	–11969	–963	5.309	–8123	3.454	0.499	0.624
	0.700	–22972	–5532	8.412	–16824	5.447	0.264	0.377
	0.600	–36066	–14372	10.465	–27262	6.218	0.123	0.206
	0.500	–50308	–27284	11.107	–38361	5.343	0.054	0.108
	0.404	–64189	–42299	10.559	–48576	3.028	0.024	0.060
bcc	0.211	–64189	–20654	21.001	–37353	8.056	0.024	0.115
	0.200	–65199	–21337	21.159	–37459	7.777	0.023	0.114
	0.100	–75990	–28898	22.717	–36303	3.572	0.012	0.122
	0.000	– ∞	–38894	∞	–30650	–3.977	0.000	0.169

Reference state: Ni(liquid)

Table IIIc. Partial quantities for Ta in the stable phases at 2073 K.

Phase	x_{Ta}	ΔG_{Ta} [J/mol]	ΔH_{Ta} [J/mol]	ΔS_{Ta} [J/(mol·K)]	G_{Ta}^{E} [J/mol]	S_{Ta}^{E} [J/(mol·K)]	a_{Ta}	γ_{Ta}
liquid	0.000	$-\infty$	−39407	∞	−138950	48.019	0.000	0.000
	0.100	−136287	−46351	43.384	−96599	24.240	0.000	0.004
	0.200	−90442	−40324	24.177	−62702	10.795	0.005	0.026
	0.300	−57187	−26915	14.603	−36435	4.592	0.036	0.121
	0.400	−32723	−10627	10.659	−16930	3.040	0.150	0.374
	0.500	−15214	5122	9.810	−3267	4.047	0.414	0.827
	0.596	−3691	17537	10.240	5234	5.934	0.807	1.355
bcc	0.789	−3691	−2007	0.813	389	−1.156	0.807	1.023
	0.800	−3430	−1830	0.772	416	−1.084	0.820	1.024
	0.900	−1559	−512	0.505	257	−0.371	0.914	1.015
	1.000	0	0	0.000	0	0.000	1.000	1.000

Reference state: Ta(bcc)

**Fig. 2.** Integral quantities of the stable phases at $T=2073$ K.**Fig. 3.** Activities in the stable phases at $T=2073$ K.**Table IV.** Standard reaction quantities at 298.15 K for the compounds per mole of atoms.

Compound	x_{Ta}	$\Delta_f G^\circ$ / (J/mol)	$\Delta_f H^\circ$ / (J/mol)	$\Delta_f S^\circ$ / (J/(mol·K))	$\Delta_f C_P^\circ$ / (J/(mol·K))
Ni ₈ Ta ₁	0.111	−13117	−12042	3.604	−0.680
Ni ₃ Ta ₁	0.250	−21802	−19785	6.765	−0.573
Ni ₂ Ta ₁	0.333	−26700	−25510	3.990	−0.510
NiTa	0.538	−36412	−37366	−3.201	−0.092
NiTa ₂	0.667	−30342	−31047	−2.364	−0.254

References

[99Cui] Y. Cui, Z. Jin: Z. Metallkd. **99** (1999) 233–241.