NICKEL BASE SINGLE CRYSTAL SUPERALLOY

TMS-196

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TMS-196

It is an advanced nickel-base single crystal superalloy containing 5wt% Ru and 4.6wt% Cr. This alloy exhibits not only good microstructural stability but also excellent combinations of resistances against creep, thermo mechanical fatigue and oxidation.

Chemical composition, wt%

Element	Co	Cr	Mo	W	Al	Ta	Hf	Re	Ru
Nominal	5.6	4.6	2.4	5.0	5.6	5.6	0.1	6.4	5.0
(Optimized)	5.3	4.4	2.3	4.8	5.7	5.3	0.1	6.1	4.8

Heat Treatment Condition (Typical)

Solution; 1300℃/1h+1340℃/10h→R.T. *, Aging; 1100℃/4h→R.T. +870℃/20h→R.T.*

*Gas Fan Cooling (GFC)

Solidus Temperature : 1390℃
Solvus Temperature : 1286℃
Heat Window for Solution Treatment : 56℃

Properties

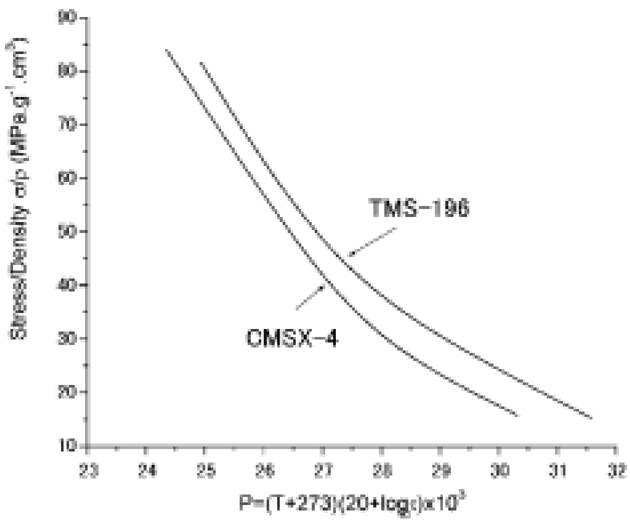
Density……….……….……….……….……… at R.T...………..9.01g/cc

Creep Rupture Strength

Conditions		Rupture life (t)	Benefit over
Temperature, ℃(T)	Stress, MPa	h	CMSX-4 (°C)
800	735	1718	47
900	392	1245	33
1000	245	1376	62
1100	137	1001	48

* Creep rupture data is obtained from the specimen with optimized composition.

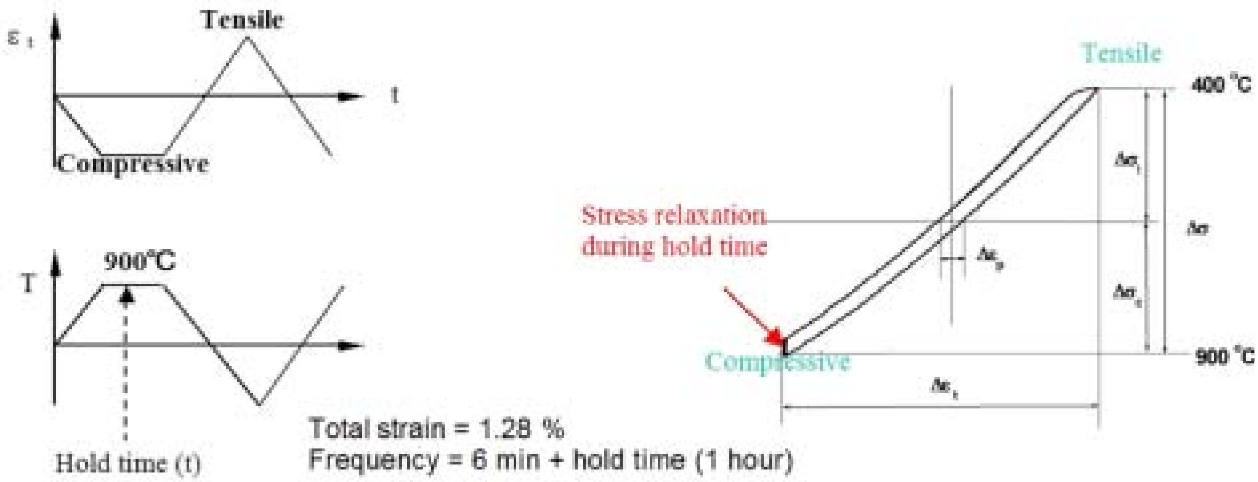
Larson-Miller Plot



Tensile Strength

Temperature ℃	0.2% Proof Stress MPa	UTS MPa
400	929	1195
750	935	1353
1000	758	1001
1100	370	539

Thermo Mechanical Fatigue



Alloy	Cycles to Failure Nf	Stress Relaxation (MPa)		
		N=1	N-Nf/2	N=Nf
Rene'N5	92	150	140	290
TMS-196	198	20	10	70

Rene'N5 **TMS-196**

Cyclic Oxidation in Air (1hour per cycle)

Temp. ℃(K) \ Cycles	Weight Change, mg/cm^2		
	10 Cycles	20 Cycles	30 Cycles
1100 (1373)	+0.11	-1.71	-2.68

Castability

Several single crystal turbine blades have been successfully cast by the Mitsubishi Heavy Industry, and the casting yield of TMS-196 is found to be similar to those of commercial 2nd generation superalloys.

Related Articles

- A. Sato, A.C. Yeh, T. Kobayashi, T. Murakumo, J.X. Zhang, T. Yokokawa and H. Harada, The 8th Liège Conference 'Advanced Materials for Power Engineering 2006', Palais des Congrès in Liège, Belgium, on the 18 - 20 September 2006

High Temperature Materials 21 Project

On June 1, 1999, ex-NRIM (now NIMS) launched an R&D project, "High Temperature Materials 21 (HTM 21)" Project, (1999. 6--2008. 3). In this Project we develop high temperature materials for 1700℃ ultra-efficient gas turbines in power generations, small but efficient gas turbines for local power systems, next generation jet engines, high performance space rockets, and so on. These materials include Ni-base single crystal superalloys up to 5th generation alloys with new coating systems, as well as alloys with new concepts, e.g., platinum group metals (PGMs)-base refractory superalloys, Cr-base alloys, and so on. Materials design of empirical and theoretical approaches and microstructure analysis to support the alloy design and developments are also conducted with a major importance. We have world wide collaborations. to enhance the high temperature materials researches mentioned above (Director; Hiroshi Harada).