INCONEL alloy MA754 (UNS N07754) is an oxide dispersion strengthened, nickel-chromium superalloy, produced by mechanical alloying. Its yttrium oxide dispersoid imparts exceptional high-temperature strength and creep resistance to the highly corrosion-resistant nickel-chromium matrix.

The alloy's strength, in conjunction with its high melting point and microstructural stability, makes it an attractive material for gas turbine engine components, furnace fixtures and skid rails, fasteners and other applications where high temperature creep and corrosion resistance are required.

Table 1 - Nominal Chemical Composition, %

Nickel	78
Chromium	20
Iron	1.0
Carbon	0.05
Aluminum	0.3
Titanium	0.5
Yttrium Oxide	0.6

Physical Properties

Table 2 - Physical Properties

Melting point[a] (Approximate Solidus)	2550°F (1400°C)
Density[b]	0.309 lb/in^3 (8.55 g/cm^3)
Permeability[c]	1.001

[a]High strength, especially at elevated temperatures, is an outstanding characteristic of INCONEL alloy MA754. The oxide dispersion strengthening (ODS) achieved through mechanical alloying remains effective at temperatures close to the alloy's melting point.
[b]The alloy's density is in the range typical of nickel-based superalloys.
[c]Measured at 200 oersteds (15.9 kA/m) and 70°F (21°C).

Table 3 - Young's Modulus of Elasticity (Longitudinal)

Temperature		Textured Bar		Untextured Bar	
°F	°C	10^3 ksi	GPa	10^3 ksi	GPa
70	21	21.6	149	29.4	203
200	93	21.3	147	29	200
400	204	20.6	142	28.1	194
600	316	19.8	137	27.1	187
800	427	18.8	130	26	179
1000	538	18	124	24.9	172
1200	649	17	117	23.6	163
1400	760	15.9	110	22.3	154
1600	871	14.8	102	20.8	143
1800	982	13.6	94	19.3	133
2000	1093	12.4	85	17.8	123

The modulus of elasticity (Young's modulus) of INCONEL alloy MA754 varies with the degree of crystallographic texture imparted during hot working. For applications requiring resistance to thermal fatigue, the alloy is processed to develop a low modulus of elasticity in the longitudinal direction. Young's modulus of INCONEL alloy MA754 varies with temperature according to the equation:

$$E/E_{RT} = 0.9988 - (1.306 \times 10^{-4}\ dT) - (4.298 \times 10^{-8}\ dT^2)$$

where:

E = Young's modulus (psi) at temperature of interest,
E_{RT} = Young's modulus at room temperature, and
dT = Temperature of interest minus room temperature (°F).

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Thermal & Electrical Properties

Thermal Expansion (CTE)

The thermal expansion characteristics of INCONEL alloy MA754 closely match those of other chromium-containing nickel alloys.

Thermal Conductivity

This property increases with temperature and is higher than for ceramics.

Electrical Resistivity

INCONEL alloy MA754 has resistivity characteristics similar to those of 80-20 Ni-Cr resistance heating alloys. Its oxide dispersion strengthening helps resist creep and sagging at high temperatures.

Table 4 - Thermal and Electrical Properties of INCONEL alloy MA754

Temperature, °C	Expansion coefficient (longitudinal), 10^{-6}•°C	Expansion coefficient (transverse), 10^{-6}•°C	Thermal conductivity, W/m•°C	Electrical resistivity, µΩ•m	Specific heat, J/kg•°C
26	-	-	14.3	1.08	440
100	12.2	12.5	15.8	1.09	461
200	13.1	13.4	17.7	1.10	488
300	13.7	14.0	19.5	1.11	515
400	14.2	14.3	21.4	1.12	540
500	14.6	14.8	23.2	1.14	567
600	15.1	15.2	25.0	1.15	595
700	15.7	15.8	27.0	1.14	620
800	16.1	16.2	28.9	1.14	647
900	16.6	16.6	30.8	1.15	672
1000	17.0	17.1	32.6	1.16	695
1100	-	-	34.2	1.18	720
1200	-	-	35.8	1.19	-

Mechanical Properties

Plate & Sheet

INCONEL alloy MA754 develops optimum high-temperature strength through controlled thermo-mechanical processing designed to create a stable, recrystallized, coarse grain structure. Plate products are processed to achieve isotropic properties.

Textured Bar

INCONEL alloy MA754 can be processed to have a highly textured crystallographic structure, producing excellent resistance to thermal fatigue. In such a condition, the properties are anisotropic. Elastic properties are also affected by the crystallographic texture.

In this condition, the ODS mechanism is augmented, for superior mechanical properties in the longitudinal direction, by the high aspect ratio grain structure. The highly directional structure is responsible for anisotropic mechanical properties. For applications that require exceptional resistance to thermal fatigue, like gas turbine vanes, INCONEL alloy MA754 is given a strong texture with a <100> crystallographic direction parallel to the working direction. Such texture results in a low modulus of elasticity in the longitudinal direction, improving resistance to thermal fatigue by lowering stresses for given thermal strains.

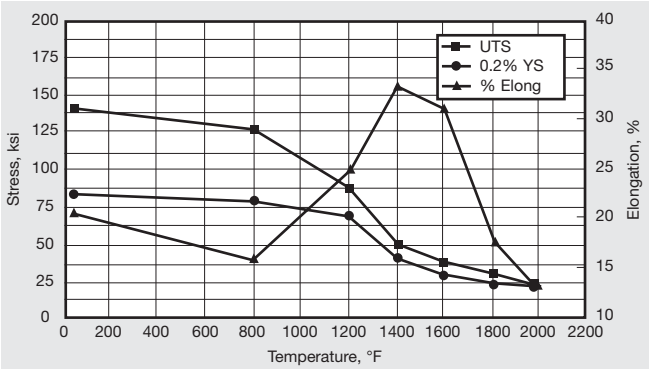

Figure 1. Tensile properties of textured bar - longitudinal.

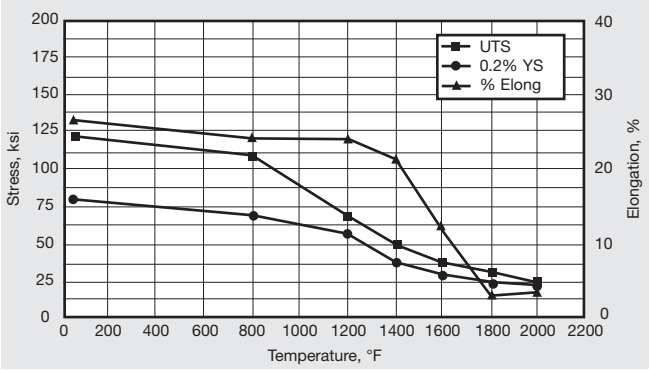

Figure 2. Tensile properties of textured bar - long transverse (L-T).

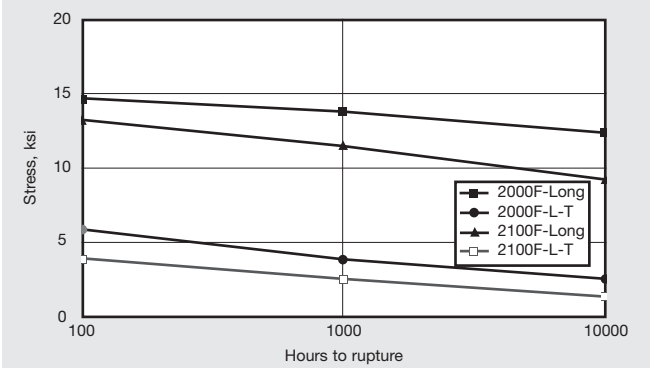

Figure 3. Stress rupture strength of INCONEL alloy MA754 textured bar.

Corrosion Resistance

Oxidation Resistance

INCONEL alloy MA754 has excellent oxidation resistance. It may be used in high-temperature oxidizing environments without the need for expensive special coatings usually required for conventional high-temperature alloys.

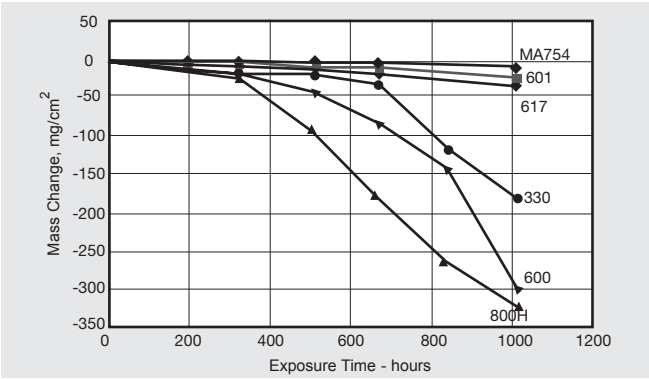

Figure 4. Mass change of several wrought high temperature alloys in air + 5% water vapor at 2150°F (1177°C).

Nitridation Resistance

The nature of the alloy's protective scale, and its high nickel content, provide excellent resistance to nitridation.

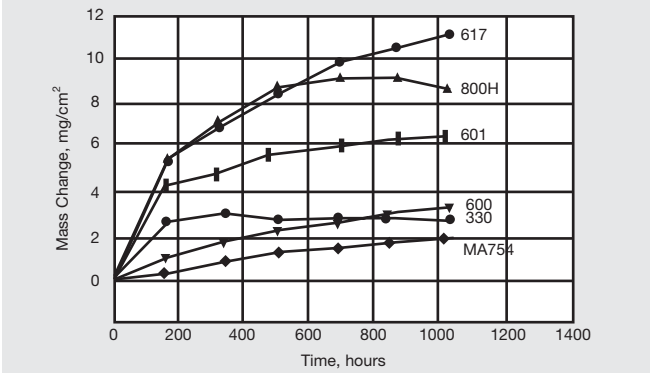

Figure 5. Mass change of several high temperature alloys in N_2-5%H_2 at 2150°F (1177°C).

Table 5 - Penetration results for eight alloys exposed in air + 5% water vapor for 1008 hours at 2150°C (1177°F)

Alloy	Metal Loss, mils	Maximum Attack, mils
330 Stainless Steel	10.0	14.6
600	12.4	13.6
617	0.8	5.6
800H	18.0	20.4
INCONEL alloy MA754	0.1	3.8
601	1.7	>23.8

Burner-Rig Properties

Uncoated INCONEL alloy MA754 has been used extensively in jet fuel combustion environments. Tests at 1700°F (927°C) for 168 h in JP-5 fuel with 0.3% sulfur and 5 ppm sea water. Air-to-fuel ratio: 30 to 1. Thermal cycle: 58 min at 1700°F (927°C), rapid cool to room temperature in 2 min.

Table 6 - Burner-Rig Properties

Material	Weight Change, Mg/cm^2		Metal Loss		Max. Attack	
	Undescaled	Descaled	mil	µm	mil	µm
INCONEL alloy MA754	-0.1	-7.4	0.79	20	3.11	79
Alloy IN-738	+1.4	-6.1	1.06	27	5.83	148
MAR-M[a] 509	+0.9	-12.4	1.10	28	5.98	152
Alloy X-40	-0.8	-9.6	1.18	30	5.71	145
Alloy 713C[b]	-386.0	-431.0	130	3304	130	3304

[a]Trademark of Martin Marietta Corp.
[b]Completely destroyed.

Creep & Fatigue Properties

INCONEL alloy MA754 is one of the most creep-resistant commercially available alloys for service at over 2000°F (1095°C). This characteristic offers superior resistance to bowing and sagging under load at high temperatures. The alloy has good thermal fatigue resistance compared to many high strength superalloys. Thermal strains are reduced in the low modulus direction of textured bar.

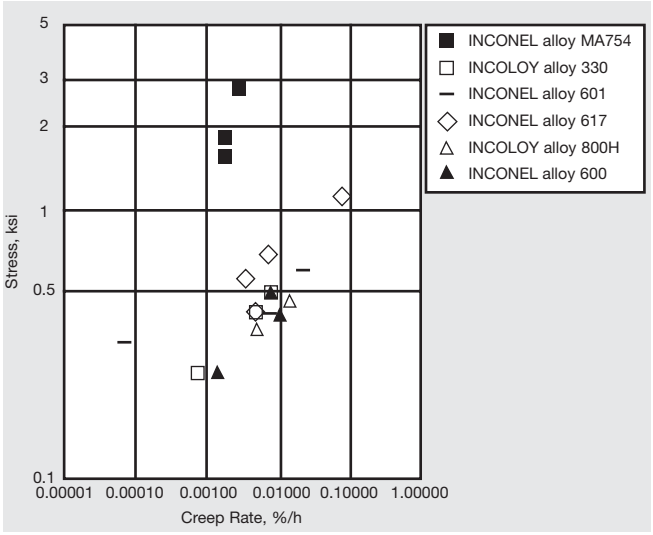

Figure 6. Minimum creep rate results for several wrought high temperature alloys at 2150°F (1177°C).

Working

Machining

The alloy is readily machined by all conventional techniques. Its annealed hardness is Rc 29. If electric discharge machining (EDM) or laser cutting is to be used, it is recommended that the recast layer be removed by grinding.

Information on machining is available in the Special Metals publication "Machining" on the website, www.specialmetals.com.

Joining

The strongest joints are produced by processes such as laser and electron beam welding and diffusion bonding. Brazing has been used for years with great success in applications such as gas turbine engines. Mechanical joints such as rivets, pins, threaded connections and fir tree joints are also often used. Conventional TIG welding can be used but leads to reduced high-temperature stress rupture strength at the joint.

Information on joining is available in the Special Metals publication "Joining" on the website, www.specialmetals.com.

Forming

In the final annealed condition, INCONEL alloy MA754 has a coarse, creep resistant grain structure, and thus exhibits limited hot formability. The alloy can be hot worked into the desired shape prior to the grain coarsening final anneal. INCONEL alloy MA754 is easily cold worked, but such deformation may cause the alloy to recrystallize to a fine grain condition upon exposure to high temperature. A fine grain structure will have reduced high temperature strength properties. Special Metals Corporation should be contacted to work with the fabricator to develop such processes.

Product Forms

INCONEL alloy MA754 is designated as UNS N07754. Alloy MA754 is available as tube, sheet, plate, round bar and flat bar.

Table 7 - Available Forms and Size Ranges of INCONEL alloy MA 754

	inches	mm
Hot-rolled sheet	0.05-0.1	1-3
Hot-rolled plate	0.2-1.5	5-38
Hot-finished round bar	0.75-2	19-51
Flat bar from:	3/4 x 4	19 x 102
to:	3 1/2 x 5 1/2	89 x 140
Tube	extruded tubing can be produced over a range of diameters and wall thicknesses.	

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