Materials capability for small bore tubing systems

aerospace
climate control
electromechanical
filtration
fluid & gas handling
hydraulics
pneumatics
process control
sealing & shielding

Parker

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Introduction

In any instrumentation application, one of the first steps to ensuring safety and reliability is to select proper materials of construction.

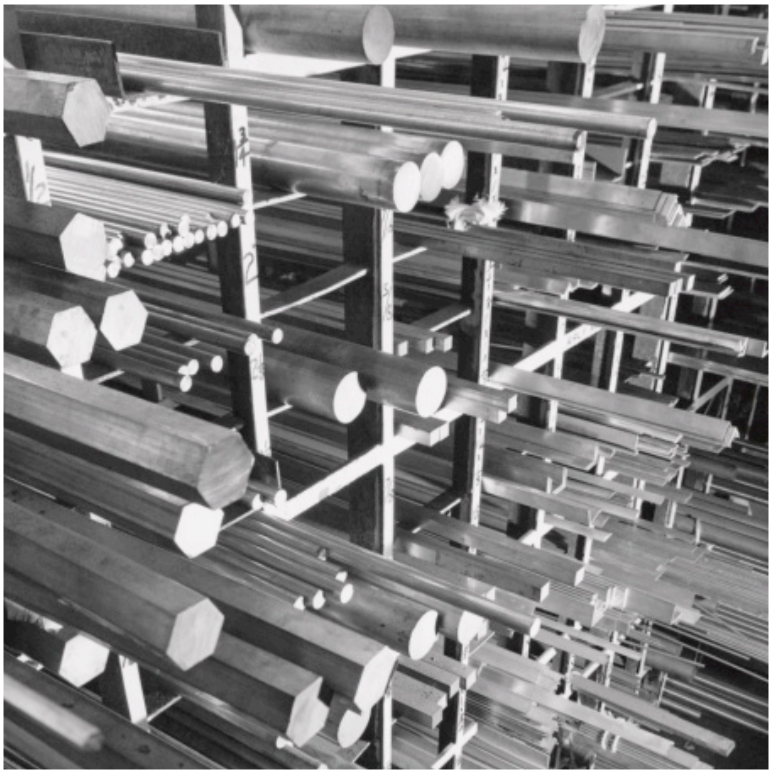
Understanding the importance of material selection and making an informed decision is critical in achieving safe and reliable operation of any facility as well as minimizing the capital cost. To maintain competitiveness and quality, the process equipment is expected to have high reliability and excellent on stream performance. When building or expanding, there is a strong incentive to select materials that have a high resistance to the environment and can tolerate a wide variation in process conditions.

There are many factors which metallurgists take into consideration before selecting the correct material to suit the specific application, the media contained and the environment. Some applications call for high operating temperatures or high resistance to acids, while others can call for high strength versus weight ratio which allows a much thinner section of tubing to be used to achieve the pressure required but at a much reduced weight.

Material selection is proving increasingly critical in many of today's instrumentation applications and has emerged as a considerable and common problem for engineers. In one hand, the increasingly growing set of materials available, and the complexity of the selection criteria, often lead to multiple possibilities meriting serious considerations and ultimately making the selection process a time consuming and expensive one. On the other hand, the fast growing competition from low cost countries had led to 'look-a-like' but nonetheless second class products made from sub-standard materials and by low quality processes.

Based on our extensive experience, gained over the decades working with the most demanding customers and applications, Parker has selected a range of high quality materials that cover most of the instrumentation and associated applications.

* For materials not covered in this brochure, please contact us directly.



Picture of a low cost product. Corrosion damage created by a low quality hardening process applied to the back ferrule

Austenitic Stainless Steel 316/316L

Stainless Steels 316/316L are austenitic grades and two of the most used alloys in a variety of industrial applications. The molybdenum addition gives this grade good resistance to general corrosion and provides increased strength at elevated temperatures. The austenitic structure also gives these grades excellent toughness, even at cryogenic temperatures. Grade 316L, the low carbon version of 316, minimizes harmful carbide precipitation due to welding.

It is common for 316 and 316L to be stocked in 'Dual Certified' form. These items have chemical and mechanical properties complying with both 316 and 316L specifications.

The corrosion resistance of stainless steel grades 316/316L is excellent in a wide range of atmospheric environments and many corrosive media. However, it is subjected to pitting and crevice corrosion in warm chloride environments, as well as to stress corrosion cracking.

Initially developed for use in paper mills, 316/316L stainless steel is typically used in the following applications:

- Food processing equipment
- Brewery equipment
- Chemical and petrochemical equipment
- Laboratory equipment
- Boat fittings
- Chemical transportation containers
- Heat exchangers
- Nuts and bolts
- Springs
- Medical implants
- General Service Process Equipment

Typical Composition	
Element	**Weight (%)**
Carbon	0.03/0.08 max
Manganese	2.00 max
Chromium	16.0 to 18.0
Nickel	10.0 to 14.0
Molybdenum	2.0 to 3.0

Typical Specifications	
Product	**Standard**
Bar	ASTM A479 ASTM A276 EN 10088-3
Forging	ASTM A182
Casting	ASTM A351
Tube	ASTM A269 ASTM A213
Other	NACE MR0175
	NACE MR0103
UNS No.	S31600/S31603

For cold working pressures please see tables 1 & 2 on page 10

Super Austenitic Stainless Steel 6Mo

Super austenitic stainless steel 6Mo is a high performance alloy designed specifically for added corrosion resistance. It has the same structure as the common austenitic alloys, and greater levels of elements such as chromium, nickel, molybdenum, copper, and nitrogen, which gives it enhanced strength and corrosion resistance.

6Mo is especially suited for high-chloride environments such as brackish water, seawater, pulp mill bleach plants, and other high-chloride process streams. It is often used as a replacement in critical components where alloy 316/316L has failed by pitting, crevice attack, or chloride stress corrosion cracking. In many applications, the super austenitic stainless steels have been found to be a technically suitable and much more cost-effective alternative than nickel-base alloys.

Typical Composition	
Element	**Weight (%)**
Carbon	0.02 max
Manganese	1.00 max
Chromium	19.5 to 20.5
Nickel	17.5 to 18.5
Molybdenum	6.0 to 6.5
Nitrogen	0.18 to 0.22
Copper	0.5 to 1.0

Typical Specifications	
Product	**Standard**
Bar	ASTM A479 ASTM A276
Forging	ASTM A182 F44
Tube	ASTM A269
Other	NACE MR0175
	NACE MR0103
UNS No.	S31254

For cold working pressures please see tables 5 & 6 on page 11

Typical applications of this alloy are:

- Seawater Handling Equipment
- Pulp Mill Bleach Systems
- Tall Oil Distillation Columns and Equipment
- Chemical Processing Equipment
- Food Processing Equipment
- Desalination Equipment
- Flue Gas Desulfurization Scrubbers
- Oil and Gas Production Equipment

Why selecting Steel 6Mo grade over Steel 316 grade?

- For all those applications which involve moderate to high chloride presence.
- For those applications in which 316 has failed or is likely to fail due to pitting, crevice or induced stress corrosion cracking.
- For those applications that require compliance to NACE standards and the existing 316 range can not meet such demand.
- For NACE equipment in processes over 60 °C, where 316 is not permitted.

Parker Hannifin carried out Stress Corrosion Cracking Testing as per ASTM G48 conducted by an independent party that determined the time to failure of 6Mo to be 3 times higher of that of 316. In service applications, those results translate into a life expectancy of 6Mo three times longer than that of 316 in the same given conditions, reducing leakage and downtime and increasing safety by over 60%.

Why selecting Steel 6Mo grade over Super duplex grades?

- Choose 6Mo for improved corrosion resistance and super duplex for increased strength. The higher strength of super duplex grades can make this material more susceptible to stress corrosion cracking under certain conditions.
- For those applications that are likely to suffer from pitting corrosion. The pitting resistance given by the PREN or Pitting Resistance Equivalent Number is higher for 6Mo than for its super duplex counterparts.

6Mo is one of our best-seller materials. It has been successfully used in a wide range of applications in the North Sea, Middle East, Mexico Gulf or Australia. Typical applications cover offshore platforms, heat exchangers or desalination plants.

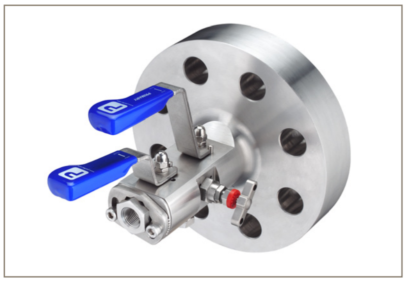
Duplex Stainless Steel

Austenitic-Ferritic stainless steels, also called duplex stainless steels, were developed more than 70 years ago in Sweden for the paper industry in order to combat corrosion problems caused by chloride-bearing cooling waters and other aggressive chemical process fluids.

Due to the high content of chromium, nitrogen, and molybdenum, these steels offer good resistance to localised and uniform corrosion. The duplex microstructure contributes to the high mechanical strength, good abrasion, erosion and fatigue resistance. Duplex steels also possesses good weldability properties.

Typical applications of duplex stainless steel are:

- Pulp and paper industry
- Components for structural design
- Storage tanks
- Cargo tanks and pipe systems in chemical tankers
- Water heaters
- Flue-gas cleaning
- Heat exchangers



Typical Composition	
Element	**Weight (%)**
Carbon	0.03 max
Manganese	2.00 max
Chromium	21.0 to 23.0
Nickel	4.5 to 6.5
Molybdenum	2.5 to 3.5
Nitrogen	0.08 to 0.02

Typical Specifications	
Product	**Standard**
Bar	ASTM A479 ASTM A276
Forging	ASTM A182 F51
Tube	ASTM A789
Other	NACE MR0175 NACE MR0103
UNS No.	S31803

For cold working pressures please consult factory

Super Duplex Stainless Steel

First used in the 1980s, Super-Duplex refers to highly alloyed, high performance Duplex stainless steel with a improved pitting and crevice corrosion resistance.

Super duplex steels were designed for specific applications where both high mechanical strength and good corrosion resistance are required.

Super Duplex Stainless Steel is noted for its high level of chromium, which gives the alloy excellent resistance to acid chlorides, acids, caustic solutions and other harsh environments.

Typical applications of super duplex stainless steel are:

- Desalination plants
- Heat exchangers
- Pollution control
- Pulp and Paper industry
- Tube & Pipe systems for petrochemical refineries
- Downhole

Typical Composition	
Element	**Weight (%)**
Carbon	0.03 max
Manganese	1.00 max
Chromium	24.0 to 26.0
Nickel	6.0 to 8.0
Molybdenum	3.0 to 4.0
Nitrogen	0.20 to 0.30
Copper	0.05 approx.

Typical Specifications	
Product	**Standard**
Bar	ASTM A479 ASTM A276
Forging	ASTM A182 F53/55
Tube	ASTM A789
Other	NACE MR0175 NACE MR0103
UNS No.	S32750/32760

For cold working pressures please consult factory

Alloy 825

Alloy 825 is a nickel-iron-chromium alloy with additions of molybdenum, copper, and titanium. The alloy is designed to provide exceptional resistance to many corrosive environments. Alloy 825 is resistant to corrosion in many acids and alkalis under both oxidising and reducing conditions, including sulphuric, sulphurous, phosphoric, nitric and organic acids, alkalis such as sodium or potassium hydroxide, and aqueous chloride solutions. High nickel content gives the alloy virtual immunity to stress corrosion cracking and good resistance to pitting and crevice.

Alloy 825 is a versatile general engineering alloy that exhibits good mechanical properties at both room and elevated temperatures (over 1000 °F).

Typical applications include:

- Chemical processing
- Pollution control
- Oil and gas recovery
- Acid production
- Nuclear fuel reprocessing

Typical Composition	
Element	**Weight (%)**
Carbon	0.05 max
Manganese	1.00 max
Chromium	19.5 to 23.5
Nickel	38.0 to 46.0
Molybdenum	2.5 to 3.5
Iron	22.0 min
Titanium	0.06 to 1.2
Aluminium	0.2 max
Copper	0.5 to 3.0

Typical Specifications	
Product	**Standard**
Bar	ASTM B425
Forging	ASTM B564
Tube	ASTM B423
Other	NACE MR0175 NACE MR0103
UNS No.	N08825

For cold working pressures please see tables 9 & 10 on page 12

Alloy 625

This alloy has outstanding resistance to pitting and crevice corrosion as well as good resistance to intergranular attack. It also is almost totally resistant to chloride-induced stress corrosion cracking. With these properties the alloy has extremely high resistance to attack by a wide range of media and environments including nitric, phosphoric, sulphuric and hydrochloric acids, as well as alkalis and organic acids in both oxidising and reducing conditions. Alloy 625 has virtually no corrosive attack in marine and industrial atmospheres with extremely good resistance to seawater, even at elevated temperatures.

It is an excellent choice for applications that require high corrosion-fatigue strength or high tensile strength applications, creep and rupture strength and weldability.

Typical applications include:

- Sour Gas Service
- Engine exhaust systems
- Fuel and Hydraulic Lines
- Distillation columns and chemical transfer lines
- Nuclear water reactors

Alloy 625 is one of our best seller materials. It is one of the preferred alloy in a wide range of sour gas applications.

Typical Composition	
Element	**Weight (%)**
Carbon	0.1 max
Manganese	0.5 max
Chromium	20.0 to 23.0
Nickel	58.0 min
Molybdenum	8.0 to 10.0
Iron	5.0 max
Columbium + Tantalum	3.15 to 4.15
Titanium	0.4 max
Aluminium	0.4 max
Cobalt	1.0 max

Typical Specifications	
Product	**Standard**
Bar	ASTM B446
Forging	ASTM B564
Tube	ASTM B444
Other	NACE MR0175 NACE MR0103
UNS No.	N06625

For cold working pressures please see tables 11 & 12 on page 13

Alloy C276

Alloy C-276 is known for its excellent resistance to a wide variety of chemical process environments, including strong oxidizers such as ferric and cupric chlorides, hot contaminated media, chlorine, formic and acetic acids, acetic anhydride, and seawater and brine solutions. Alloy C-276 alloy has excellent resistance to pitting and to stress-corrosion cracking. It is also one of the few materials that withstands the corrosive effects of wet chlorine gas, hypochlorite, and chlorine dioxide. Alloy C-276 can resist the formation of grain boundary precipitates in the weld heat-affected zone, making it also a common candidate for most chemical and petrochemical processing applications in the as-welded condition.

This alloy might be used in any environment that requires resistance to heat and corrosion but where the mechanical properties of the metal must be retained.

Typical applications include:

- Chemical processing
- Air Pollution control
- Pulp and Paper Production
- Marine Engineering
- Waste Treatment

For cold working pressures please see tables 13 & 14 on page 13

Typical Composition	
Element	**Weight (%)**
Carbon	0.01 max
Manganese	1.00 max
Chromium	14.5 to 16.5
Nickel	51.0 min
Molybdenum	15.0 to 17.0
Iron	4.0 to 7.0
Tungsten	3.0 to 4.5
Cobalt	2.5 max
Vanadium	0.35 max

Typical Specifications	
Product	**Standard**
Bar	ASTM B574
Forging	ASTM B564
Tube	ASTM B622
Other	NACE MR0175 NACE MR0103
UNS No.	N10276

Titanium

Titanium is virtually immune to environmental attack. It withstands urban pollution, marine environments, the sulphur compounds of industrial areas and is failure-proof in even more aggressive environments. The uses for titanium in industry are growing faster than ever before as more and more engineers are discovering it can reduce lifecycle costs across a broad range of equipment and processes. Titanium has an exceptionally high strength to weight ratio, allowing for lighter components or reduced wall thicknesses. Any remaining higher up front costs are almost always recouped in multiple due to increased production time and reduced maintenance.
Titanium forms a very tenacious surface oxide layer, which is an outstanding corrosion inhibitor. In many harsh environments it can outlast competing materials as much as 5 times longer. Lower failure rates translate to less downtime, reduced maintenance and total lower cost.

Typical applications include:

- Chemical processing
- Power Generation
- Aerospace and Defence
- Petrochemical Refineries
- Desalination Plants

Typical Composition Grade 2	
Element	**Weight (%)**
Nitrogen	0.03 max
Carbon	0.08 max
Hydrogen	0.015 max
Iron	0.3 max
Oxygen	0.25 max
Titanium	Remainder

Typical Composition Grade 5	
Element	**Weight (%)**
Nitrogen	0.05 max
Carbon	0.08 max
Hydrogen	0.015 max
Iron	0.4 max
Oxygen	0.2 max
Aluminium	5.5 to 6.75
Vanadium	3.5 to 4.5
Titanium	Remainder

Typical Specifications	
Product	**Standard**
Bar	ASTM B348
Plate	ASTM B265
Forging	ASTM B381
Tube	ASTM B338
Other	NACE MR0175
UNS No.	R50400/56400

For cold working pressures please see tables 15 & 16 on page 13

Alloy 400

Alloy 400, also known as Monel™, is a nickel-copper alloy, resistant to sea water and steam at high temperatures as well as to salt and caustic solutions. The alloy possesses excellent corrosion resistance in a wide variety of media and is also characterized by good weldability and moderate to high strength.

The alloy has been used in a variety of applications. It has excellent resistance to rapidly flowing brackish water or seawater. It is particularly resistant to hydrochloric and hydrofluoric acids when they are de-aerated. Indeed, it is one of few metallic materials which can be used in contact with fluorine, hydrofluoric acid, hydrogen fluoride and their derivatives.

The alloy is widely used in the chemical, oil and marine industries. Good mechanical properties from sub-zero temperatures up to 1020 °F.

Typical applications include:

- Valves, pumps, shafts, fittings, and fasteners, especially in marine environment
- Chemical and hydrocarbon processing equipment
- Crude oil distillation towers
- Gasoline and freshwater tanks
- Seawater Handling Equipment

Typical Composition Grade 2	
Element	**Weight (%)**
Nickel	63.0 min
Copper	28.0 to 34.0
Iron	2.5 max
Manganese	2.0 max
Carbon	0.3 max

Typical Specifications	
Product	**Standard**
Bar	ASTM B164
Forging	ASTM B564
Tube	ASTM B165
Other	NACE MR0175 NACE MR0103
UNS No.	N04400

For cold working pressures please see tables 7 & 8 on page 12

Brass

Brass is a metal alloy of Copper and Zinc. Small additions of other alloying elements are added to modify the properties so that the resulting material is fit for a given purpose.

Brasses are medium strength engineering materials, comparable to high strength structural steels and some stainless steels and aluminium alloys. In the softened or annealed condition brasses are ductile and strong but when hardened by cold working their strength increases markedly. Brass has excellent machinability.

While brass may be less corrosion resistant than other copper alloys, its performance is quite adequate for many applications. However, brass tarnishes. Exposed to the atmosphere, it quickly forms a brown or gray-green protective corrosion film. Under certain conditions, brass can also dezincify. Dezincification is associated with submerged or stagnant exposure conditions, often in acidic media. Under atmospheric exposure, this form of corrosion is usually limited to superficial attack.

Typical applications include:

- Valves, pumps, shafts, fittings, and fasteners.
- Heat Exchangers Tubes
- Automotive Industry
- Marine Engineering
- Piping

Typical Composition Grade 2	
Element	**Weight (%)**
Copper	60.0 to 63.0
Load	2.5 to 3.7
Iron	0.35 max
Zinc	Remainder

Typical Specifications	
Product	**Standard**
Bar	ASTM B16
UNS No.	C36000

For cold working pressures please consult factory

Carbon Steel

Carbon steel, also called plain carbon steel, is a malleable, iron-based metal containing carbon, small amounts of manganese, and other elements that are inherently present. It is the most widely used engineering material, and accounts for approximately 85%, of the annual steel production worldwide.

Despite its relatively limited corrosion resistance, carbon steel is still used in large tonnages in numerous industrial applications.

Typical applications of Carbon Steel are:

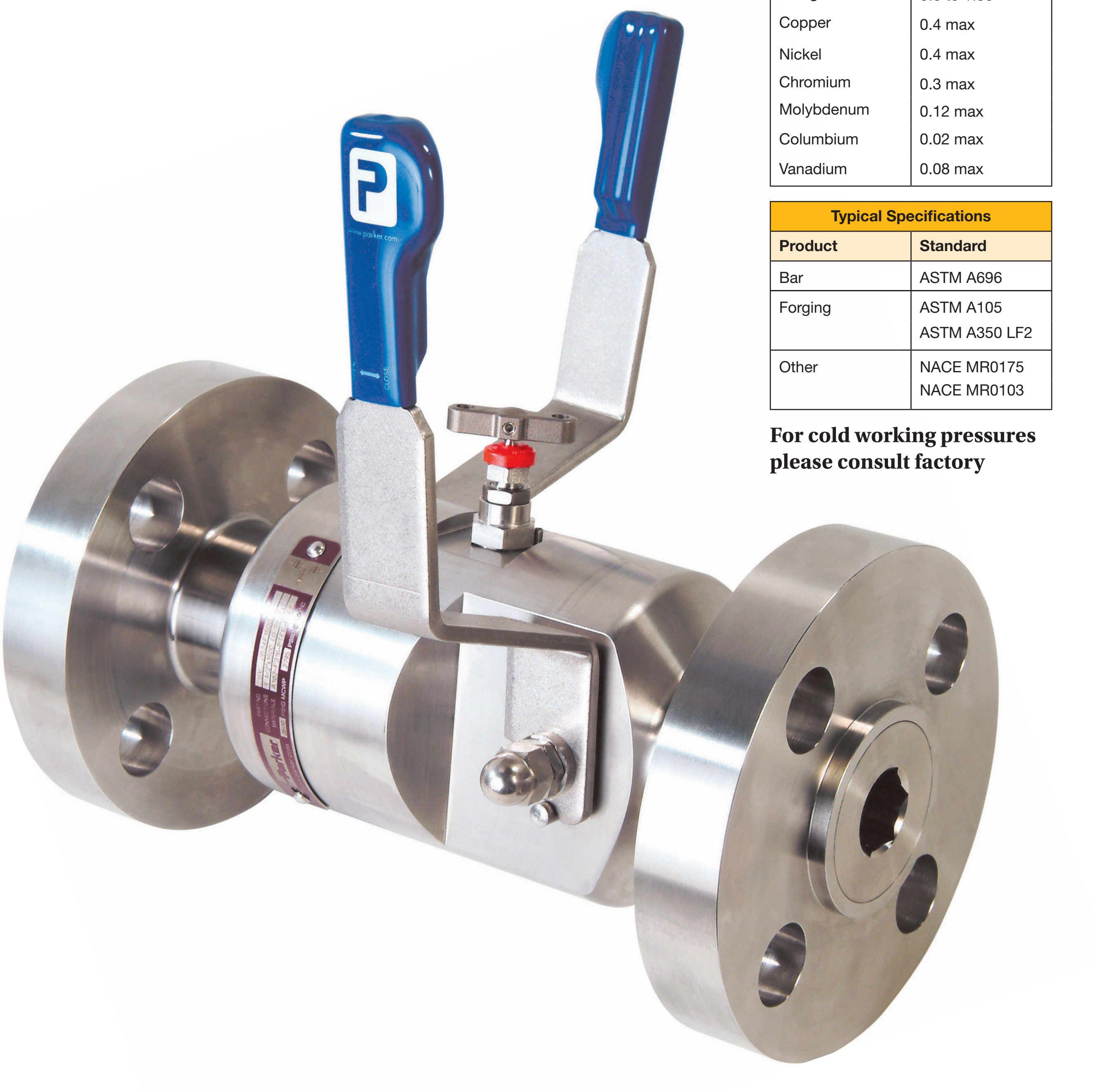
- Pipeline Systems
- Mining
- Metal Processing Equipment
- Transportation
- Fossil Fuel Power Plants
- Petroleum Production & Refining

Typical Composition ASTM A105	
Element	**Weight (%)**
Carbon	0.35 max
Manganese	28.0 to 34.0
Copper	0.4 max
Nickel	0.4 max
Chromium	0.3 max
Molybdenum	0.12 max
Vanadium	0.08 max

Typical Composition ASTM A105 LF2	
Element	**Weight (%)**
Carbon	0.3 max
Manganese	0.6 to 1.35
Copper	0.4 max
Nickel	0.4 max
Chromium	0.3 max
Molybdenum	0.12 max
Columbium	0.02 max
Vanadium	0.08 max

Typical Specifications	
Product	**Standard**
Bar	ASTM A696
Forging	ASTM A105 ASTM A350 LF2
Other	NACE MR0175 NACE MR0103

For cold working pressures please consult factory



Austenitic Stainless Steel 316

Tubing Specification: High Quality, Fully Annealed, Stainless Steel Tubing to ASTM A269 Grade 316/316L UNS S31600/S31603. Recommended Tube Hardness 80 HRB. Maximum Permissible Hardness 90 HRB.

Table 1	316/316 Stainless Steel															Imperial
Tube O.D. Size	Wall Thickness, inches															
	0.010	0.012	0.014	0.016	0.020	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.120	0.134	0.156	0.188
1/16	5600	6900	8200	9500	12100	16800										
1/8						8600	10900									
3/16						5500	7000	10300								
1/4						4000	5100	7500	10300							
5/16							4100	5900	8100							
3/8							3300	4800	6600							
1/2							2600	3700	5100	6700						
5/8								3000	4000	5200	6100					
3/4								2400	3300	4300	5000	5800				
7/8								2100	2800	3600	4200	4900				
1									2400	3200	3700	4200	4700			
1 1/4										2500	2900	3300	3700	4100	4900	
1 1/2											2400	2700	3000	3400	4000	4500
2												2000	2200	2500	2900	3200

Working pressure is measured in 'psig'

Table 2	316/316 Stainless Steel									Metric
Tube O.D. Size	Wall Thickness, mm									
	0.8	1.0	1.2	1.5	1.8	2.0	2.2	2.5	2.8	3.0
3	720									
6	330	430	520	680						
8		310	380	490						
10		240	300	380	470					
12		200	240	310	380	430				
14		180	220	280	340	390	430			
15		170	200	260	320	360	400			
16			190	240	300	330	370	430		
18			170	210	260	290	330	380		
20			150	190	230	260	290	330	380	
22			140	170	210	230	260	300	340	
25					180	200	230	260	300	320

Working pressure is measured in 'bar'

- Not recommended for gas service
- Recommended for all services - standard assembly
- Recommended for all services - Use pre-assembly tool
- Recommended for all services - Use 'Hyferset' pre-assembly tool
- No data/Not recommended/No solution

Tungum - 316 Fittings

Tubing Specification: High Quality, Fully Annealed, Stainless Steel Tubing to ASTM B706 Grade UNS C69100. Recommended Tube Hardness 120 Vickers HV5. Maximum Permissible Hardness 140 Vickers HV5.

Table 3			Tungum				Imperial	
Tube O.D. Size	Wall Thickness, inches							
	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.12
1/8	6400	8400						
3/16	4100	5300	7900					
1/4		3800	5600	7900				
5/16		3000	4400	6100	8100			
3/8		2500	3600	4900	6500	7700		
1/2			2800	3800	5000	5900	6900	
5/8			2200	3000	3900	4600	5300	
3/4			1800	2400	3200	3700	4300	
7/8				2100	2700	3100	3700	4100
1					2300	2700	3200	3500

Working pressure is measured in 'psig'

Table 4			Tungum					Metric
Tube O.D. Size	Wall Thickness, mm							
	0.8	1	1.2	1.5	2	2.5	2.8	3
3	400							
6	250	320	400	520				
8		230	290	370	520			
10		180	220	290	400			
12			180	23-0	320	420	480	
16			140	180	250	320	370	
18			130	160	220	280	320	
20			110	140	200	250	290	
22				130	180	230	260	280
25					150	200	220	240

Working pressure is measured in 'bar'

Recommended for all services - standard assembly

No data/Not recommended/No solution

Super Austenitic 6Mo

Tubing Specification: High Quality, Fully Annealed, Super Stainless Steel Tubing to ASTM A269/A213 Grade UNS S31254. Recommended Tube Hardness 80 HRB. Maximum Permissible Hardness 90 HRB.

Table 5			6Mo				Imperial
Tube O.D. Size	Wall Thickness, inches						
	0.02	0.028	0.035	0.049	0.065	0.083	0.095
1/16							
1/8	7100	10500					
3/16		6700	8600				
1/4		4900	6300				
5/16			4900	7100			
3/8			4000	5800	8000		
1/2			3200	4600	6200		
5/8				3600	4900		
3/4				3000	4000	5200	
7/8				2500	3400	4400	
1					2900	3800	4400

Working pressure is measured in 'psig'

Table 6			6Mo					Metric
Tube O.D. Size	Wall Thickness, mm							
	0.8	1	1.2	1.5	1.8	2	2.2	2.5
3	550							
6	410	520						
8		380	470					
10		300	370	470				
12		250	300	380	470			
14			270	340	420			
15			250	320	390			
16			230	300	360			
18			210	260	320	360		
20			180	230	290	320		
22				210	260	290	320	
25					220	250	280	320

Working pressure is measured in 'bar'

Not recommended for gas service

Recommended for all services - standard assembly

Recommended for all services - Use pre-assembly tool

Recommended for all services - Use 'Hyferset' pre-assembly tool

No data/Not recommended/No solution

Alloy 400

Tubing Specification: High Quality, Fully Annealed, Alloy 400 Tubing to ASTM B165 Grade UNS N04400.
Recommended Tube Hardness 70 HRB. Maximum Permissible Hardness 75 HRB.

Table 7	Alloy 400						Imperial
Tube O.D. Size	Wall Thickness, inches							
	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.12
1/8	8000	10400						
1/4	3700	4800	7000	9800				
5/16		3700	5400	7500				
3/8		3100	4400	6100				
1/2		2400	3500	4700	6200			
3/4			2200	3000	4000	4600	5400	
1				2200	2900	3400	3900	4300

Working pressure is measured in 'psig'

Table 8	Alloy 400							Metric
Tube O.D. Size	Wall Thickness, mm							
	0.8	1	1.2	1.5	2	2.5	2.8	3
3	670	890						
6	310	400	490	640				
8		290	350	460				
10		230	280	360				
12		190	230	290	400			
18			160	200	270			
20			140	180	240	310	350	
25				140	190	240	280	300

Working pressure is measured in 'bar'

Not recommended for gas service

Recommended for all services - standard assembly

No data/Not recommended/No solution

Alloy 825

Tubing Specification: High Quality, Fully Annealed, Alloy 825 Tubing to ASTM B163 or B423 Grade UNS N08825.
Recommended Tube Hardness 80 HRB. Maximum Permissible Hardness 90 HRB.

Table 9	Alloy 825			Imperial
Tube O.D. Size	Wall Thickness, inches			
	0.035	0.049	0.065	0.083
1/4	5400	8700	11100	
3/8	3500	5500	7600	
1/2	2700	4300	5900	

Working pressure is measured in 'psig'

Table 10	Alloy 825				Metric
Tube O.D. Size	Wall Thickness, mm				
	0.8	1	1.2	1.5	2
6	260	450	610	730	
10		260	350	440	
12		210	280	360	

Working pressure is measured in 'bar'

Not recommended for gas service

Recommended for all services - standard assembly

Recommended for all services - Use pre-assembly tool

No data/Not recommended/No solution

Alloy 625

Tubing Specification: High Quality, Fully Annealed, Alloy 625 Tubing to ASTM B444 Grade 2 UNS N06625.
Recommended Tube Hardness 85 HRB. Maximum Permissible Hardness 93 HRB.

Table 11	Alloy 625		
Tube O.D. Size	Wall Thickness, inches		
	0.035	0.049	0.065
1/4	6800		
3/8	4400	6400	8700
1/2		5000	6800
3/4			4400

Working pressure is measured in 'psig'

Table 12	Alloy 625				Metric
Tube O.D. Size	Wall Thickness, mm				
	0.8	1	1.2	1.5	1.8
6	440	570			
10	260	330	400	510	630
12			330	420	

Working pressure is measured in 'bar'

- Recommended for all services - standard assembly
- Recommended for all services - Use pre-assembly tool
- Recommended for all services - Use 'Hyferset' pre-assembly tool
- No data/Not recommended/No solution

Alloy C276

Tubing Specification: High Quality, Fully Annealed, Alloy C276 Tubing to ASTM B622 Grade UNS N10276.
Recommended Tube Hardness 85 HRB. Maximum Permissible Hardness 93 HRB.

Table 13	Alloy C276			Imperial
Tube O.D. Size	Wall Thickness, inches			
	0.028	0.035	0.049	0.065
1/4	5500			
3/8		4500	6500	8900
1/2		3500	5100	6900
5/8		2800		

Working pressure is measured in 'psig'

Table 14	Alloy C276			Metric
Tube O.D. Size	Wall Thickness, mm			
	0.8	1	1.2	1.5
6	450	580		
10		330	410	520
12		270	330	430
15		230		

Working pressure is measured in 'bar'

- Not recommended for gas service
- Recommended for all services - standard assembly
- Recommended for all services - Use pre-assembly tool
- No data/Not recommended/No solution

Titanium Grade 2

Tubing Specification: High Quality, Fully Annealed, Titanium Tubing to ASTM B338 Grade 2 UNS R50400.
Recommended Tube Hardness 75 HRB. Maximum Permissible Hardness 85 HRB.

Table 15	Titanium Grade 2			Imperial
Tube O.D. Size	Wall Thickness, inches			
	0.028	0.035	0.049	0.065
1/4	3300	4200	6200	
3/8		2700	4000	5400
1/2		2100	3100	

Working pressure is measured in 'psig'

Table 16	Titanium Grade 2			Metric
Tube O.D. Size	Wall Thickness, mm			
	0.8	1	1.2	1.5
6	280	350	440	
10		200	250	320
12		170	200	

Working pressure is measured in 'bar'

- Not recommended for gas service
- Recommended for all services - standard assembly
- Recommended for all services - Use pre-assembly tool
- No data/Not recommended/No solution

Suparcase™ for A-LOK® Back Ferrules

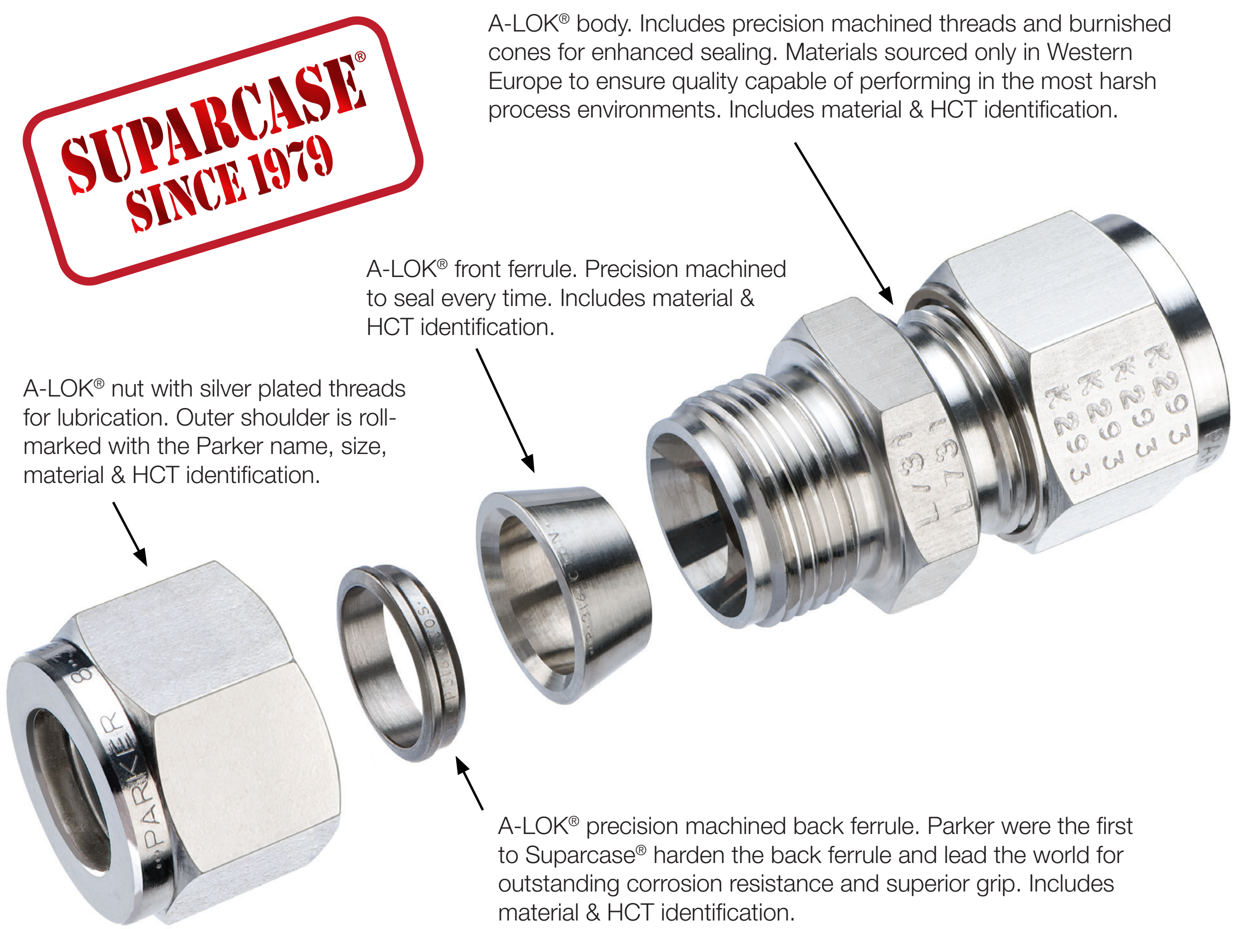
The first step in ensuring the integrity of any system is to choose the right materials for the job. That's why Parker supply fittings in a wide range of exotic materials for applications where corrosion is an issue, and where new, harder materials for tubing for high-integrity applications are being used.

The Suparcase™ PRINCIPLE

The Parker Suparcase™ surface treatment is an unique process that allows stainless steels and other alloys to be hardened without affecting, and even increasing, the corrosion resistance of the given materials. Parker has been using the proprietary Suparcase process to surface harden stainless steel ferrules for approximately 20 years. The process achieves a carbon supersaturated surface layer by altering the oxide passive layer on the surface of the stainless steel, without any detrimental effects.

Good Tube Grip = Harder Rear Ferrule = Smarter, Faster, Cleaner, Safer

- Suparcase™ process perfected by Parker gives the Differential Hardness
- Some competitor hardening process corrode (i.e. Nitride or Edge Hardening)
- Suparcase™ increases the corrosion resistance
- Suparcase™ is applied to all back ferrules, all sizes



Suparcase™ Advantages

The result is a thin surface region supersaturated with carbon in solid solution. This surface region has some unusual advantageous properties:

- **Improved Hardness**
  Hardness Test – Suparcased samples are at least 250% harder than their untreated counterparts.
- **Increased Fatigue Strength**
  Bending Test – Suparcased samples showed 50% increase in fatigue strength with respect to the same untreated samples under the same number of cycles.
- **No change in shape, size or colour**
- **Suparcase Layer does not crack or delaminate during forming**
- **Outstanding Wear and Erosion Resistance**
  Wear Test performed on a high pressure homogenizer made out of Stainless Steel 316 – The Suparcase™ samples increased the wear & erosion resistance by 13 times in air and by 10 times in seawater with respect to their untreated counterparts.
- **Exceptional Corrosion Resistance**
  ASTM G48 - Standard Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution. Test Results on Type 316 Suparcased™ stainless steel:

Condition	ASTM G 48 Ferric Chloride Test Results
As-machined (Cold Worked)	6.1% weight loss
As-machined + Suparcase™	0.0% weight loss
Annealed + Suparcase™	**No corrosion**

As-machined + Suparcase™

As-machined (Cold Worked)

ASTM G150 Critical Pitting Temperature. CPT measures the temperature at which pitting is likely to start:

Alloy	UNS Number	CPT Range - °C
316	S31600	0 - 30
317L	S31703	32 - 45
904L	N08904	30 - 55
316 Suparcase™	S31600	69 - 75
6Mo	S31254	70 - 90

Materials Range for Corrosion Control

Our experienced credentials in materials selection are the results of years of expertise in successful applications worldwide.

Materials Range
Parker offers the most extensive range of alloys in the market. The range varies from conventional steels to high nickel alloys and titanium for the most demanding applications. The table below depicts the standard range of materials per product family. Other alloys might be offered on request.

	A-LOK® Fittings	Phastite® Fittings	CPI	MPI	Valves	Manifolds	Flanged Products
Brass	Yes	No	Yes	No	Yes	No	No
Carbon Steel	No	No	No	No	Yes	No	Yes
Stainless Steel 316/316L	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Duplex Steel	No	Yes	No	No	Yes	Yes	Yes
Superduplex Steel	No	Yes	No	No	No	Yes	Yes
Super austenitic 6Mo	Yes	Yes	Yes	No	Yes	Yes	Yes
Monel 400	Yes	Yes	Yes	No	Yes	Yes	Yes
Alloy 825	Yes	Yes	Yes	No	Yes	Yes	Yes
Alloy 625	Yes	Yes	Yes	No	Yes	Yes	Yes
Alloy C-276	Yes	Yes	Yes	No	Yes	Yes	Yes
Titanium	Yes	No	Yes	No	Yes	Yes	Yes

General Guidelines for Materials Cost and Availability

* For instrumentation applications

Specific Combinations for Particular Applications

- Parker best practice is using the same material for the instrumentation equipment and the tubing.
- If different materials need to be mixed, it is the end user responsibility to assess and ensure the correct functioning of the given application.
- Although Parker does not necessarily recommends mixing dissimilar materials, experience has shown that for certain applications it is an acceptable practice. For instance, Parker stainless steel 316 fittings have been successfully used in selected applications with Tungum tube and the system was fully compatible in terms of performance. Despite Tungum being initially more expensive to buy, life time costing showed it to be the most cost-effective material for tubing in this particular application.
- If you would like to discuss your particular applications with us, please contact us and we will help you add value to your system.

Some of our experience

Here are some basic guidelines based on our extensive knowledge and experience in applications worldwide:

- Think about cost effectiveness, safety and reliability
- A cheap option today usually translate into high cost of ownership tomorrow
- Do not mix tube and fitting/ valve alloys whenever possible
- Use Super Duplex for its tensile strength
- Do not use Twin Ferrule on Super Duplex rather use Phastite
- Use our range of exotic materials for demanding applications and NACE compliance

Notes

Notes

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