Austenitic Stainless Steel

Aperam 316A

Low Carbon with a Combination of Molybdenum and Silicon

Chemical Composition

Elements (%)	C	Si	Cr	Ni	Mo	N
316A	0.025	1.00	18.00	9.50	0.50	0.065

Typical values

Grade	European designation	American designation	IMDS Nr
316A	X2CrNiSi18-10/1.4682 [1] X2CrNi18-9/1.4307 [1]	UNS 30416	1165152410

[1] According to EN 10088-2

This grade complies with:

- Aperam Stainless Europe - Safety Information Sheet for Stainless Steel
- European Directive 2000/53/EC on end-of-life vehicles and later modifications
- NFA 36 711 standard "Stainless steel intended for use in contact with foodstuffs, products and beverages for human and animal consumption (non packaging steel)", dated August 2021
- NSF/ANSI 51 International Standard for "Food Equipment Materials" and of the FDA (United States Food and Drug Administration) regarding materials used for food contact, dated 2023
- French Decree No. 2007-766, dated 10 of May 2007, and Regulation No. 1935/2004 of the European Parliament and of the Council of 27 October 2004 on materials and articles intended to come into contact with food (repealing Directives 80/590/EEC and 89/109/ EEC)
- French regulatory paper dated 13 January 1976 relating to materials and articles made of stainless steel in contact with foodstuffs
- 1.4682, depending on the precise standard in use, can therefore be readily applied e.g. for ASME code construction or API 620 or API 650 storage tanks while inception of the specific grade in the various standards and codes themselves is ongoing.

Key Features

The principal features of our 316A grade are:

- A unique, cost-effective alternative to 316L (1.4404)
- Improved resistance to corrosion in acids and chloride-containing media, as well as to pitting, crevice, and intergranular corrosion -even after welding
- Excellent weldability and polishing
- High ductility
- Good drawability

Applications

- Heating: heat exchangers, flues, heating pumps
- Mechanical equipment, paper industry, pumps
- Transport: naval engineering, road transport (IMO tanks, swap bodies and trailers)
- Chemical and pharmaceutical industries
- Oil & Gas industry
- Water industry, food industry
- Building & construction, tubes
- ...

Product Range

	Coils	Sheets / Blanks	Discs	Precision Strip			Precision Sheet		Tubes
Thickness (mm)	0.30 up to 13	0.15 up to 13	0.38 up to 2.50	0.3 up to 2.5	0.07 up to 2.5	0.075 up to 2.5	0.5 up to 2.5	0.20 up to 2.5	0.80 up to 2
Width (mm)	up to 2,000	80 up to 2,000	Ø 15 up to 1,000	5 up to 650			508 up to 3,000		Ø 8 up to 80
Finish	2R / 2B / 2D / 1D	2R / 2B / 2D / 1D	2R / 2B / 2D / 1D	2B / 2D	2H	2R	2B / 2D	2R / 2H	2B / 2D

For flat bars or any other dimensions, please consult us.

Physical Properties

Cold rolled and annealed sheet

Density	d	kg/dm³	20°C	7.9
Melting temperature		°C	Liquidus	1,440
Specific heat	c	J/kg.K	20°C	475
			600°C	600
			1,200°C	660
Thermal conductivity	k	W/m.K	20°C	14
			600°C	23
Mean thermal expansion coefficient	α	10^{-6}/K	20-100°C 100-300°C 300-500°C	18 18.5 19.5
Electric resistivity	ρ	Ω mm²/m	20°C	0.76
Magnetic permeability	μ	at 0.8 kA/m DC or AC	20°C	1.005
Young's modulus	E	GPa	20°C	200

Poisson's coefficient: 0.30

Mechanical Properties

Test piece

Length = 50 mm (thickness < 3 mm)
Length = 5.65 √ S_0 (thickness ≥ 3 mm)
Cold rolled

In the annealed condition

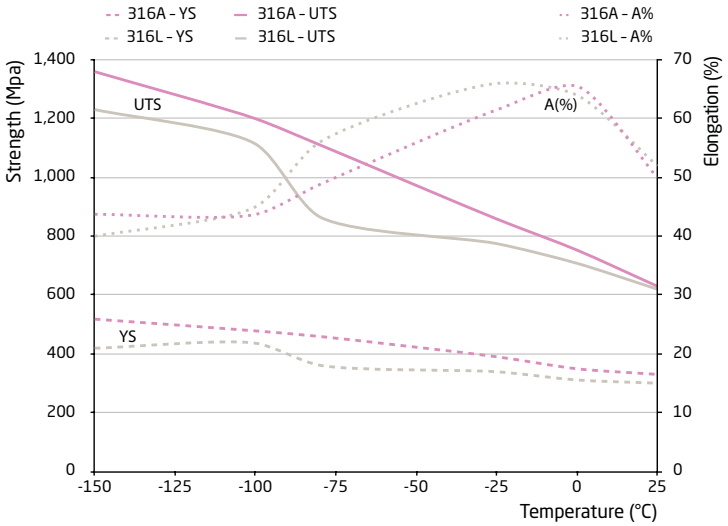
In accordance with ISO-EN10088-2
Test piece perpendicular to rolling direction

Grades	European designation	ASTM A240	Rm(1) (MPa)	$Rp_{0.2}$(2) (MPa)	A(3) %
304L	1.4307	304L	650	300	54
316L	1.4401/1.4404	316/316L	620	300	52
316A	**1.4682**	**UNS30416**	**630**	**330**	**50**
K44	1.4521	444	520	370	29
DX2205	1.4462	2205	840	620	29

1 MPa = 1 N/mm² - Typical values
(1) Ultimate Tensile Strength (UTS) - (2) Yield Strength (YS) - (3) Elongation (A)

Cryogenic mechanical properties

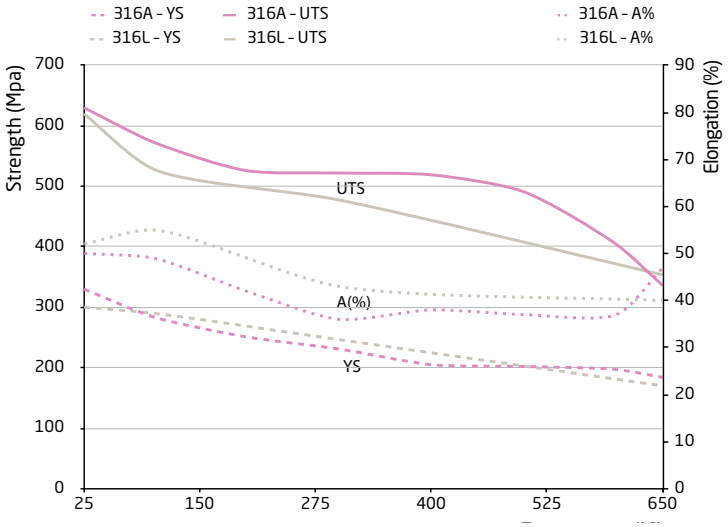
Better mechanical strength of 316A compared to 316L with almost the same elongation at fracture.



Method: 10 x 80 specimen.
Preload = 50 MPa / Elastic rate = $8.8 \cdot 10^{-5} \cdot s^{-1}$
Plastic rate = $6.47 \cdot 10^{-4} \cdot s^{-1}$.

High temperature mechanical properties from RT to 650°C

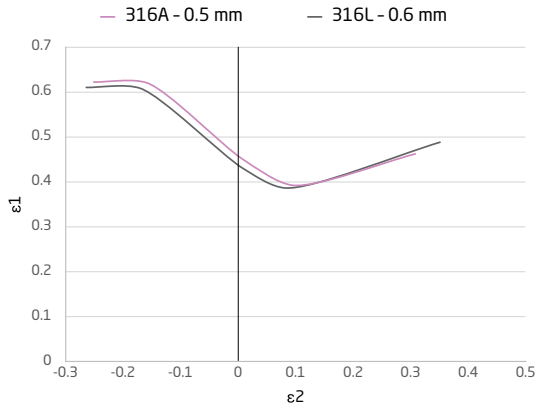
Better mechanical strength of 316A compared to 316L with almost the same elongation at fracture.
Lower elongation of 316A vs 316L.

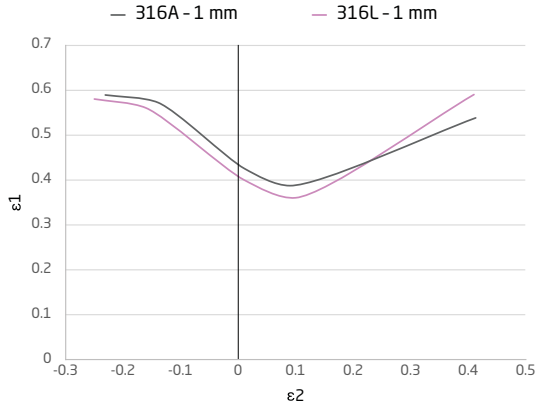


Method: 10 x 27 specimen.
Preload = 30 MPa / Elastic rate = 0.5%·min⁻¹
Plastic rate = 2%·min⁻¹.

Forming

In the annealed condition, our 316A grade can be readily cold formed using all standard processes (bending, contour forming, drawing, deep drawing, flow turning and stretching).





Deep drawing (Swift test)

The Swift test is used to determine the Limiting Drawing Ratio (LDR). LDR is defined by the maximum ratio between the blank diameter (variable) and the punch diameter (fixed) that the drawing operation can be successfully performed.

Grades	Thickness (mm)	rN	LDR
316A	**0.5**	**1.17**	**2.14**
	1	**1.06**	**2.17**
316L	0.6	1.10	2.21
	1	1.14	2.14

Stretching (Erichsen test)

The stretching behaviour is characterized by the dome height (h) of the Erichsen test, also known as Index 'EI'.

Grades	Thickness (mm)	Erichsen Index
316A	**0.5**	**11.7**
	1	**12.3**
316L	0.6	11.2
	1	11.9

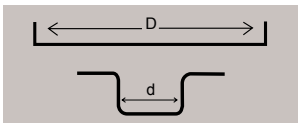
Bending

Our 316A has good bending capacity up to 180°, with very small bending radii for thicknesses below 0.8 mm. For thicker gauges, a bending radius of at least half the thickness of the sheet is recommended. When bending the material, the elastic springback must always be taken into consideration.

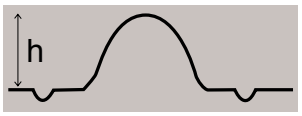
Grades	European designation	ASTM A240	LDR*	EI** (mm)
304L	1.4307	304L	1.91	11.4
316L	1.4401/1.4404	316/316L	2.01	11.5
316A	**1.4682**	**UNS30416**	**2.2**	**12.0**
K44	1.4521	444	2.10 - 2.15	8.6
DX2205	1.4462	2205	1.9 - 1.95	9.5

* Limiting Drawing Ratio
** Erichsen Index - Lubricant = Mobilux EP00 - Typical values tests done on 0.8 mm thickness.

$$LDR = \frac{D_{max}}{d}$$



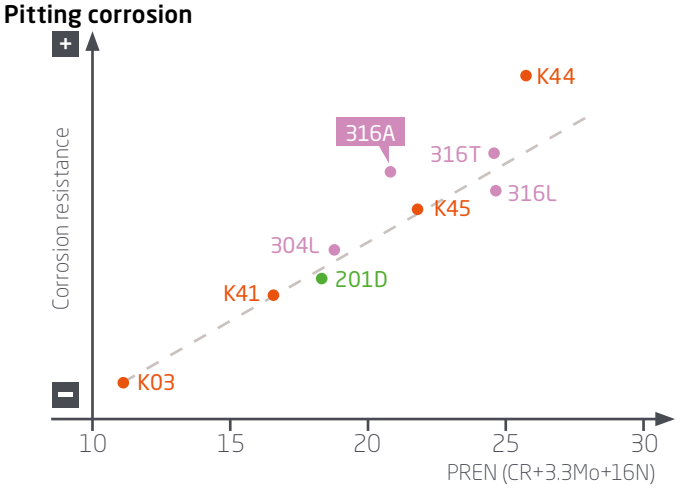
EI =



Corrosion Resistance

Offering excellent resistance in acid solutions and good resistance in chloride containing media, our 316A grade is well-suited for manufacturing parts that come into contact with seawater at low temperatures.

Pitting corrosion



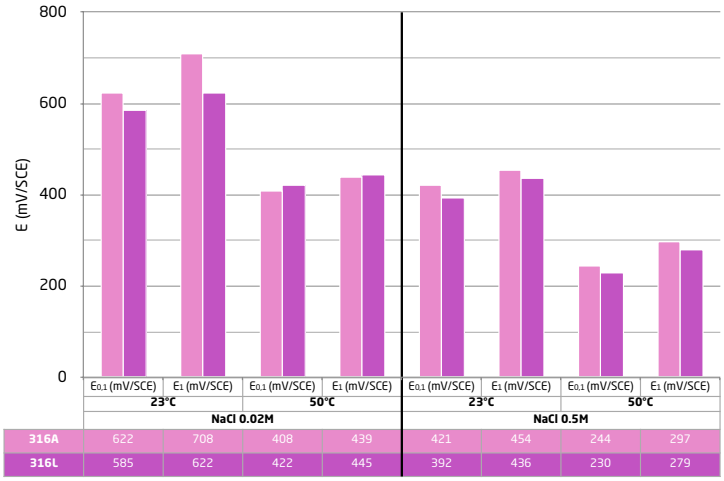
PREN based on composition does not reflect its real corrosion resistance. Real equivalent PREN is 24.

Pitting potential

In variations following the temperature and the chloride concentration.

Grades	NaCl 0.02M/23°C	NaCl 0.02M/50°C
316A	**625 mV**	**410 mV**
304L	540 mV	385 mV
316L	585 mV	425 mV

Typical values



	$E_{0.1}$ (mV/SCE)	E_t (mV/SCE)	$E_{0.1}$ (mV/SCE)	E_t (mV/SCE)	$E_{0.1}$ (mV/SCE)	E_t (mV/SCE)	$E_{0.1}$ (mV/SCE)	E_t (mV/SCE)
	23°C		50°C		23°C		50°C	
	NaCl 0.02M				NaCl 0.5M			
316A	622	708	408	439	421	454	244	297
316L	585	622	422	445	392	436	230	279

Crevice corrosion

Depassivation pH in a deaerated NaCl 2M environment at 23°C

Crevice corrosion occurs in two stages. During the first stage (initiation), chloride accumulates and acidification begins. This eventually causes depassivation within the crevice region. A depassivation pH is the critical condition for passivity breakdown.

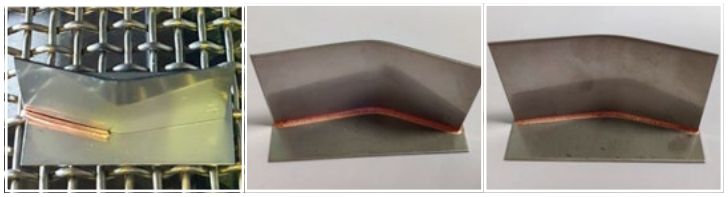
The metal begins to dissolve during the second stage (propagation). This process can be slowed down using grades that contain molybdenum and nickel as both elements are known to decrease the speed of propagation.

Intergranular corrosion

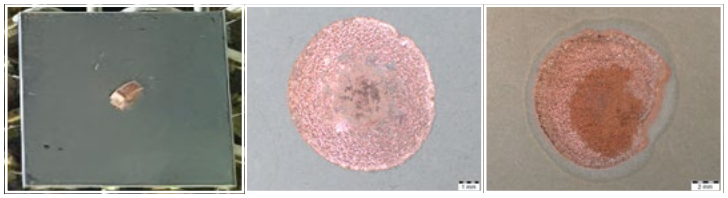
This grade is recommended when there is a risk of intergranular corrosion as long as the following requirements of the standard intergranular corrosion tests are met: EN ISO 3651-2 (sensitizing treatments T1 and T2), ASTM A 262, ex-DIN 50914.

Brazing

316A demonstrates excellent brazing behavior with copper, ensuring well-controlled wetting and capillarity in the brazing joint. Like 316L, it exhibits minimal copper penetration along grain boundaries.



T-brazing test | 316A | 316L



Sessile Test | 316A | 316L

Welding

Welding process	No filler material	With filler metal			Shielding gas
	Typical thicknesses	Thicknesses	Filler material		
			Rod	Wire	
Resistance: spot, seam	≤ 2 mm				
TIG	< 1.5 mm	> 0.5 mm	ER 316 L	ER 316 L	Ar Ar + 5% H_2 Ar + He
PLASMA	< 1.5 mm	> 0.5 mm		ER 316 L	Ar Ar + 5% H_2 Ar + He
MIG		> 0.8 mm		ER 316 L (Si)	Ar + 2% CO_2 Ar + 2% O_2 Ar + 2% CO_2 + 1% H_2 Ar + 2% CO_2 + He
SAW		> 2 mm		ER 316 L	
Electrode		Repairs	E 316 L		
Laser	< 5 mm				Ar Under certain circumstances: N_2

In general, heat treatment is not required after welding. However, to fully restore the metal's corrosion resistance, the welds must be mechanically or chemically descaled and passivated. In case of applications at temperatures above 500°C, a specific filler material must be used to guarantee a ferrite level below 8% in the weld.

Heat Treatment and Finishing

Annealing

After cold forming (work hardening) and welding, using an annealing treatment for a couple of minutes at 1,050 ± 25°C, followed by air cooling or water quenching, will restore the microstructure (recrystallisation and dissolution of carbides) and eliminates internal stresses.
After annealing, pickling, followed by passivation, is necessary.

Pickling

- Nitric-Hydrofluoric acid mixture (10% HNO_3 + 2% HF) at ambient temperature or up to 60°C
- Sulfuric-nitric acid mixture (10% H_2SO_4 + 0.5% HNO_3) at 60°C
- Use descaling pastes for weld areas

Passivation

- 20-25% HNO_3 solution (36° Baumé) at 20°C
- Use passivating pastes for weld zones

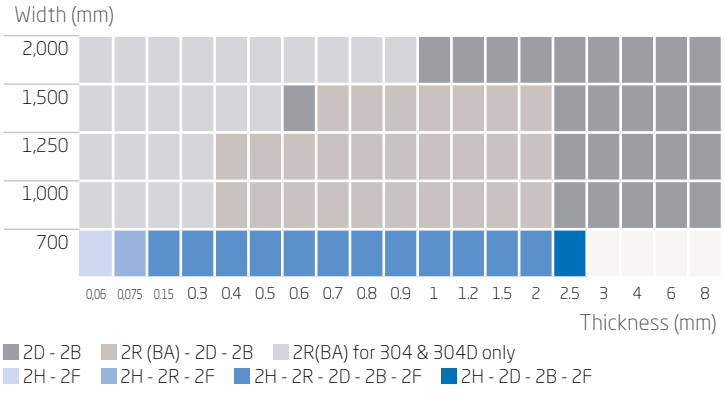
Polishing

The surface of 316A is suitable for all kinds of polishing (grit, scotch-brite, electro polishing).

Size range

Our size range is based on our production capabilities. Please contact us for the latest information per grades on offer.

Cold Rolled



Hot Rolled and HRC