

# Ferritic Stainless Steel 4016

## Steel Grade

Outokumpu	EN	ASTM	UNS
4016	1.4016	430	S43000

## Characteristic Properties

Outokumpu 4016 is a ferritic stainless steel that has good corrosion resistance in mildly corrosive environments. It is oxidation resistant at elevated temperatures, up to approximately 800°C. It is ductile, does not work harden readily, and is well suited for deep drawing and bending as well as other types of forming operations like roll forming and stretch bending. Outokumpu supplies grade 4016 in different decorative cold rolled surface finishes, making it suitable for applications with high aesthetic and hygienic demands.

## Chemical Composition

The chemical composition may vary slightly between different product standards. The required standard will be fully met as specified on the order.

## Typical Applications

4016 is used in a variety of interior applications where material cost and corrosion performance are important factors. Typical applications include washing machines, dish-washers, sinks, sink rims, counter tops, cooker hoods, refrigerators, tableware and restaurant equipment. Other applications include architectural use like indoor cladding. Its oxidation resistance can be exploited in the construction of flue gas ducts.

## Chemical Composition

Table 1

Outokumpu Steel Name	International Steel no		Chemical Composition (wt-%) acc. EN 10088	
	EN	ASTM	Cr	C max
4016	1.4016	430	16-18	0.08

## Mechanical Properties

The slightly higher proof strength than for austenitic stainless steels, in combination with lower work hardening make 4016 an attractive choice for applications where forming operations are necessary. Its ductility, however, is not as high as that of austenitic stainless steels, although similar to that of carbon steels. Like other ferritic stainless steels, 4016 has reduced toughness at low temperatures.

Outokumpu uses European Standard EN10088-2 when applicable. The permitted design values may vary between product forms. The appropriate values are given in the relevant specifications.

## Mechanical Properties

**Cold rolled strip, minimum values according to EN 10088-2 at 20°C, transverse direction**

Table 2

Steel Grade	Proof Strength Rp0.2 MPa	Tensile Strength Rm MPa	Elongation A5 %
4016	280	450-600	20

### Tensile Properties at elevated temperatures

#### Proof Strength Rp0.2 (MPa), minimum values

Table 3

Grade	Proof Strength Rp0.2 (MPa), minimum values						
	100°C	150°C	200°C	250°C	300°C	350°C	400°C
4016	220	215	210	205	200	195	190

## Physical Properties

Guidance data from EN 10088-1

### Physical Properties, typical values at 20°C

Table 4

Density	Kg/dm <sup>3</sup>	7.7
Modulus of Elasticity	GPa	220
Thermal Conductivity	W/m°C	25
Electrical Resistivity	μΩm	0.60
Magnetizable		Yes

### Physical Properties at elevated temperatures

#### Modulus of Elasticity (GPa)

Table 5

Steel Grade	Modulus of Elasticity at (GPa)				
	20°C	100°C	200°C	300°C	400°C
4016	220	215	210	205	195

### Physical Properties at elevated temperatures

#### Linear expansion (RT=> T)×10-6/°C

Table 6

Steel Grade	Thermal Expansion between 20°C and T (10-6/°C)				
	100°C	200°C	300°C	400°C	500°C
4016	10.0	10.0	10.5	10.5	11.0

## Corrosion Resistance

4016 has good resistance to atmospheric corrosion in indoor applications. When used in regions with more corrosive atmospheres, for example industrial zones or coastal areas, a smooth surface finish becomes important to avoid staining and regular cleaning is necessary to maintain the original appearance. 4016 is resistant to most domestic liquids such as detergents, soaps and organic acids present in food.

Like most ferritic stainless steel 4016 is not susceptible to chloride induced stress corrosion cracking and shows good

resistance against many alkaline solutions, a wide range of diluted organic acids as well as against aqueous solutions that do not contain halides, i.e. that are free from chlorides, fluorides, bromides and iodides.

When exposed to elevated temperatures, 4016 forms an oxide scale that adheres well, even during thermal cycling. For continuous service, the upper temperature limit is 800°C in dry air.

**Fabrication**

**Forming**

4016 from Outokumpu has very good deep drawability due to its low work hardening.

To utilize its good forming properties, it might sometimes be necessary to perform the deep-drawing operation in several steps with intermediate annealing.

**Annealing**

For full softness and ductility, 4016 should be annealed at 770-830°C after cold forming.

**Machining**

Outokumpu 4016 is relatively easy to machine. Compared to austenitic grades, it has lower tendency to build-up edges, which, in turn, gives a larger machining window. Since the machinability is comparable to that of structural carbon steels, the same recommendations regarding choice of tool, cutting speed and cutting feed can be used.

**Welding**

Grade 4016 can be welded by the common fusion and resistance techniques. When cooling down from

temperatures above 900°C, sensitization to intergranular corrosion is likely to occur and welded joints are often less ductile and have a higher hardness than the base material due to grain growth and martensite formation.

Nevertheless, welded joints that are adequate for most applications where grade 4016 is used are achievable. Special attention is required to avoid brittle weld fractures during fabrication by minimizing discontinuities, maintaining low weld heat input, and occasionally warming the part before forming.

Spot or laser welding would be the methods of choice for thin sheet material.

Recommended filler metals are ISO 19 9 L, ISO 23 12 L and ISO 17. At service temperatures above 450°C, a nickel base filler, EN ISO 6082, is recommended.

**Surface Properties**

4016 from Outokumpu is produced in several cold rolled finishes; ranging from non-directional pickled finishes to directional polished or brushed surfaces, see Table 7.

**Surface finishes**

Table 7

	Available surface finishes	
4016	2B	Cold rolled, heat treated, pickled, skin passed (traditional matt finish)
	2J	Dry Brushed (DB)
	2G	Wet Ground (3N)
	2K	Fine polished (4N)

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