

# Duplex and high-strength stainless steels

Outokumpu Forta range

outokumpu  
high performance stainless steel



[outokumpu.com/forta](https://outokumpu.com/forta)



# We believe in a world that lasts forever

Outokumpu is a global leader in the advanced materials business, creating stainless steels that are efficient, long lasting, and recyclable. A strong customer focus, sustainability, and technical excellence are at the heart of everything we do.

As an open and approachable company, our customers rely on our advice to help them select products that will deliver the best long-term performance for their needs.

With over a century of innovation behind us and some of the best minds in the business, we continue to develop pioneering materials to meet the demands of tomorrow.

The durability of stainless steel means that it is not only the best, but also the most economically sustainable choice for a wide range of applications. All of our products are made from an average of 85% recycled material and are fully recyclable at the end of their lifecycles.

Together with our customers and partners, we are building a world that lasts forever.

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## The inside view

Duplex and other high strength stainless steels that enable thinner structures and weight reduction (yield strength  $R_{p0.2} > 400$  MPa. PRE 18 to 43).

Outokumpu has been producing austenitic stainless steel for over a century, duplex stainless steel for 80 years, and working with the automotive industry for 50 years. This legacy of innovation and consistent quality means that we have the right product for every application.

By grouping our products into ranges based on performance, rather than stainless steel type, we aim to make choosing the best product for your application easier. The Forta range contains the following product types:

- Duplex products for high strength, corrosion resistance, and enhanced resistance to stress corrosion cracking
- H-series austenitic products for high strength and high ductility
- Temper rolled products for high strength and high hardness

Unlike carbon steels, Forta range duplex products, with their superior corrosion resistance, do not need to be painted or coated, making them a more cost effective long-term choice. Because duplex products are also high strength, thinner gauges can potentially be used, which saves on material costs. Duplex also has a similar thermal expansion

to carbon steels making it possible to combine the two in the same application. The weldability of duplex steels is good, provided the suggested welding procedures are followed.

Forta H400 has been used in the automotive industry for structural parts for over 10 years. Forta H400 allows you to create lighter, more durable components while improving passenger safety. We also manufacture the newer Forta H500 product with higher yield strength. Forta H-series products are available in an industry-leading range of thicknesses and widths. We also have data to support our automotive customers with welding, forming, painting, corrosion, and simulation. Please contact our technical experts who can support you with extensive investigation data. Unlike the carbon steels and aluminum they often replace in automotive applications, Forta H-series products are fully recyclable, reduce CO<sub>2</sub> emissions, and enable new lightweighting potential.

Temper rolled products are standard stainless steels like Core 304/4301 and Supra 316L/4404 treated for higher strength and hardness, and are commonly used in tanks, bus chassis, and railcars. They offer better corrosion resistance than carbon steel and do not need to be coated or painted.

Contact us at [outokumpu.com/contacts](https://outokumpu.com/contacts) to find out what product is right for your next project.



When you need stainless steel for high temperature applications (above 250 °C/480 °F), austenitic products from the Core, Supra, or Ultra ranges are preferable. For temperatures above 550 °C/1020 °F, check the Therma range.



# Forta range applications

## Duplex applications

- Pressure piping systems for seawater, chemicals, and oil and gas handling
- Pressure vessels like digesters, evaporators, fermenters, autoclaves, water heaters, and road tankers
- Storage tanks for pulp, chemicals, biofuels, beverages, grains, and ore slurry
- Structural components for bridges, offshore platforms, sluice and flood gates, steel frameworks, and rebar for concrete structures
- Blast and fire walls on offshore platforms
- Cargo tanks in chemical tankers
- Evaporators in desalination plants
- Heat exchangers in petrochemical plants
- Suction roll shells in paper machines
- Flue-gas cleaning equipment
- Rotors, impellers, and shafts
- Vehicle and chassis components
- Flanges and valves

## H-series applications

- Automotive applications including structural safety parts, chassis parts, and complex-forming parts
- Railroad cars, trucks, buses, and agricultural vehicles

## Temper rolled applications

- Tanks and containers
- Bus chassis and railroad car components
- Shielding rings for beer kegs

Contact us at [outokumpu.com/contacts](https://outokumpu.com/contacts) to find out which of our products is right for your next project.



If you need stainless steel for very low temperature environments (-40 °C/-40 °F or below), austenitic stainless steels from the Core, Supra, or Ultra range are usually a better choice than Forta duplex products.



# Choosing the right product

## Duplex products

Outokumpu name	Typical applications	Product forms
<b>Forta DX 2205</b> The most popular duplex product on the market. Offers very good resistance to uniform and localized corrosion and stress corrosion cracking in combination with high mechanical strength.	<ul style="list-style-type: none"> <li>Tanks in chemical tankers</li> <li>Pulp and paper industry applications such as digesters and process tanks</li> <li>Oil and gas industry applications such as flanges, valves, tubes, and pipes</li> <li>Structural components in bridges</li> </ul>	C, H, P, B, R, S, T
<b>Forta LDX 2101</b> A lean-alloyed duplex product with good resistance to localized and uniform corrosion, as well as stress corrosion cracking, making it a good substitute for coated carbon steel. Also offers high mechanical strength and good machinability.	<ul style="list-style-type: none"> <li>Storage tanks</li> <li>Household heaters</li> <li>Structural components for floodgates and bridges or rebar for concrete structures</li> <li>Pulp and paper industry applications</li> <li>Flanges and valves</li> </ul>	C, H, P, B, R, S, T
<b>Forta DX 2304</b> A duplex product with a leaner alloying composition than Forta DX 2205. It has good resistance to localized and uniform corrosion, as well as stress corrosion cracking, combined with high mechanical strength.	<ul style="list-style-type: none"> <li>Offshore topside applications</li> <li>Storage tanks</li> <li>Rebar</li> <li>Flanges and valves</li> </ul>	C, H, P, B, R, S, T

## Product forms



**C**  
Cold rolled coil and sheet



**H**  
Hot rolled coil and sheet



**P**  
Quarto plate



**B**  
Bar



**R**  
Wire rod



**S**  
Semifinished (bloom, billet, ingot & slab)



**T**  
Pipe

Outokumpu name	Typical applications	Product forms
<b>Forta EDX 2304</b> An enhanced version of Forta DX 2304 with better corrosion resistance and higher mechanical strength.	<ul style="list-style-type: none"> <li>Offshore topside structural components</li> <li>Tank applications</li> <li>Flanges and valves</li> </ul>	C, H, P, B, R, S
<b>Forta LDX 2404</b> A low-nickel, high-nitrogen duplex product with higher mechanical strength than Forta DX 2205. Offers very good resistance to localized and uniform corrosion, as well as stress corrosion cracking.	<ul style="list-style-type: none"> <li>Storage tanks</li> <li>Structural components for flood and sluice gates</li> <li>Mining industry applications such as dewatering equipment</li> <li>Flanges and valves</li> </ul>	C, H, P, B, R, S, T
<b>Forta SDX 100</b> A super duplex with higher corrosion resistance and mechanical strength than Forta DX 2205. Often used in extremely corrosive environments such as desalination, chemical, or offshore subsea applications.	<ul style="list-style-type: none"> <li>Industrial piping</li> <li>Scrubbers</li> <li>Tubes for oil and gas applications</li> <li>Deep-sea pipelines</li> <li>Flanges and valves</li> </ul>	P, B, R, S
<b>Forta SDX 2507</b> A super duplex product with higher corrosion resistance and mechanical strength than Forta DX 2205. Often used in extremely corrosive environments such as desalination, chemical, or offshore subsea applications.	<ul style="list-style-type: none"> <li>Desalination plants</li> <li>Industrial piping</li> <li>Scrubbers</li> <li>Tubes for oil and gas applications</li> <li>Deep-sea pipelines</li> <li>Flanges and valves</li> </ul>	C, H, P, B, R, S, T
<b>Forta FDX 25</b> A duplex stainless steel with improved formability and good resistance to uniform and localized corrosion, as well as stress corrosion cracking. It has high mechanical strength and excellent forming properties and is used in applications where the use of standard duplex is restricted due to its formability limitations.	<ul style="list-style-type: none"> <li>Plate heat exchangers</li> <li>Deep drawing applications for thin material such as beer kegs</li> <li>Pump components</li> <li>Flanges and valves</li> </ul>	C, H
<b>Forta FDX 27</b> A duplex product with improved formability and better corrosion resistance than Forta FDX 25. It has high strength and excellent forming properties and is used in applications where the use of standard duplex is restricted due to its formability limitations.	<ul style="list-style-type: none"> <li>Plate heat exchangers</li> <li>Deep drawing applications for corrosive environments</li> <li>Pump components</li> <li>Flanges and valves</li> </ul>	C, H

## H-series products

Outokumpu name	Typical applications	Product forms
<b>Forta H400</b> Forta H400 has higher strength than standard Core 304/4301 and a lower nickel content, making it a cost-effective and lightweight austenitic product for the automotive industry. It has been used in automotive applications for over 10 years.	<ul style="list-style-type: none"> <li>• Cross members</li> <li>• Strut domes</li> <li>• Bumpers</li> </ul>	C, H
<b>Forta H500</b> Forta H500 has a higher yield strength than Forta H400, making it a cost-effective and lightweight austenitic stainless steel for the automotive industry and other transport or construction applications.	<ul style="list-style-type: none"> <li>• Structural components for transport applications</li> <li>• Tube and profile applications</li> </ul>	C, H
<b>Forta H800 and Forta H1000</b> Forta H800 and Forta H1000 are strain hardened materials with a higher yield strength than Forta H500, which creates further possibilities for lightweighting in the automotive industry and other transport or construction applications.	<ul style="list-style-type: none"> <li>• Structural components for transport applications</li> <li>• Tube and profile applications</li> </ul>	C, H

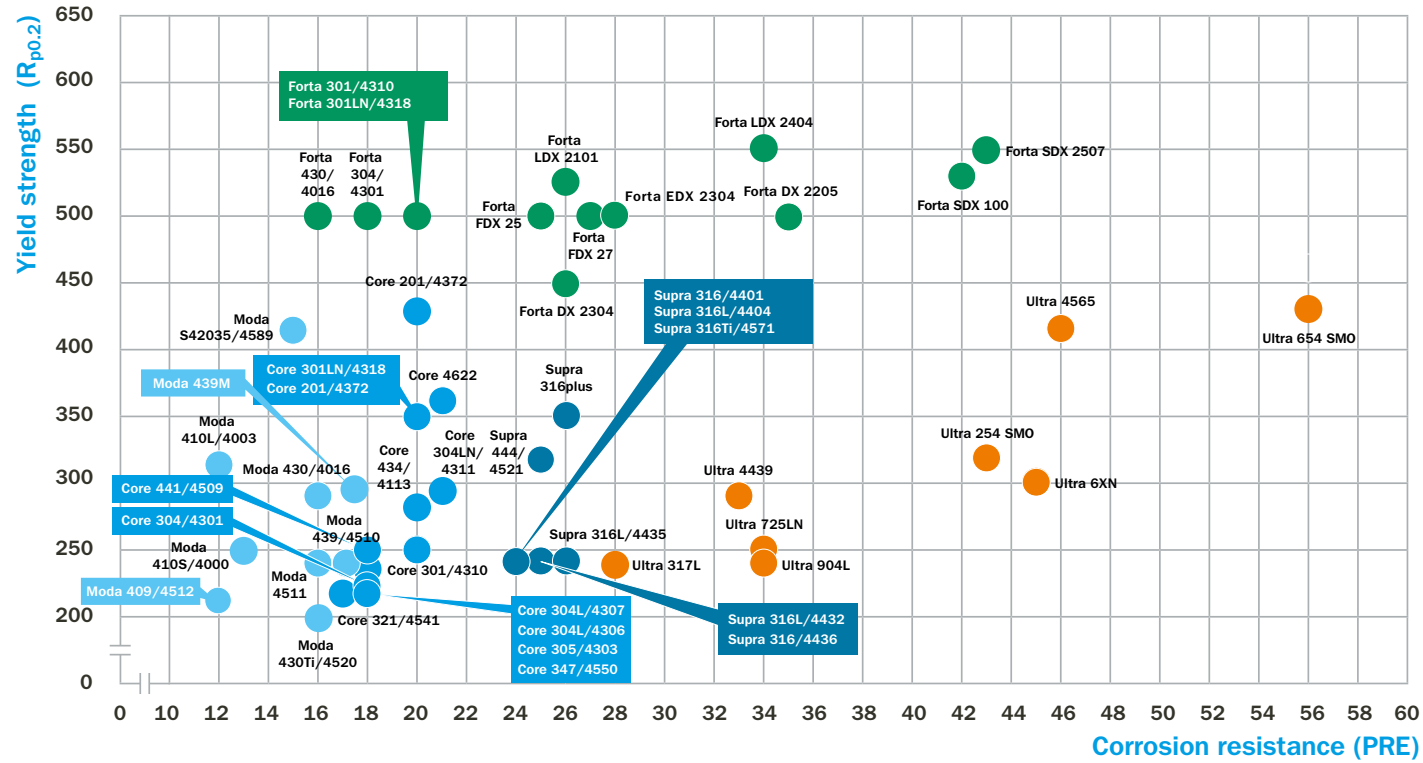
## Temper rolled products

Outokumpu name	Typical applications	Product forms
<b>Forta 430/4016</b> A classic 16% chromium ferritic stainless steel for mildly corrosive environments. Not recommended for welding due to its decreased intergranular corrosion resistance.	<ul style="list-style-type: none"> <li>• Tanks</li> <li>• Cutlery</li> <li>• Household appliances</li> </ul>	C
<b>Forta 301LN/4318</b> A low-carbon, nitrogen-alloyed alternative to Forta 301/4310 with elevated strength, making it particularly suitable for lightweight construction applications.	<ul style="list-style-type: none"> <li>• Vehicle chassis</li> </ul>	C
<b>Forta 301/4310</b> A lower chromium and nickel variant of Core 304/4301 with high work hardening capacity. Used for items subject to high mechanical loading.	<ul style="list-style-type: none"> <li>• Springs</li> <li>• Press plates</li> <li>• Conveyor chains</li> <li>• Mixer blades</li> <li>• Automotive cylinders and head gaskets</li> </ul>	C

Outokumpu name	Typical applications	Product forms
<b>Forta 304/4301</b> A classic 18% chromium, 8% nickel austenitic stainless steel. Forta 304/4301 is an all-purpose product with good resistance to atmospheric corrosion and to many organic and inorganic chemicals.	<ul style="list-style-type: none"> <li>• Vehicle chassis</li> <li>• Containers</li> <li>• Constructions</li> </ul>	C
<b>Forta 304L/4307</b> A low-carbon alternative to Core 304/4301. Forta 304L/4307 is an all-purpose product with good resistance to atmospheric and intergranular corrosion.	<ul style="list-style-type: none"> <li>• Steel constructions</li> <li>• Containers</li> <li>• Vehicle chassis</li> </ul>	C
<b>Forta 316/4401</b> A normal-carbon, molybdenum-alloyed stainless steel that is widely used for various applications with higher than average corrosion resistance requirements. Forta 316/4401 is strengthened with temper rolling for applications that require specific strength.	<ul style="list-style-type: none"> <li>• Chemical tanks</li> </ul>	C
<b>Forta 316L/4404</b> A low-carbon, molybdenum-alloyed alternative to Supra 316/4401 that is widely used for various applications with higher than average corrosion resistance requirements. Forta 316L/4404 is strengthened with temper rolling for applications that require specific strength as well as improved weldability and intergranular corrosion resistance.	<ul style="list-style-type: none"> <li>• Chemical tanks and tubing</li> <li>• Pulp and paper process equipment</li> </ul>	C
<b>Forta 316plus</b> A temper rolled alternative to Supra 316plus for applications that require excellent corrosion resistance, improved strength, and weight savings.	<ul style="list-style-type: none"> <li>• Heat exchangers</li> <li>• Tanks</li> </ul>	C
<b>Forta 316Ti/4571</b> A titanium-stabilized, molybdenum-alloyed austenitic steel for highly corrosive environments, including applications in elevated temperatures.	<ul style="list-style-type: none"> <li>• Chimney constructions</li> <li>• Flue gas applications</li> </ul>	C

# Product performance comparison

## Strength vs. corrosion resistance



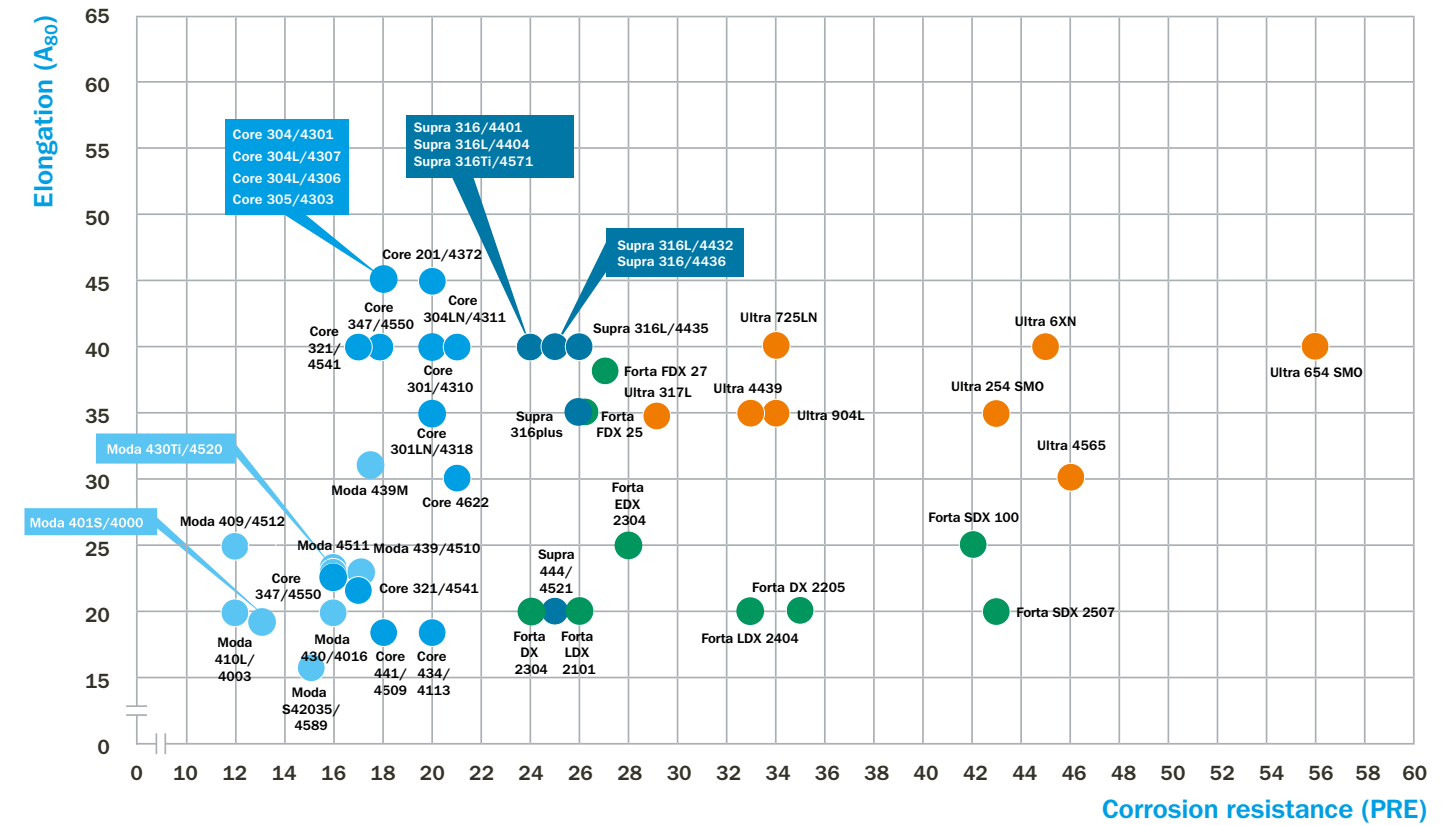
- Moda – Mildly corrosive environments (PRE up to 17)
- Core – Corrosive environments (PRE 17 to 22)
- Supra – Highly corrosive environments (PRE 22 to 27)
- Forta – Duplex and other high strength (PRE 18 to 43)
- Ultra – Extremely corrosive environments (PRE > 27)

PRE calculation =  $\%Cr + 3.3 \times \%Mo + 16 \times \%N$

Note: PRE values shown are Outokumpu typical values. Yield strength ( $R_{p0.2}$ ) according to EN 10088-2 minimum values for cold rolled strip. Yield strength for temper rolled products ranges from 500-2000 MPa. Yield strength according to strength classes in EN 10088-2 do not have an influence on corrosion resistance.

For more values by product, please see [steelfinder.outokumpu.com](http://steelfinder.outokumpu.com)

## Elongation vs. corrosion resistance



- Moda – Mildly corrosive environments (PRE up to 17)
- Core – Corrosive environments (PRE 17 to 22)
- Supra – Highly corrosive environments (PRE 22 to 27)
- Forta – Duplex and other high strength (PRE 18 to 43)
- Ultra – Extremely corrosive environments (PRE > 27)

PRE calculation =  $\%Cr + 3.3 \times \%Mo + 16 \times \%N$

Note: PRE values shown are Outokumpu typical values. Elongation ( $A_{80}$ ) according to EN 10088-2 minimum values for cold rolled strip.

For more values by product, please see [steelfinder.outokumpu.com](http://steelfinder.outokumpu.com)



Learn more at [outokumpu.com/forta](http://outokumpu.com/forta)



# Product properties

## Forta range

Duplex and other high strength  
(yield strength  $R_{p0.2} > 400$  MPa. PRE 18 to 43)

Steel designations				Performance				Typical chemical composition, % by mass					
Outokumpu name	EN	ASTM		PRE	$A_{80}$ %	$R_{p0.2}$ MPa	Grade family	C	Cr	Ni	Mo	N	Others
		Type	UNS										
<b>Duplex, high strength, high corrosion resistance and enhanced resistance to stress corrosion cracking</b>													
Forta DX 2205	1.4462	–	S32205	35	20	500	D	0.02	22.4	5.7	3.1	0.17	–
Forta LDX 2101	1.4162	–	S32101	26	20	530	D	0.03	21.5	1.5	0.3	0.22	5Mn Cu
Forta DX 2304	1.4362	–	S32304	26	20	450	D	0.02	23.0	4.8	0.3	0.1	Cu
Forta EDX 2304	1.4362	–	S32304	28	25 <sup>1)</sup>	500 <sup>1)</sup>	D	0.02	23.8	4.3	0.5	0.18	Cu
Forta LDX 2404	1.4662	–	S82441	34	20	550	D	0.02	24.0	3.6	1.6	0.27	3Mn Cu
Forta SDX 100	1.4501	–	S32760	42	25 <sup>2)</sup>	530 <sup>2)</sup>	D	0.02	25.4	6.9	3.8	0.27	W Cu
Forta SDX 2507	1.4410	–	S32750	43	20	550	D	0.02	25.0	7.0	4.0	0.27	–
Forta FDX 25	1.4635 <sup>3)</sup>	–	S82012	25	35 <sup>4)</sup>	500 <sup>4)</sup>	D	≤0.05	19.0–20.5	0.8–1.5	0.1–0.6	0.16–0.26	2–4Mn
Forta FDX 27	1.4637 <sup>3)</sup>	–	S82031	27	35 <sup>4)</sup>	500 <sup>4)</sup>	D	≤0.04	19.0–22.0	2.0–4.0	0.6–1.4	0.14–0.24	≤2.5Mn
<b>High strength and high ductility</b>													
Forta H400	1.4376	–	–	–	40	400 <sup>5)</sup>	A	0.035	17.5	4.0	–	0.20	6.8Mn
Forta H500	–	–	–	–	50	500	A	–	–	–	–	–	–
Forta H800	–	–	–	–	30	800	A	–	–	–	–	–	–
Forta H1000	–	–	–	–	13	1000	A	–	–	–	–	–	–
<b>High strength and high hardness (temper rolled)</b>													
Forta 430/4016	1.4016	430	S43000	16	–	500–700	F	0.05	16.2	–	–	–	–
Forta 301LN/4318	1.4318	301LN	S30153	20	–	500–900	A	0.02	17.7	6.5	–	0.14	–
Forta 301/4310	1.4310	301	S30100	20	–	500–2000	A	0.1	17	7	–	–	–
Forta 304/4301	1.4301	304	S30400	18	–	500–900	A	0.04	18.1	8.1	–	–	–
Forta 304L/4307	1.4307	304L	S30403	18	–	500–900	A	0.02	18.1	8.1	–	–	–
Forta 316/4401	1.4401	316	S31600	24	–	500–700	A	0.04	17.2	10.1	2.1	–	–
Forta 316L/4404	1.4404	316L	S31603	24	–	500–700	A	0.02	17.2	10.1	2.1	–	–
Forta 316plus	1.4420	–	S31655	25	–	500–700	A	0.02	20.3	8.6	0.7	0.19	–
Forta 316Ti/4571	1.4571	316Ti	S32100	24	–	500–700	A	0.04	16.8	10.9	2.1	–	Ti

<sup>1)</sup> Outokumpu MDS-D35 for EDX 2304 <sup>2)</sup> Min values for plate acc. to EN 10088-2. <sup>3)</sup> Designation included in Stahl-Eisen-Liste. <sup>4)</sup> Min. values acc. to ASTM A240, for coil and strip ≤ 5 mm. <sup>5)</sup> Values acc. to EN 10088-2 and Stahl-Eisen-Liste.

Note: PRE values and chemical composition figures shown are Outokumpu typical values. Yield strength ( $R_{p0.2}$ ) and elongation ( $A_{80}$ ) are based on EN 10088-2 minimum values for cold rolled strip unless marked otherwise.

For more values by product, please see [steelfinder.outokumpu.com](http://steelfinder.outokumpu.com)

## Duplex cheaper than coated carbon steel

Tank fabricator Ellimetal in the Netherlands was considering coated carbon steel for a storage tank. By switching to Forta LDX 2101, they saved 3% on initial costs. As Forta LDX 2101 does not need to be coated, the customer also saves on long-term maintenance.

### Initial cost calculation for coated carbon steel tank:

Carbon steel: 73%  
External coating: 6%  
Internal coating: 21%  
Total: 100%

### Cost of tank in Forta LDX 2101

Total: 97% of coated carbon steel cost

“ The customer saved 3% initially by using Forta LDX 2101 instead of coated carbon steel.



Looking for expert help to choose the best product for your next project?  
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## Forta H400 in the Porsche Panamera

Porsche used Forta H400 hydroformed tube to create a dashboard cowl in the Porsche Panamera. Forta H400 was selected due to its excellent crash and safety properties.

Outokumpu Forta range H-series products help automotive manufacturers to create structural parts that are both lightweight and exhibit good crash behavior, which improves safety. Forta H-series products have all the advantages of steels with an austenitic microstructure – good weldability and formability – without the cost-intensive and volatile alloying element nickel.

Forta H400 has been used in the automotive industry for over 10 years in structural parts like B pillars, cross members, channels, and bumpers. Our Forta H500, Forta H800, and Forta H1000 stainless steels build on this successful history while offering even better yield strength.



Contact our automotive technical customer support to get the support you need to successfully use our Forta H-series products in your automotive application.

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## Forta 316plus in transport containers

The Langh Group needed a wear and corrosion-resistant steel for transport containers for ships, trucks, and trains.

The properties of temper rolled Outokumpu Forta 316plus allow for thinner wall thickness – meaning a lower overall container weight – while enabling transportation of aggressive and sharp bulk materials.

Developed by Outokumpu, Forta 316plus is a unique product that provides a competitive alternative to Supra 316L/4404. Forta 316plus contains less nickel and molybdenum and has higher strength than Supra 316L/4404, even in the annealed condition, due to higher nitrogen alloying.



I was excited to find out about 316plus as it offered better material performance than 316L, but the price was lower.

Markku Yli-Kahri, Langh Group



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# Working towards forever.

We work with our customers and partners to create long lasting solutions for the tools of modern life and the world's most critical problems: clean energy, clean water, and efficient infrastructure. Because we believe in a world that lasts forever.

outokumpu classic			outokumpu pro					
<b>Moda</b> Mildly corrosive environments	<b>Core</b> Corrosive environments	<b>Supra</b> Highly corrosive environments	<b>Forta</b> Duplex & other high strength	<b>Ultra</b> Extremely corrosive environments	<b>Dura</b> High hardness	<b>Therma</b> High service temperatures	<b>Prodec</b> Improved machinability	<b>Deco</b> Special surfaces

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