Forta DX 2205

EN 1.4462, ASTM UNS S32205

General characteristics

Forta DX 2205 is the most popular duplex product on the market. It offers very good resistance to uniform and localized corrosion and stress corrosion cracking in combination with high mechanical strength.

Austenitic-ferritic stainless steels, also referred to as duplex stainless steels, combine many of the beneficial properties of ferritic and austenitic steels. Due to their high chromium and nitrogen content, and often also molybdenum, these steels offer good resistance to localized and uniform corrosion. The duplex microstructure contributes to their high strength and high resistance to stress corrosion cracking, and also improves also abrasion and erosion resistance. Duplex steels have good weldability. Outokumpu produces a whole range of duplex products, from the lean-alloyed Forta LDX 2101 up to the super duplex products Forta SDX 2507 and Forta SDX 100. All duplex grades have the maximum service temperature restricted to 250 or 325 °C according to EN10028-7 or ASME II-D 2007 respectively.

The lower nickel content of duplex grades compared to austenitic grades with similar corrosion resistance makes them more price stable. Duplex grades have approximately twice the strength of austentic grades with similar corrosion resistance, thus thinner gauges can be used in many applications.

Typical applications

- Tanks in chemical tankers
- Pulp and paper industry applications such as digesters and process tanks
- Oil and gas industry applications such as flanges, valves, tubes, and pipes
- Structural components in bridges

Products & dimensions

Cold rolled products, available dimensions (mm)

Surface finish		Coil / Strip		Plate / Sheet	
		Thickness	Width	Thickness	Width
2B	Cold rolled, heat treated, pickled, skin passed	0.50-3.00	30-1280	0.50-3.00	35-1280
2BB	Bright-pickled	0.60-3.50	30-1250	0.60-3.50	600-1250

2C	Cold rolled, heat treated	0.60-5.00	30-1250		
2D	Cold rolled, heat treated, pickled	0.60-5.00	30-1280	0.60-5.00	35-1280
2E	Cold rolled, heat treated, mech. desc. pickled	0.50-5.00	30-2050	0.50-5.00	300-2050
2G	Ground	0.60-3.00	30-1250	0.60-3.00	600-1250
2J	Brushed or dull polished	0.60-3.00	30-1250	0.60-3.00	600-1250
2M	Patterned	0.40-2.50	36-1450		
2R	Cold rolled, bright annealed	0.05-3.00	3-1250	0.50-3.00	350-1250

Continous hot rolled products, available dimensions (mm)

Surface finish		Coil / Strip		Plate / Sheet	
		Thickness	Width	Thickness	Width
1C	Hot rolled, heat treated, not descaled	4.00-8.50	750-1350		
1D	Hot rolled, heat treated, pickled	3.40-10.00	50-2040	3.50-9.13	300-2040
1U	Black hot rolled	4.00-8.50	750-1350		

Quarto plate products, available dimensions (mm)

Surface finish		Coil / Strip		Plate / Sheet	
		Thickness	Width	Thickness	Width
1D	Hot rolled, heat treated, pickled			5.00-100.00	400-3260
1G	Ground			10.00-34.99	400-3260

Chemical composition

Forta DX 2205 is available as S31803 and S32205 according to the UNS designation system. S32205 has higher minimum values for the main alloying elements.

The typical chemical composition for this grade is given in the table below, together with composition limits given for the product according to different standards. The required standard will be fully met as specified on the order.

The chemical composition is given as % by mass.

	C	Mn	Cr	Ni	Mo	N	Other
Typical	**0.02**		**22.4**	**5.7**	**3.1**	**0.17**	
ASME II A SA-240	≤0.030	≤2.00	21.0-23.0	4.50-6.50	2.50-3.50	0.08-0.20	
ASME II A SA-240	≤0.030	≤2.00	22.0-23.0	4.50-6.50	3.00-3.50	0.14-0.20	
ASTM A240	≤0.030	≤2.00	21.0-23.0	4.5-6.5	2.5-3.5	0.08-0.20	
ASTM A240	≤0.030	≤2.00	22.0-23.0	4.5-6.5	3.0-3.5	0.14-0.20	
EN 10028-7	≤0.030	≤2.00	21.0-23.0	4.5-6.5	2.5-3.5	0.10-0.22	
EN 10088-2	≤0.030	≤2.00	21.0-23.0	4.5-6.5	2.5-3.5	0.10-0.22	
EN 10088-3	≤0.030	≤2.00	21.0-23.0	4.5-6.5	2.5-3.5	0.10-0.22	
EN 10088-4	≤0.030	≤2.00	21.0-23.0	4.5-6.5	2.5-3.5	0.10-0.22	
IS 6911	≤0.030	≤2.00	21.0-23.0	4.5-6.5	2.5-3.5	0.08-0.20	
IS 6911	≤0.030	≤2.00	22.0-23.0	4.5-6.5	3.0-3.5	0.14-0.20	

Corrosion resistance

Uniform corrosion

Uniform corrosion occurs when all, or at least a large section, of the passive layer is destroyed. This typically occurs in acids or in hot alkaline solutions. The influence of the alloy composition on the resistance to uniform corrosion may vary significantly between different environments. For guidance on material selection in a large number of environments capable of causing uniform corrosion, consult the tables and isocorrosion diagrams in the Outokumpu Corrosion Handbook.

Pitting and crevice corrosion

Chloride ions in a neutral or acidic environment facilitate local breakdown of the passive layer. As a result, pitting and crevice corrosion can propagate at a high rate, causing corrosion failure in a short time. Since the attack is small and may be covered by corrosion products or hidden in a crevice, it often remains undiscovered until perforation or leakage occurs. Resistance to pitting corrosion is determined mainly by the content of chromium, molybdenum, and nitrogen in the stainless steel. This is often illustrated using the pitting resistance equivalent (PRE). The PRE value can be used for rough comparisons of different materials. A more reliable means, however, is to rank the steel according to the critical pitting temperature (CPT) of the material. There are several different methods available, for example ASTM G 150. The CPT values are shown in the table below. Higher contents of chromium, molybdenum, and nitrogen also enhance the crevice corrosion resistance of the stainless steel. Typical values of the critical crevice corrosion temperature (CCT) according to ASTM G48 Method F are included in the table below. The CPT and CCT values vary with product form and surface finish. The values given are for ground surfaces. Both ASTM G150 and ASTM G48 are methods for ranking the relative pitting or crevice corrosion resistance of the different stainless steels, but they do not give the maximum temperature for using these alloys in real service environments.

For more information on corrosion resistance, please refer to the Outokumpu Corrosion Handbook or contact our corrosion experts.

Pitting corrosion resistance		Crevice corrosion resistance
PRE	CPT	CCT
35	52±3	20

Pitting Resistance Equivalent (PRE) is calculated using the following formula: PRE = %Cr + 3.3 x %Mo + 16 x %N
Corrosion Pitting Temperature (CPT) as measured in the Avesta Cell (ASTM G 150), in a 1M NaCl solution (35,000 ppm or mg/l chloride ions).
Critical Crevice Corrosion Temperature (CCT) is obtained by laboratory tests according to ASTM G 48 Method F

Mechanical properties

Mechanical properties at room temperature are shown in the table below.

Cold rolled coil and sheet	$R_{p0.2}$ MPa	$R_{p1.0}$ MPa	R_m MPa	Elongation[1] %	Impact strength J	Rockwell	HB	HV
Typical (thickness 1 mm)	**690**	**740**	**880**	**47**				
ASME II A SA-240	≥ 450		≥ 620				≤ 293	
ASME II A SA-240	≥ 450		≥ 655				≤ 293	
ASTM A240	≥ 450		≥ 620				≤ 293	
ASTM A240	≥ 450		≥ 655			≤ 31HRC	≤ 293	
EN 10028-7	≥ 500		700 - 950	≥ 20				
EN 10088-2	≥ 500		700 - 950	≥ 20				
EN 10088-4	≥ 500		700 - 950	≥ 20				
IS 6911	≥ 450		≥ 620			≤ 31HRC	≤ 293	
IS 6911	≥ 450		≥ 655			≤ 32HRC	≤ 293	

Hot rolled coil and sheet	$R_{p0.2}$ MPa	$R_{p1.0}$ MPa	R_m MPa	Elongation[1] %	Impact strength J	Rockwell	HB	HV
Typical (thickness 4 mm)	**630**	**725**	**840**	**30**			**250**	
ASME II A SA-240	≥ 450		≥ 620				≤ 293	
ASME II A SA-240	≥ 450		≥ 655				≤ 293	
ASTM A240	≥ 450		≥ 620				≤ 293	
ASTM A240	≥ 450		≥ 655				≤ 293	
EN 10028-7	≥ 460		700 - 950	≥ 25				

EN 10088-2	≥ 480		700 - 950	≥ 25				
EN 10088-4	≥ 480		700 - 950	≥ 25				
IS 6911	≥ 450		≥ 620			≤ 31HRC	≤ 293	
IS 6911	≥ 450		≥ 655			≤ 32HRC	≤ 293	

Hot rolled quarto plate	$R_{p0.2}$ MPa	$R_{p1.0}$ MPa	R_m MPa	Elongation[1)] %	Impact strength J	Rockwell	HB	HV
Typical (thickness 15 mm)	**510**		**750**	**35**			**230**	
ASME II A SA-240	≥ 450		≥ 620			≤ 31HRC	≤ 293	
ASME II A SA-240	≥ 450		≥ 655			≤ 31HRC	≤ 293	
ASTM A240	≥ 450		≥ 620			≤ 31HRC	≤ 293	
ASTM A240	≥ 450		≥ 655			≤ 31HRC	≤ 293	
EN 10028-7	≥ 460		640 - 840	≥ 25				
EN 10088-2	≥ 460		640 - 840	≥ 25				
EN 10088-4	≥ 460		640 - 840	≥ 25				
IS 6911	≥ 450		≥ 620			≤ 31HRC	≤ 293	
IS 6911	≥ 450		≥ 655			≤ 32HRC	≤ 293	

Wire rod	$R_{p0.2}$ MPa	$R_{p1.0}$ MPa	R_m MPa	Elongation[1)] %	Impact strength J	Rockwell	HB	HV
Typical	**510**		**750**	**35**				

[1)]Elongation according to EN standard:
A_{80} for thickness < 3 mm.
A for thickness ≥ 3 mm.
Elongation according to ASTM standard A_{2},, or A_{50}.

Physical properties

The physical properties at room temperature are shown in the table below. Data according to EN10088 or EN10095.

Density kg/dm^3	Modulus of elasticity GPa	Thermal exp. at 100 °C $10^{-6}/°C$	Thermal conductivity W/m°C	Thermal capacity J/kg°C	Electrical resistance µΩm	Magnetizable
7.8	200	13	15	500	0.8	Yes

Fabrication

Duplex stainless steel is suitable for all forming processes applicable to stainless steel. The high proof strength compared to austenitic and ferritic stainless steel can impose some differences in forming behavior depending on the chosen forming technique, such as an increased tendency to springback. This point is particularly relevant to the forming of any high-strength steel. If the forming process is not already decided, it is possible to choose the most suitable one for duplex grades. Moreover, an excellent interplay between high proof strength, work hardening rate, and elongation mean that the duplex grades are particularly well suited to lightweight and cost-efficient applications with complex shapes. The impact of the high strength varies for different forming techniques. Common to all is that the estimated forming forces will be higher than for the corresponding austenitic and ferritic stainless steel grades. This effect will usually be lower than expected from just the increase in strength since the choice of duplex stainless steel is often associated with down gauging. It is important to consider that duplex stainless steel may also place higher demands on the tool materials and the lubricanta. Downgauging should also be considered in this case.

Welding

The best results can be obtained with the use of designed fillers. Forta DX 2205 can be welded with high-productivity methods (kg/h). For heavy gauge thickness, heat input up to 3 kJ/mm can often be used without impairing weld properties. Duplex steels generally have good weldability and can be welded using most of the common methods used for austenitic stainless steel:

- Shielded metal arc welding (SMAW)
- Gas tungsten arc welding TIG(GTAW)
- Gas metal arc welding MIG (GMAW)
- Flux-cored arc welding (FCW)
- Plasma arc welding (PAW)
- Submerged arc welding (SAW)
- Laser welding
- Resistance welding
- High frequence welding

More detailed information concerning welding procedures can be obtained from the Outokumpu Welding Handbook, available from our sales offices.

Standards & approvals

Forta DX 2205 corresponds in American standards to two different steel designations: UNS S31803 and UNS S32205. The latter has closer tolerance limits for some alloying elements to further optimize properties such as corrosion resistance and strength – the properties described in this datasheet correspond to UNS S32205.

Outokumpu produces and certifies materials to most international and national standards. Work is continuously ongoing to have the different grades approved for relevant standards.

Standard	Designation
ASME SA-240M Code Sect. II. Part A	UNS S32205; UNS S32205
ASTM A240/A240M	UNS S32205; UNS S32205
EN 10028-7, PED 2014/68/EU	1.4462
EN 10088-2	1.4462
EN 10088-3	1.4462
EN 10088-4	1.4462
IS 6911, AMENDMENT NO. 2	ISS 1803; ISS 2205

Contacts & Enquiries

Contact your nearest sales office

www.outokumpu.com/contacts

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.

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high performance stainless steel

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