

## Steel grades

| Outokumpu | EN     | ASTM          |
|-----------|--------|---------------|
| LDX 2101® | 1.4162 | S32101        |
| 2304      | 1.4362 | S32304        |
| 2205      | 1.4462 | S32205/S31803 |
| SAF 2507® | 1.4410 | S32750        |

## Characteristic properties

- Good to very good resistance to uniform corrosion
- Good to very good resistance to pitting and crevice corrosion
- High resistance to stress corrosion cracking and corrosion fatigue
- High mechanical strength
- Good abrasion and erosion resistance
- Good fatigue resistance
- High energy absorption
- Low thermal expansion
- Good weldability

## Applications

- Pulp and paper industry
- Desalination plants
- Flue-gas cleaning
- Cargo tanks and pipe systems in chemical tankers
- Seawater systems
- Firewalls and blast walls on offshore platforms
- Bridges
- Components for structural design
- Storage tanks
- Pressure vessels
- Heat exchangers
- Water heaters
- Rotors, impellers and shafts

## General characteristics

Austenitic-ferritic stainless steel also referred to as duplex stainless steels, combine many of the beneficial properties of ferritic and austenitic steels. Due to the high content of chromium and nitrogen, and often also molybdenum, these steels offer good resistance to localised and uniform corrosion. The duplex microstructure contributes to the high strength and high resistance to stress corrosion cracking. Duplex steels have good weldability.

Outokumpu produces a whole range of duplex grades from the lean alloyed LDX 2101® up to the super duplex grades SAF 2507® and 1.4501®. This publication presents the properties of LDX 2101®, 2304, 2205 and SAF 2507®. The properties of 1.4501 is in general terms very similar to those of SAF 2507®. 1.4501 is delivered if specified.

## Chemical composition

The typical chemical compositions of Outokumpu grades are shown in table 1. The chemical composition of a specific steel grade may vary slightly between different national standards. The required standard will be fully met as specified on the order.

## Chemical composition

Table 1

|            | Outokumpu steel name | International steel No |         | Chemical composition, %<br>Typical values |      |    |     |     |        | National steel designations,<br>superseded by EN |        |                 |      |
|------------|----------------------|------------------------|---------|---|------|----|-----|-----|--------|--|--------|-----------------|------|
|            |                      | EN                     | ASTM    | C   | N    | Cr | Ni  | Mo  | Others | BS   | DIN    | NF              | SS   |
| Duplex     | LDX 2101®            | 1.4162                 | S32101  | 0.03                                      | 0.22 | 21 | 1.5 | 0.3 | 5Mn    | –  | –      | –               | –    |
|            | 2304                 | 1.4362                 | S32304  | 0.02                                      | 0.10 | 23 | 4.8 | 0.3 | –      | –  | 1.4362 | Z3 CN 23-04 Az  | 2327 |
|            | 2205                 | 1.4462                 | S32205* | 0.02                                      | 0.17 | 22 | 5.7 | 3.1 | –      | 318S13   | 1.4462 | Z3 CND 22-05 Az | 2377 |
|            | 4501                 | 1.4501                 | S32760  | 0.02                                      | 0.25 | 25 | 7.0 | 3.8 | W,Cu   | –  | –      | –               | –    |
|            | SAF 2507®            | 1.4410                 | S32750  | 0.02                                      | 0.27 | 25 | 7.0 | 4.0 | –      | –  | –      | Z3 CND 25-06 Az | 2328 |
| Austenitic | 4307                 | 1.4307                 | 304L    | 0.02                                      | –    | 18 | 8.3 | –   | –      | 304S11   | 1.4307 | Z3 CN 18-10     | 2353 |
|            | 4404                 | 1.4404                 | 316L    | 0.02                                      | –    | 17 | 11  | 2.1 | –      | 316S11   | 1.4404 | Z3 CND 17-11-02 | 2348 |
|            | 904L                 | 1.4539                 | N08904  | 0.01                                      | –    | 20 | 25  | 4.3 | 1.5Cu  | 904S13   | 1.4539 | Z2 NCDU 25-20   | 2562 |
|            | 254 SMO®             | 1.4547                 | S31254  | 0.01                                      | 0.20 | 20 | 18  | 6.1 | Cu     | –  | –      | –               | 2378 |

\* Also available as S31803

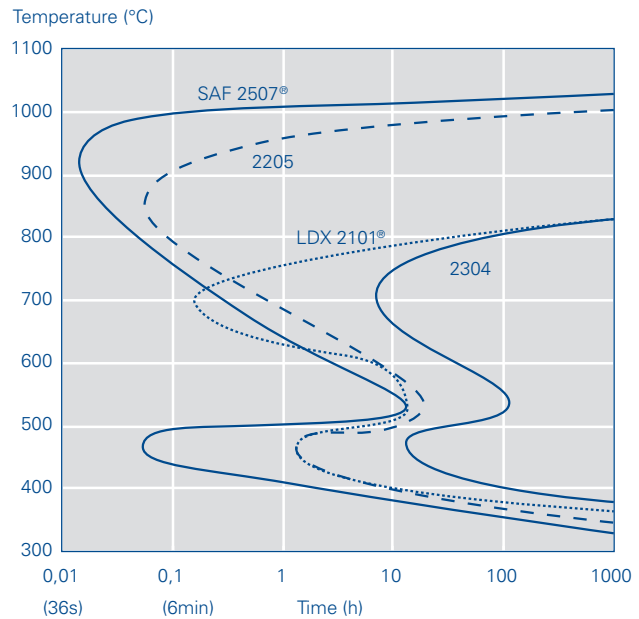
### Microstructure

The chemical composition of duplex steels is balanced to give approximately equal amounts of ferrite and austenite in solution-annealed condition. The higher the annealing temperature the higher the ferrite content.

Duplex steels are more prone than austenitic steels to precipitation of phases causing embrittlement and reduced corrosion resistance. The formation of intermetallic phases such as sigma phase occurs in the temperature range 600-950°C and reformation of ferrite occurs in the range 350-525°C (475°C embrittlement).

Exposures at these temperatures should therefore be avoided. In normal welding and heat-treatment operations the risk of embrittlement is low. However, certain risks exist, for example at heat treatment of thick sections, especially if the cooling is slow.

Figure 1 illustrates the relation between time and temperature that leads to a reduction of the impact toughness with 50%.



**Fig. 1.** Curves for reduction of impact toughness to 50% compared to solution annealed condition.

### Mechanical properties

Tables 2-4 show the mechanical properties for flat rolled products. Data according to EN 10088 and EN 10028 when applicable. LDX 2101® is not yet listed in EN 10088, data corresponds to ASTM A240 and to an internal standard, AM 611. The allowable design values may vary between product forms. The appropriate values are given in the relevant specifications.

#### Mechanical properties at 20°C

Table 2

|                   | Minimum values, according to EN 10088 |     |     | Typical values |         |         |     |     |
|-------------------|---------------------------------------|-----|-----|----------------|---------|---------|-----|-----|
|                   | P                                     | H   | C   | P (15mm)       | H (4mm) | C (1mm) |     |     |
| <b>LDX 2101®*</b> |                                       |     |     |                |         |         |     |     |
| Proof strength    | $R_{p0.2}$                            | MPa | 450 | 480            | 530     | 480     | 570 | 600 |
| Tensile strength  | $R_m$                                 | MPa | 650 | 680            | 700     | 700     | 770 | 800 |
| Elongation        | $A_5$                                 | %   | 30  | 30             | 30      | 38      | 38  | 35  |
| Hardness          | HB                                    |     |     |                |         | 225     | 230 | 230 |
| <b>2304</b>       |                                       |     |     |                |         |         |     |     |
| Proof strength    | $R_{p0.2}$                            | MPa | 400 | 400            | 450     | 450     | 520 | 545 |
| Tensile strength  | $R_m$                                 | MPa | 630 | 650            | 650     | 670     | 685 | 745 |
| Elongation        | $A_5$                                 | %   | 25  | 20             | 20      | 40      | 35  | 35  |
| Hardness          | HB                                    |     |     |                |         | 210     | 220 | 225 |
| <b>2205</b>       |                                       |     |     |                |         |         |     |     |
| Proof strength    | $R_{p0.2}$                            | MPa | 460 | 460            | 500     | 510     | 620 | 635 |
| Tensile strength  | $R_m$                                 | MPa | 640 | 700            | 700     | 750     | 820 | 835 |
| Elongation        | $A_5$                                 | %   | 25  | 25             | 20      | 35      | 35  | 35  |
| Hardness          | HB                                    |     |     |                |         | 250     | 250 | 250 |
| <b>SAF 2507®</b>  |                                       |     |     |                |         |         |     |     |
| Proof strength    | $R_{p0.2}$                            | MPa | 530 | 530            | 550     | 550     | 590 | 665 |
| Tensile strength  | $R_m$                                 | MPa | 730 | 750            | 750     | 820     | 900 | 895 |
| Elongation        | $A_5$                                 | %   | 20  | 20             | 20      | 35      | 30  | 33  |
| Hardness          | HB                                    |     |     |                |         | 250     | 265 | 255 |

P = hot rolled plate. H = hot rolled strip. C = cold rolled coil and strip.

\* Mechanical properties according to ASTM A240 and to internal standard, AM 611.

**Impact toughness.**

**Minimum values according to EN 10028, transverse direction, J** Table 3

|       | <b>LDX 2101®*</b> | <b>2304</b> | <b>2205</b> | <b>SAF 2507®</b> |
|-------|-------------------|-------------|-------------|------------------|
| 20°C  | 60                | 60          | 60          | 60               |
| -40°C | 27                | 40          | 40          | 40               |

\* Values from internal standard, AM 611

**Tensile properties at elevated temperatures.**

**Minimum values according to EN 10028, MPa**

Table 4

|       | <b>LDX 2101®*</b>       |                      | <b>2304</b>             |                      | <b>2205</b>             |                      | <b>SAF 2507®</b>        |                      |
|-------|-------------------------|----------------------|-------------------------|----------------------|-------------------------|----------------------|-------------------------|----------------------|
|       | <b>R<sub>p0.2</sub></b> | <b>R<sub>m</sub></b> | <b>R<sub>p0.2</sub></b> | <b>R<sub>m</sub></b> | <b>R<sub>p0.2</sub></b> | <b>R<sub>m</sub></b> | <b>R<sub>p0.2</sub></b> | <b>R<sub>m</sub></b> |
| 100°C | 380                     | 590                  | 330                     | 540                  | 360                     | 590                  | 450                     | 680                  |
| 150°C | 350                     | 560                  | 300                     | 520                  | 335                     | 570                  | 420                     | 660                  |
| 200°C | 330                     | 540                  | 280                     | 500                  | 315                     | 550                  | 400                     | 640                  |
| 250°C | 320                     | 540                  | 265                     | 490                  | 300                     | 540                  | 380                     | 630                  |

\* Values for hot rolled and cold rolled strip according to AM 611

**Fatigue**

The high tensile strength of duplex steels also implies high fatigue strength. Table 5 shows the result of pulsating tensile fatigue tests ( $R = \sigma_{min}/\sigma_{max} = 0.1$ ) in air at room temperature. The fatigue strength has been evaluated at 2 million

cycles and a 50% probability of rupture. The test was made using round polished bars. As shown by the table the fatigue strength of the duplex steels corresponds approximately to the proof strength of the material.

**Fatigue, pulsating tensile test, MPa**

Table 5

|                   | <b>LDX 2101®</b> | <b>2304</b> | <b>2205</b> | <b>SAF 2507®</b> | <b>4404</b> |
|-------------------|------------------|-------------|-------------|------------------|-------------|
| R <sub>p0.2</sub> | 478              | 446         | 497         | 565              | 280         |
| R <sub>m</sub>    | 696              | 689         | 767         | 802              | 578         |
| Fatigue strength  | 500              | 450         | 510         | 550              | 360         |

**Physical properties**

Physical data according to EN 10088 apply for all our duplex steels, see Table 6.

**Typical values**

Table 6

|                                |                       | <b>20°C</b> | <b>100°C</b> | <b>200°C</b> | <b>300°C</b> |
|--------------------------------|-----------------------|-------------|--------------|--------------|--------------|
| Density                        | g/cm <sup>3</sup>     | 7.8         |              |              |              |
| Modulus of elasticity          | GPa                   | 200         | 194          | 186          | 180          |
| Poissons ratio                 |                       | 0.3         |              |              |              |
| Linear expansion at (RT → T)°C | X10 <sup>-6</sup> /°C | –           | 13.0         | 13.5         | 14.0         |
| Thermal conductivity           | W/m°C                 | 15          | 16           | 17           | 18           |
| Thermal capacity               | J/kg°C                | 500         | 530          | 560          | 590          |
| Electric resistivity           | μΩm                   | 0.80        | 0.85         | 0.90         | 1.00         |

RT = Room temperature

**Corrosion resistance**

The duplex steels provide a wide range of corrosion resistance in various environments. For a more detailed description of their resistance, see our Corrosion Handbook. A brief description follows below regarding their resistance in different types of environments.

**Uniform corrosion**

Uniform corrosion is characterised by a uniform attack on the steel surface that has come into contact with a corrosive medium. The corrosion resistance is generally considered good if the corrosion rate is less than 0.1 mm/year. Due to their high chromium content, duplex steels offer excellent corrosion resistance in many media. LDX 2101<sup>®</sup> has, in most cases, a better resistance than 4307 and in some cases as good as 4404. 2304 is in most cases equivalent to 4404, while the other more highly-alloyed duplex steels show even better resistance.

**Sulphuric acid**

The isocorrosion diagram in sulphuric acid is shown in Figure 2. In sulphuric acid contaminated by chloride ions, 2205<sup>®</sup> shows much better resistance than 4404 and a similar resistance to that of 904L, Figure 3.

**Hydrochloric acid**

Stainless steel grades such as 4307 and 4404 have very limited use in hydrochloric acid because of the risk of uniform and localised corrosion. High-alloyed steels such as SAF 2507 and to some extent also 2205 can be used in dilute hydrochloric acid, Figure 4. Pitting is normally not a problem in the area below the boundary line in the isocorrosion diagram but crevices should be avoided.

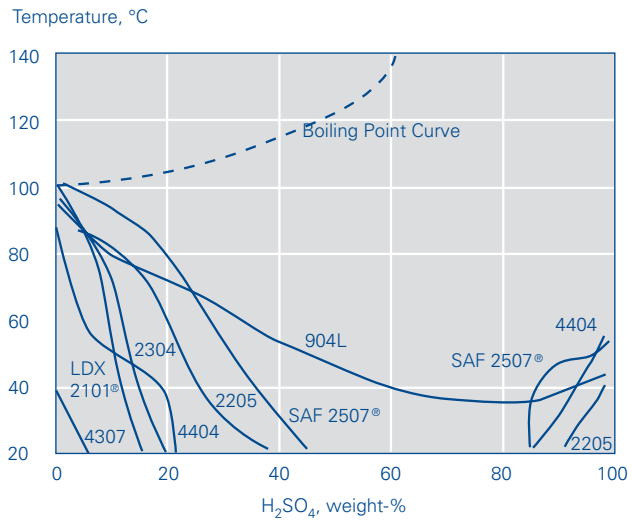
**Nitric Acid**

In strongly oxidising acids, e.g. nitric acid, non-molybdenum alloyed steels are often more resistant than the molybdenum alloyed steels. LDX 2101<sup>®</sup> and 2304 are good alternatives because of their high chromium content in combination with a low molybdenum content.

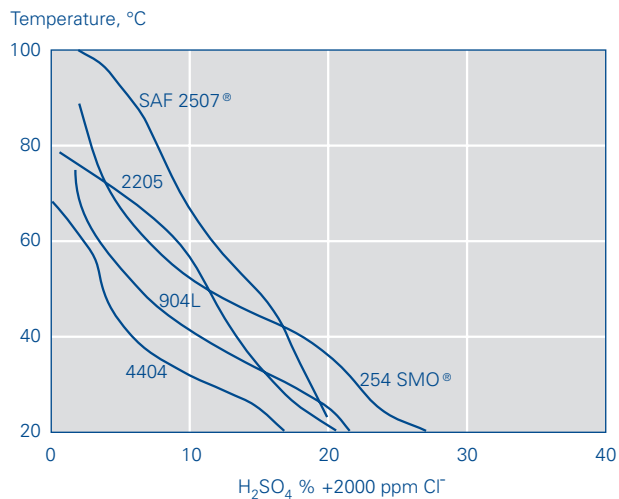
**Pitting and crevice corrosion**

The resistance to pitting and crevice corrosion increases with the content of chromium, molybdenum and nitrogen in the steel. This is often illustrated by the pitting resistance equivalent (PRE) for the material, which can be calculated by using the formula:  $PRE = \%Cr + 3,3x\%Mo + 16x\%N$ . PRE values given for different grades are presented in table 7. Due to their different alloying levels, the four duplex steels show considerable differences in this respect. LDX 2101<sup>®</sup> has a resistance approaching that of 4404, 2304 is on a level with conventional molybdenum-alloyed steels of the 4404 type, while 2205 is on a level with 904L and SAF 2507<sup>®</sup> with 6Mo steels.

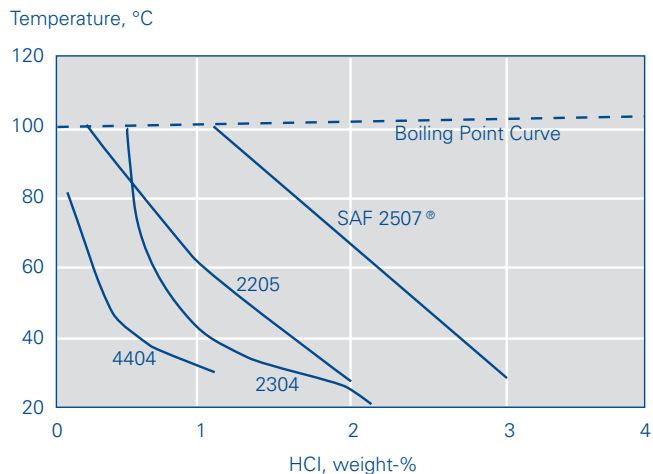
The PRE value can be used for a rough comparison between different materials. A much more reliable way of ranking steels is according to the critical pitting temperature



**Fig. 2.** Isocorrosion curves, 0.1 mm/year, in sulphuric acid.



**Fig. 3.** Isocorrosion curves, 0,1 mm/year, in sulphuric acid containing 2000 ppm chloride ions.



**Fig. 4.** Isocorrosion curves 0.1mm/year, in hydrochloric acid.

(CPT). There are several methods available to measure CPT. The electrochemical method, used by Outokumpu makes it possible to measure the resistance to pitting without interference from crevice corrosion (ASTM G 150). The results are given as the critical pitting temperature, CPT, at which pitting is initiated. The pitting corrosion resistance of the steels in a ground (P320 mesh) condition is shown in Figure 5. The actual value of the as delivered surface may differ between product forms.

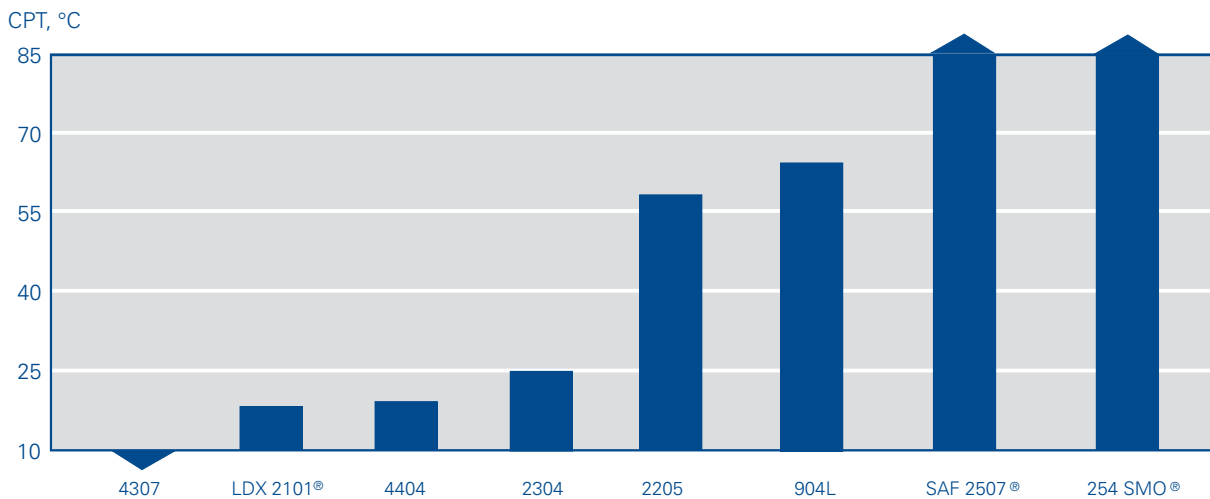
When ranking the resistance to crevice corrosion, it is common to measure a critical temperature at which corrosion is initiated in a well defined solution. The typical critical crevice corrosion temperatures (CCT) measured in 6% FeCl<sub>3</sub> + 1% HCl according to ASTM G48 Method F, is presented in figure 6. Different products and different surface finishes,

e.g. mill finish surfaces, may show CCT values that differ from the values given in the figure.

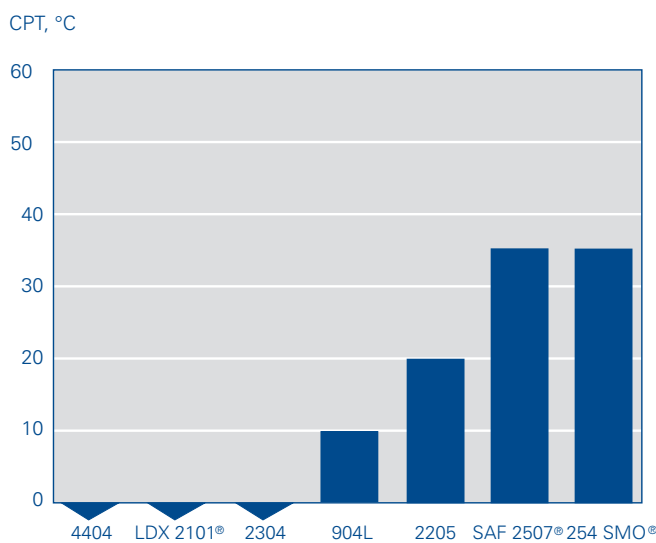
**PRE values for different austenitic and duplex grades.**

Table 7

| Steel grade | PRE |
|-------------|-----|
| 4307        | 18  |
| 4404        | 24  |
| LDX 2101®   | 26  |
| 2304        | 26  |
| 904L        | 34  |
| 2205        | 35  |
| 254 SMO®    | 43  |
| SAF 2507®   | 43  |



**Fig. 5.** Typical critical pitting corrosion temperatures (CPT) in 1M NaCl measured according to ASTM G150 using the Avesta Cell. Test surfaces wet ground to 320 mesh. CPT varies with product form and surface finish.



**Fig. 6.** Typical critical crevice corrosion temperature (CCT) according to ASTM G48 Method F. Test surfaces dry ground to 120 mesh. CCT varies with product form and surface finish

**Stress corrosion cracking**

Conventional austenitic stainless steel can be attacked by stress corrosion cracking (SCC) in chloride environments at elevated temperatures. Stainless steels of the duplex type are less susceptible to this type of corrosion.

Different methods are used to rank stainless steel grades with regard to their resistance to SCC. The results can vary depending on the method and testing environment. The resistance to stress corrosion cracking in a chloride solution under evaporative conditions can be determined according to the drop evaporation method. This means that a salt solution is allowed to slowly drip onto a heated specimen, while it is being subjected to tensile stress.

By this method the threshold value is determined for the maximum relative stress not resulting in rupture after 500 hours testing at 100°C. The threshold value is usually expressed as a percentage of the proof strength of the steel at 200°C. Figure 7 shows the results of such a test. It is evident that duplex steels are superior to conventional austenitic stainless steel, such as 4307 and 4404.

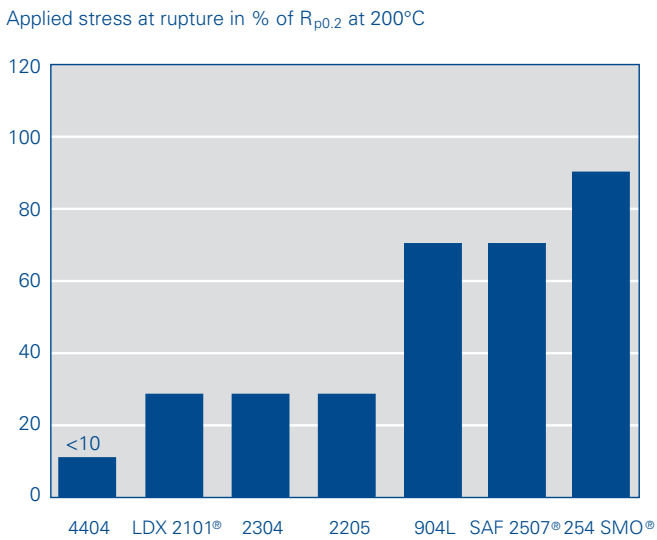


Fig. 7. Typical threshold stresses determined using the drop evaporation test.

#### Sulphide induced stress corrosion cracking

In the presence of hydrogen sulphide and chlorides the risk of stress corrosion cracking, at low temperatures, increases. Such environments can exist, for example, in boreholes for oil and gas wells. Duplex grades, such as 2205 and SAF 2507® have demonstrated good resistance, while 13% chromium steels have shown a tendency towards stress corrosion cracking. However, caution should be observed regarding conditions with high partial pressure of hydrogen sulphide and where the steel is subjected to high internal stress. 2205 and SAF 2507® are both approved materials according to NACE MR0175 “Standard Material Requirements – Metals for Sulfide Stress Cracking and Stress Corrosion Cracking Resistance in Sour Oilfield Environments”

#### Corrosion fatigue

The combination of high mechanical strength and very good resistance to corrosion gives duplex steels a high corrosion fatigue strength. S-N curves for 2205 and 4404 in synthetic seawater are shown in Figure 8. The corrosion fatigue strength of 2205 is considerably higher than that of 4404.

#### Intercrystalline corrosion

Due to the duplex microstructure and low carbon content, these steels have very good resistance to intercrystalline corrosion. The composition of the steel ensures that austenite is reformed in the heat-affected zone after welding. The risk of undesirable precipitation of carbides and nitrides in the grain boundaries is thus minimised.

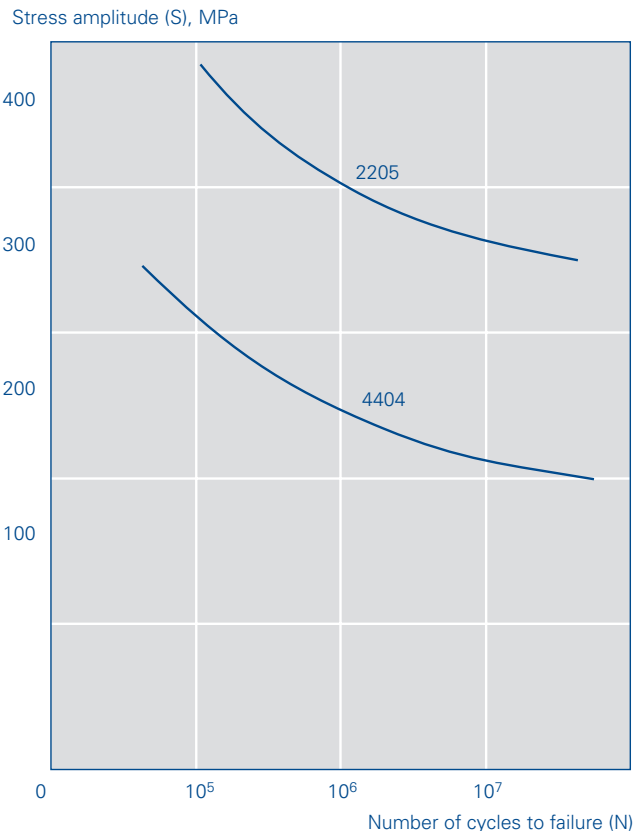


Fig. 8. Corrosion fatigue of stainless steel in synthetic seawater. Rotating bending test, 1500 r/min, with smooth specimens from 15 mm plate.

#### Erosion corrosion

Stainless steel in general offers good resistance to erosion corrosion. Duplex grades are especially good thanks to their combination of high surface hardness and good corrosion resistance. Examples of applications where this is beneficial are systems subjected to particles causing hard wear e.g. pipe systems containing water with sand or salt crystals.

#### Galvanic Corrosion

Galvanic corrosion can occur when two dissimilar metals are connected. The noblest material is protected while the less noble material is more severely attacked. As long as the duplex stainless steels are passive they are, in most environments, nobler than other metallic construction materials, meaning that the stainless steel is protected while the corrosion rate of e.g. carbon steel is increased.

Galvanic corrosion does not occur between different grades of stainless steels as long as both grades are passive.

**Fabrication**

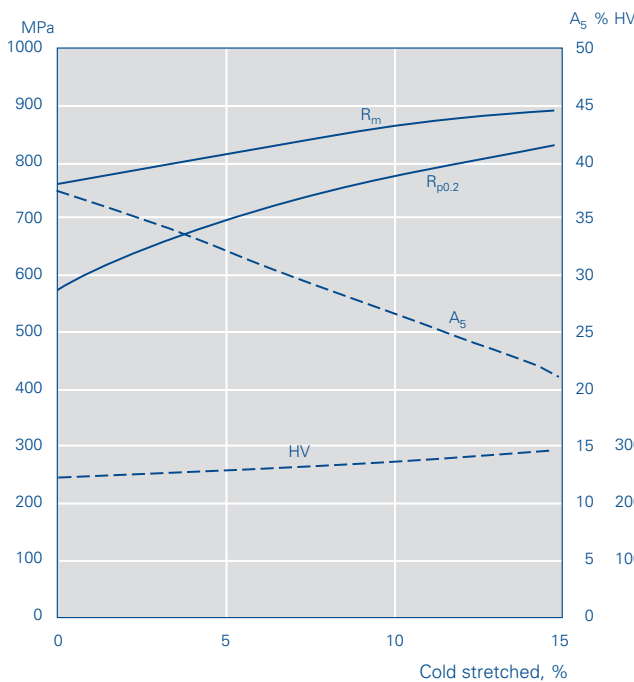
Duplex steels are suitable for most forming operations used in stainless steel fabrication. However, due to the higher mechanical strength and lower toughness, operations such as deep drawing, stretch forming and spinning are more demanding to perform than with austenitic steel. The high strength of the duplex grades, may cause a relatively high spring back.

**Hot forming**

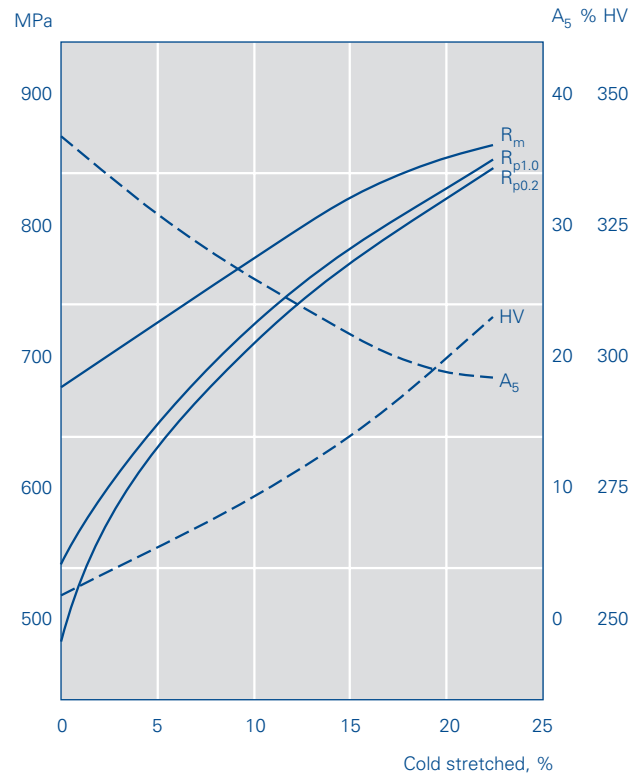
Hot working is performed at the temperatures illustrated in Table 8. It should, however, be observed that the strength of the duplex materials is low at high temperatures and fabricated components require support during fabrication. Hot working should normally be followed by quench annealing.

**Cold forming**

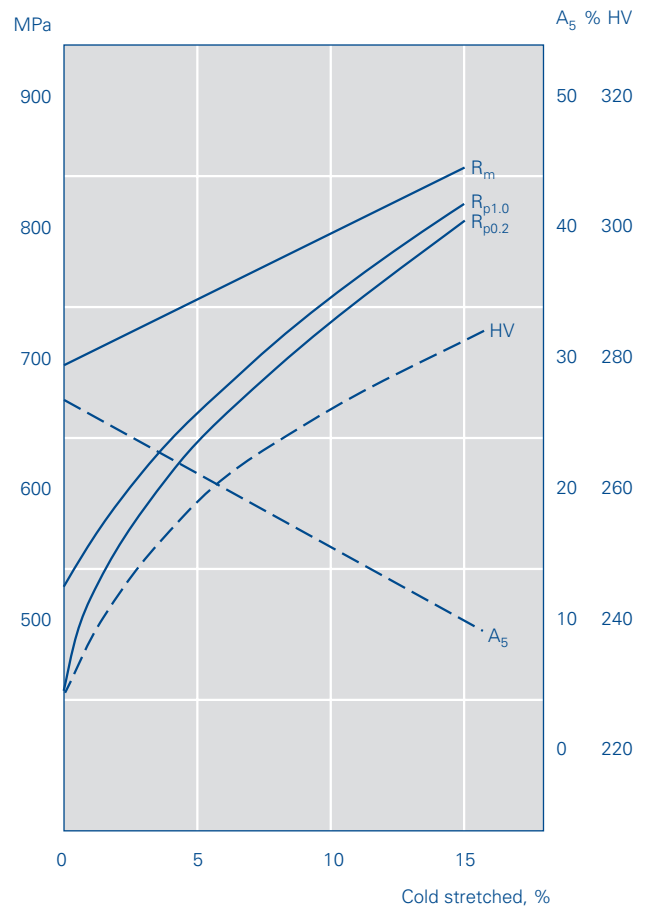
Due to the high proof strength of duplex material, greater working forces than those required for austenitic steel are usually needed for cold forming of duplex steel. Figures 9 to 11 show diagrams of the work hardening of LDX 2101®, 2304 and 2205 respectively.



**Fig. 9.** Mechanical properties of LDX 2101® after cold working.



**Fig. 10.** Mechanical properties of 2304 after cold working.



**Fig. 11.** Mechanical properties of 2205 after cold working.

### Heat treatment

Temperatures suitable for heat treatment are presented in Table 8. The heat treatment should be followed by subsequent rapid cooling in water or air. This treatment applies for both solution annealing and stress relieving. The latter can in special cases be done at 500-550°C. Further information concerning these operations is available from Outokumpu.

**Characteristic temperatures, °C** Table 8

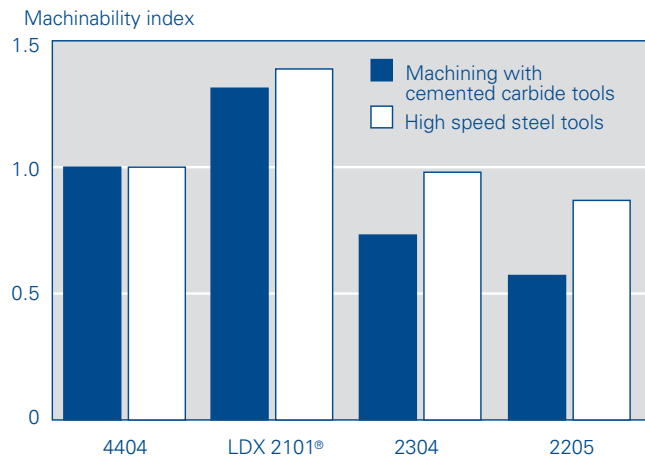
|                         | LDX 2101® | 2304     | 2205      | SAF 2507® |
|-------------------------|-----------|----------|-----------|-----------|
| Hot forming             | 1100-900  | 1100-900 | 1150-950  | 1200-1025 |
| Quench annealing        | 1020-1080 | 950-1050 | 1020-1100 | 1040-1120 |
| Stress relief annealing | 1020-1080 | 950-1050 | 1020-1100 | 1040-1120 |

See also "Welding"

### Machining

Duplex steels are generally more demanding to machine than conventional austenitic stainless steel such as 4404, due to the higher hardness. However LDX 2101® has shown excellent machining properties.

The machinability can be illustrated by a machinability index, as illustrated in Figure 12. This index, which increases with improved machinability, is based on a combination of test data from several different machining operations. It provides a good description of machinability in relation to 4404. Note, however, that the machinability index does not describe the relative performance between high-speed steel and carbide tools. For further information contact Outokumpu.



**Fig. 12.** Machinability index for duplex and some other stainless steels.



**Welding**

Duplex steels generally have good weldability and can be welded using most of the welding 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)
- Others; laser, resistance welding, high frequency welding

Due to the balanced composition, the heat-affected zone obtains a sufficiently high content of austenite to maintain a good resistance to localised corrosion. The individual duplex steels have slightly different welding characteristics. For more detailed information regarding the welding of individual grades, contact Outokumpu. The following general instructions should be followed:

- The material should be welded without preheating.
- The material should be allowed to cool between passes, preferably to below 150°C.
- To obtain good weld metal properties in as welded condition, filler material shall be used. For LDX 2101® reasonably good properties can be obtained also without filler.

- The recommended arc energy should be kept within certain limits to achieve a good balance between ferrite and austenite in the weld. The heat input should be adapted to the steel grade and be adjusted in proportion to the thickness of the material to be welded.
- Post-weld annealing after welding with filler is not necessary. In cases where heat treatment is considered, e.g., for stress relieving, it should be carried out in accordance with the temperatures stated in Table 8, but with the minimum temperature increased with 30-50°C to secure full dissolution of intermetallic phase in the the weld metal.
- To ensure optimum pitting resistance when using GTAW and PAW methods, an addition of nitrogen in the shielding/purging gas is recommended.

**Post Fabrication treatment**

In order to restore the stainless steel surface and achieve good corrosion resistance after fabrication, it is often necessary to perform a post fabrication treatment. There are different methods available, both mechanical methods such as brushing, blasting and grinding and chemical methods, e.g. pickling. Which method to apply depend on what consequences the fabrication caused, i.e. what type of imperfections to be removed, but also on requirements with regard to corrosion resistance, hygienic demands and aesthetic appearance. For more information contact Outokumpu.

**Welding consumables**

Table 9

| Product form                  | ISO Designation | Typical composition, % |      |      |      |      | Ferrite FNA |
|-------------------------------|-----------------|------------------------|------|------|------|------|-------------|
|                               |                 | C                      | Cr   | Ni   | Mo   | N    |             |
| <b>Welding of LDX 2101®</b>   |                 |                        |      |      |      |      |             |
| Covered electrode             | LDX 2101®*      | 0.04                   | 23.5 | 7.0  | 0.3  | 0.14 | 35          |
| Solid wire (MIG, TIG, SAW)    | LDX 2101®*      | 0.03                   | 23.0 | 7.0  | 0.3  | 0.14 | 40          |
| Flux cored wire               | LDX 2101®*      | 0.03                   | 24.0 | 9.0  | 0.6  | 0.14 | 35          |
| <b>Welding of SAF 2304</b>    |                 |                        |      |      |      |      |             |
| Covered electrodes            | 2304*           | 0.02                   | 24.5 | 9.0  | 0.2  | 0.12 | 30          |
| Solid wire                    | 2304*           | 0.02                   | 23.5 | 7.5  | <0.5 | 0.14 | 40          |
| Flux cored wire               | 2304*           | 0.03                   | 24.5 | 9.0  | 0.2  | 0.12 | 35          |
| <b>Welding of 2205</b>        |                 |                        |      |      |      |      |             |
| Covered electrodes (ISO 3581) | 22 9 3 N L R    | 0.02                   | 23.0 | 9.5  | 3.0  | 0.15 | 30          |
| Solid wire (ISO14343)         | 22 9 3 N L      | 0.02                   | 23.0 | 8.5  | 3.1  | 0.17 | 45          |
| Flux cored wire (ISO 17633)   | 22 9 3 N L      | 0.03                   | 23.0 | 9.0  | 3.2  | 0.13 | 45          |
| <b>Welding of SAF 2507®</b>   |                 |                        |      |      |      |      |             |
| Covered electrode (ISO 3581)  | 25 9 4 N L R    | 0.03                   | 25.5 | 10.0 | 3.6  | 0.23 | 30          |
| Solid wire (ISO 14343)        | 25 9 4 N L      | 0.02                   | 25.0 | 9.5  | 4.0  | 0.25 | 35          |

\* Avesta Welding Designation. Filler for 2205 can be used for most applications

## Products

Table 10

|                                   |  |
|-----------------------------------|--|
| Hot rolled plate, sheet and strip | Dimensions according to Outokumpu product program. |
| Cold rolled sheet and strip       | Dimensions according to Outokumpu product program. |
| Bars and forging                  | Dimensions according to Outokumpu product program. |
| Tube, Pipe and Fittings           | Dimensions according to Outokumpu product program. |

See also [www.outokumpu.com/prodprog](http://www.outokumpu.com/prodprog)

## Material Standards

Table 11

|  |   |
|--|---|
| EN 10028-7                                     | Flat products for pressure purposes – Stainless steels  |
| EN 10088-2                                     | Stainless steels – Corrosion resisting sheet/plate/strip for general and construction purposes                              |
| EN 10088-3                                     | Stainless steels – Corrosion resisting semi-finished products/bars/rods/wire/sections for general and construction purposes |
| EN 10217-7                                     | Welded steel tubes for pressure purposes – Stainless steel tubes  |
| EN 10272                                       | Stainless steel bars for pressure purposes  |
| EN 10296-2                                     | Welded circular steel tubes for mechanical and general engineering purposes - Stainless Steel tubes                         |
| ASTM A182 / ASME SA-182                        | Forged or rolled alloy-steel pipe flanges, forged fittings etc for high temperature service                                 |
| ASTM A240 / ASME SA-240                        | Heat-resisting Cr and Cr-Ni stainless steel plate/sheet/strip for pressure purposes   |
| ASTM A276                                      | Stainless and heat-resisting steel bars/shapes  |
| ASTM A479 / ASME SA-479                        | Stainless steel bars for boilers and other pressure vessels   |
| ASTM A789 / ASME SA-789                        | Seamless and welded duplex stainless steel tubing for general purposes  |
| ASTM A790 / ASME SA-790                        | Seamless and welded duplex stainless steel pipe   |
| ASTM A815 / ASME SA-815                        | Wrought ferritic, duplex, martensitic stainless steel piping fittings   |
| ASTM A928                                      | Duplex stainless steel pipe welded with addition of filler metal  |
| VdTÜV WB 418                                   | Ferritisch-austenitischer Walz- und Schmiedestahl, 1.4462   |
| VdTÜV WB 496                                   | Ferritisch-austenitischer Walz- und Schmiedestahl, 1.4362   |
| VdTÜV 508                                      | Ferritisch-austenitischer Walz- und Schmiedestahl, 1.4410   |
| NACE MR0175                                    | Sulphide stress cracking resistant material for oil field equipment   |
| Norsok M-CR 630, MDS D45                       |   |
| ASME Boiler and Pressure Vessel Code Case 2418 | 21Cr-5Mn-1.5Ni-Cu-N (UNS S32101), Austenitic-Ferritic Duplex Stainless Steel Section VIII, Division 1                       |

Outokumpu 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 optimise properties such as corrosion resistance and strength, the properties described in this datasheet corresponds to UNS S32205.

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*Outokumpu is an international stainless steel company. Our vision is to be the undisputed number one in stainless, with success based on operational excellence. Customers in a wide range of industries use our stainless steel and services worldwide. We are dedicated to helping our costumers gain competitive advantage.*



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