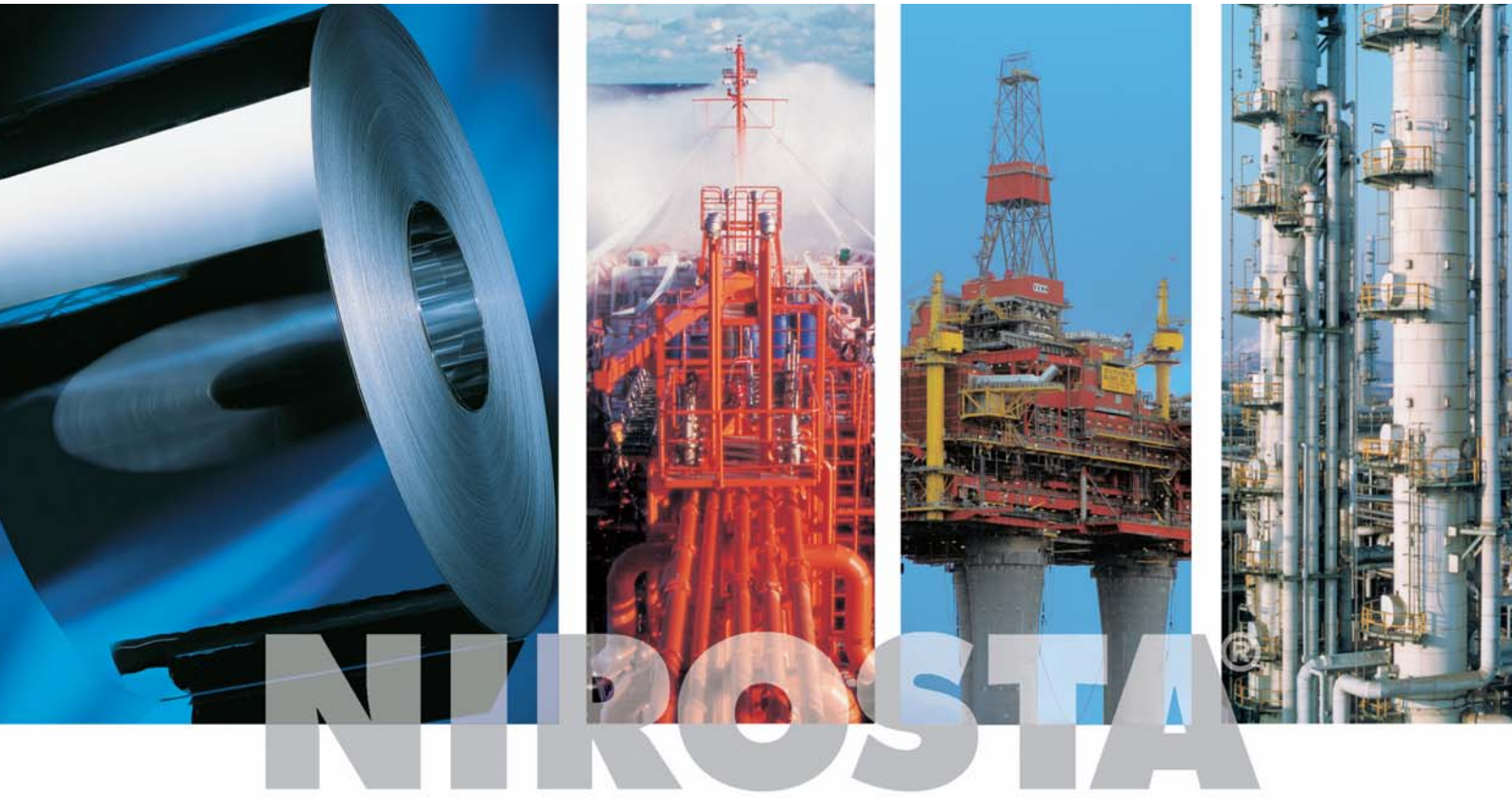
NIROSTA® 4462
(UNS S 31803/UNS S 32205)

Ferritic-austenitic duplex steel with high strength and corrosion resistance



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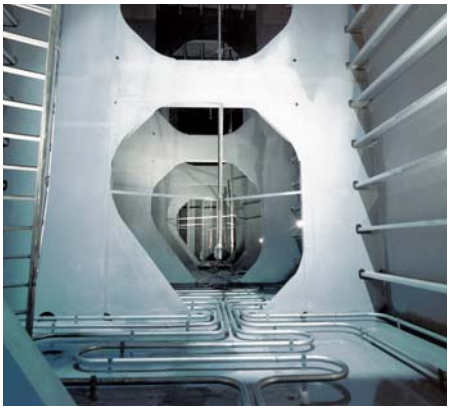


Properties and uses

NIROSTA® 4462 is a duplex stainless steel with a microstructure containing roughly equal amounts of ferrite and austenite. Thanks to its two-phase microstructure, the steel displays high strength and good resistance to stress corrosion cracking, corrosion fatigue and erosion. Its high chromium and molybdenum contents provide good resistance to general corrosion and local corrosion such as pitting, crevice corrosion and stress corrosion cracking in chloride- and H_2S-containing media. The addition of nitrogen has a positive effect on strength, increases resistance to local corrosion, prevents ferritization in the weld area – previously a problem with ferritic-austenitic steels – and retards the precipitation of carbides and intermetallic phases in heat-affected areas.
Thanks to its good corrosion resistance and mechanical properties, NIROSTA® 4462 is mainly used in applications with high corrosion loads.
These include: pipe systems in chemical tankers, storage and transport containers for aggressive media, seawater desalination plants and offshore applications, e.g. for sour gas pipelines and load-bearing structures.
For specific applications we recommend consulting our technical customer support service.

Welding properties

The duplex steel NIROSTA® 4462 can be welded by all known methods, including:
Manual TIG welding
TIG plasma welding
TIG orbital welding
Electron beam welding and
Laser beam welding.

To form an adequate ferritic-austenitic structure in the weld, filler materials containing higher amounts of nickel (approx. 8 % - 9 %) are usually used. Particularly suitable filler materials are Thermanit 22/09 and Thermanit 25/07 Cu T.
Welding is usually carried out without preheating; the interpass temperature should not exceed 150 °C. To achieve a good ferrite-to-austenite ratio, heat input should be between 0.5 and 2.0 kJ/mm depending on plate thickness and the weld should not be subjected to accelerated cooling.
Welding to austenitic and unalloyed steels is possible.

Product range

Hot- and cold-rolled coil

Hot-rolled coil
Thickness 4.00 to 8.00 mm*)
Width max. 1,350 mm
Coil weight max. 22 t
Finish 1D (hot-rolled, heat-treated, descaled)
*) depending on width

Cold-rolled coil
Thickness 1.00 to 4.00 mm
Width max. 1,350 mm
Coil weight max. 22 t
Finish 2B (cold-rolled, annealed, pickled, skin-passed)

Cut-to-length sheet from hot- and cold-rolled coil and other sizes on request.

Typical chemical composition (mass %)

C	Cr	Ni	Mo	N
0.025	22 – 23	4.5 – 6.5	3.0 – 3.5	0.10 – 0.20

Mechanical properties for cold-rolled sheets (solution annealed)

Strength properties

at RT	Typical values
$R_{p\,0,2}$	≥ 480 MPa
R_m	680 – 880 MPa
A_5	≥ 25 %

at elevated temperatures

cold-rolled

T (°C)	50	100	150	200	250	280
$R_{p\,0,2}$ min. (MPa)	410	360	335	310	295	285

hot-rolled

T (°C)	50	100	150	200	250	280
$R_{p\,0,2}$ min. (MPa)	410	360	335	310	295	285

Physical properties

Density (g/cm³)	**Modulus of elasticity** at 20 °C (10^3 MPa)	**Thermal conductivity** at 20 °C (W/m · K)	**Specific heat** at 20 °C (J/g · K)
7.8	200	16	0.45

Thermal expansion between 20 °C and 100 °C (10^{-6} m/m · K)	200 °C	300 °C	**Electrical resistivity** at 20 °C (Ω · mm²/m)	**Magnetic**
12.0	12.5	13.0	0.80	Yes

Heat treatment

All product forms are usually supplied in the solution annealed condition.

Hot forming °C	Cooling	**Heat treatment** °C	Holt time after reaching core temperature approx 2 min/mm wall thickness	Cooling Water or air at adequate speed
900-1200	Air	1050-1100		

Mechanical structure after heat treatment: ferritic-austenitic (ferrite content 40 – 60 %)

Standards

NIROSTA® 4462 meets The requirements of German and foreign standards in relation to composition and properties	**Germany**[1]**:**	EN 10088-2	1.4462 X2CrNiMoN22-5-3
	Europe:	EN 10088-2	1.4462
	USA:	ASTM/UNS	S 31803/S 32205

1) For requirement AD W2, technical specification VdTÜV Wb 418.

Corrosion

NIROSTA® 4462 is not susceptible to intergranular corrosion and even in the welded condition meets the requirements of the Strauss test to SEP 1877, Pract. I and the Streicher test to ASTM A262, Pract. B.

Corrosion resistance in chloride-containing media is usually indicated by the pitting resistance equivalent number (PREN).

PREN = % Cr + 3.3 x % Mo + 30 x % N

For the duplex steel 1.4462 the pitting resistance equivalent number is > 37.5. NIROSTA® 4462 thus has a significantly higher PREN than the duplex steel NIROSTA® 4362 and the molybdenum-alloyed austenitics NIROSTA® 4401, NIROSTA® 4404 and NIROSTA® 4571.

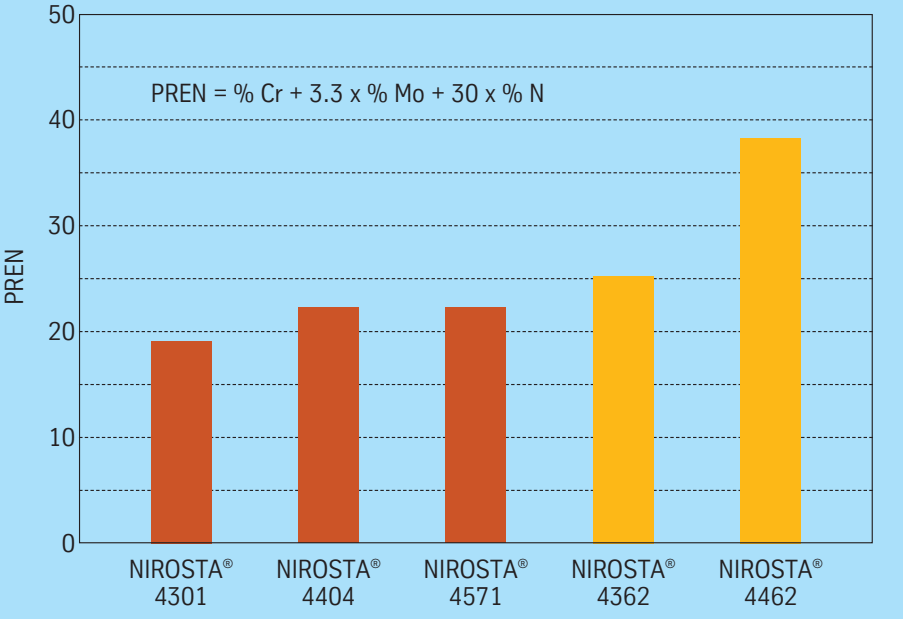
The pitting resistance of NIROSTA® 4462 is significantly higher than that of the molybdenum-alloyed austenitics. Laboratory tests in a neutral 0.5 % NaCl solution show a critical pitting potential of 700 – 750 mV for NIROSTA® 4462 at a temperature of 50 °C. For the materials NIROSTA® 4362, NIROSTA® 4404 and NIROSTA® 4571 the critical pitting potential is 500 – 550 mV, for NIROSTA® 4301 only 400 – 450 mV.

The resistance of NIROSTA® 4462 in seawater is generally very good, although under unfavorable conditions corrosive attack may occur in narrow crevices.

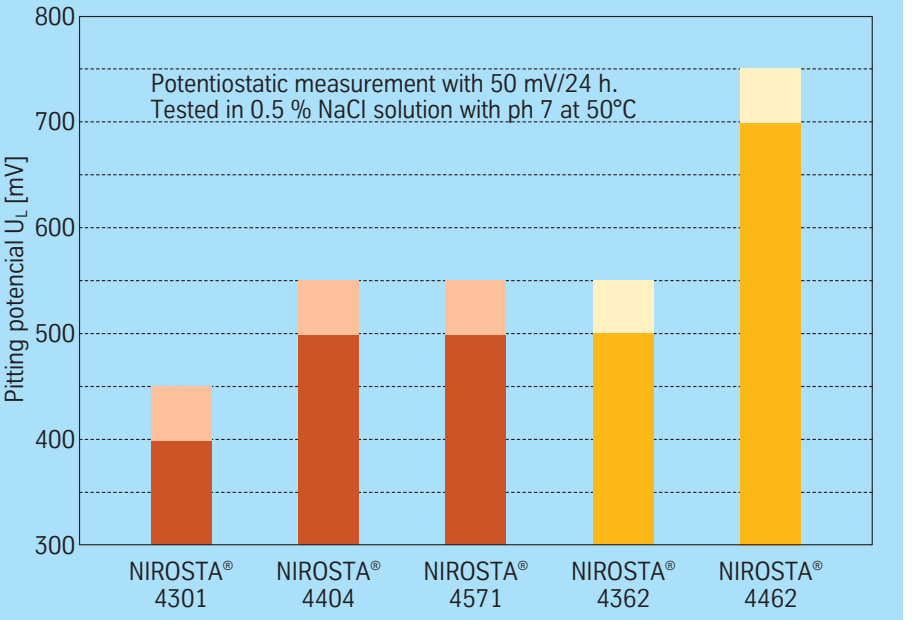
Thanks to its two-phase microstructure, NIROSTA® 4462 displays good resistance to stress corrosion cracking.

Due to the high chromium and molybdenum contents, corrosion resistance and in particular the capacity for repassivation in acids, also in the presence of impurities, is better than with austenitic steels.

PRE numbers of various stainless steels



Pitting resistance of duplex steels compared with austenitic steels

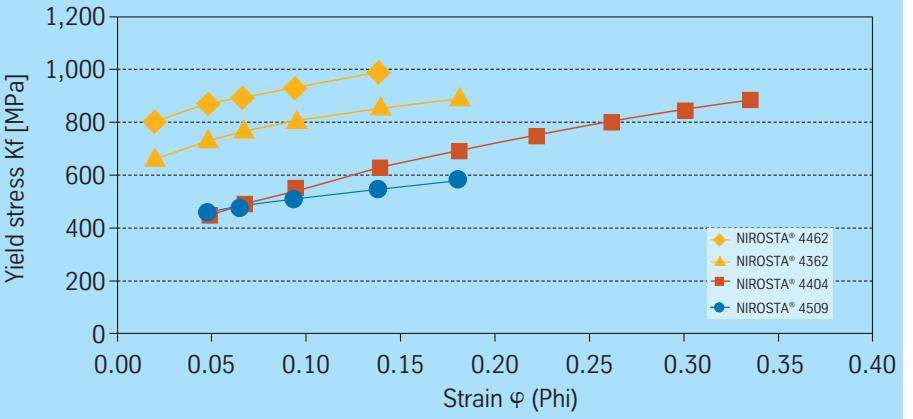


Forming properties
Due to its high strength values, the forming properties of NIROSTA® 4462 are naturally limited compared with austenitic steels.

As a result of the two-phase microstructure, the forming properties of the material lie between those of a pure ferritic and a pure austenitic material.

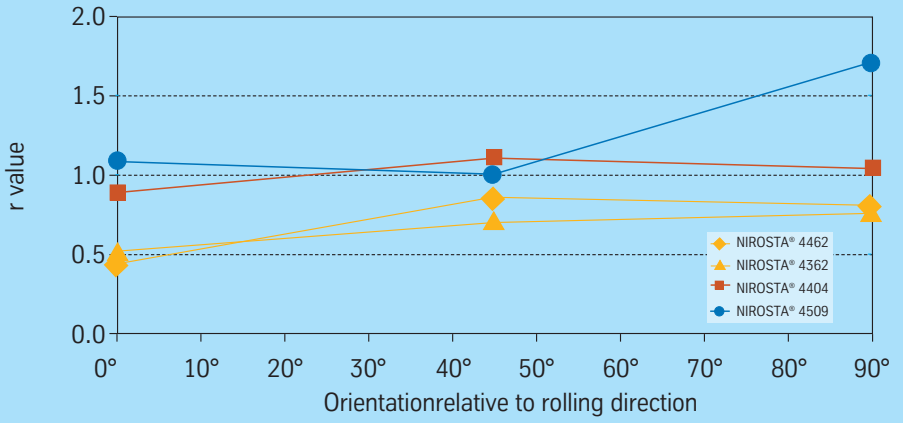
Strain hardening takes place with a strain hardening exponent n of around 0.3 and is therefore more pronounced than with the ferritic steels.
On the other hand, the stress-strain curve of the duplex steel NIROSTA® 4462 rises less steeply than with pure austenitic steels, which have a strain hardening exponent of around 0.4.

Stress-strain curves



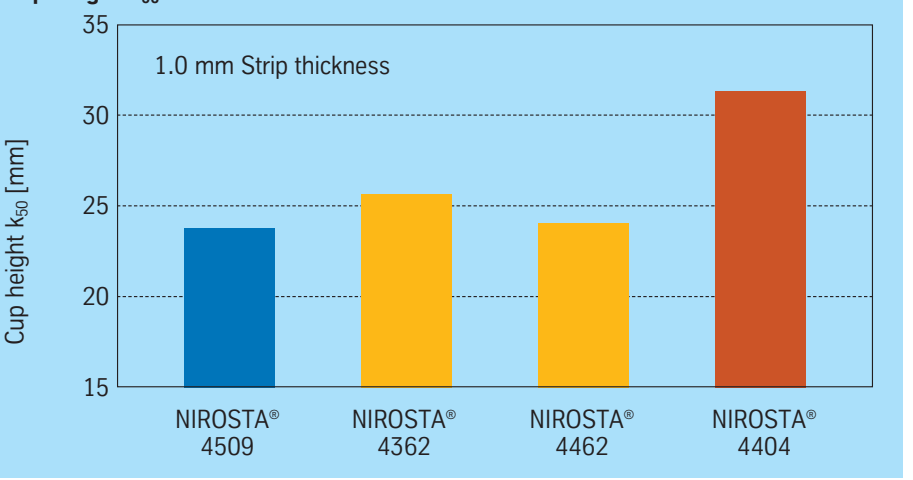
The anisotropy value r of NIROSTA® 4462 is well below 1 for all orientations and thus indicates limited formability by deep drawing.

Anisotropy value of various stainless steels



In stretch-draw forming, the forming properties of the duplex steel NIROSTA® 4462 are similar to those of the ferritic steels.

Cup height k_{50} for various stainless steels



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Range of products
- Cold-rolled strip and sheet
- Hot-rolled strip and sheet
- Precision strip

in the steel grades
- NIROSTA® stainless
- THERMAX® heat-resistant

All ThyssenKrupp Nirosta's plants are certified acc. to ISO 9001.

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