

# NIROSTA® 4362 (UNS S 32304)

Ferritic-austenitic duplex steel with high strength and corrosion resistance



# NIROSTA®

A company  
of ThyssenKrupp  
Stainless

**ThyssenKrupp Nirosta**



ThyssenKrupp

# NIROSTA® 4362 (UNS S 32304)

## Properties and uses

NIROSTA® 4362 is a duplex stainless steel with a ferritic-austenitic microstructure. It has a chromium content of around 22%, while the nickel content is around 3.5%. In contrast to the well-known duplex steel NIROSTA® 4462, NIROSTA® 4362 contains no molybdenum. NIROSTA® 4362 also has a slightly elevated nitrogen content of up to 0.20% which increases resistance to local corrosion and raises strength.

This alloy composition produces the ferritic-austenitic microstructure typical of duplex steels, with each phase accounting for roughly 50% of volume. The ferritic-austenitic microstructure is associated with relatively high values for 0.2% yield strength and tensile strength which are significantly higher than those of the pure ferritic or pure austenitic stainless steels. The requirements of standards 10088-2 and ASTM A 240 are comfortably exceeded.

Despite the high 0.2% yield strength and tensile strength values, high elongation values are also achieved, lying between those for purely ferritic and purely austenitic steels.

In terms of corrosion resistance in chloride-containing media NIROSTA® 4362 is comparable with the molybdenum-alloyed austenitic steels NIROSTA® 4401, NIROSTA® 4404 and NIROSTA® 4571. Compared with the well-known duplex steel NIROSTA® 4462, NIROSTA® 4362 has lower corrosion resistance due to the absence of molybdenum.

These properties make NIROSTA® 4362 ideal for applications which require high strength and adequate corrosion resistance. Potential uses include:

- Pipes and tanks in oil and gas production and in the chemical industry
- High-strength profiles and fasteners in the construction industry
- Tanks and containers

Due to its lower content of nickel and molybdenum compared with NIROSTA® 4401, NIROSTA® 4404 and NIROSTA® 4571, NIROSTA® 4362 is a cost-effective alternative to the molybdenum-alloyed austenitics.

## Welding properties

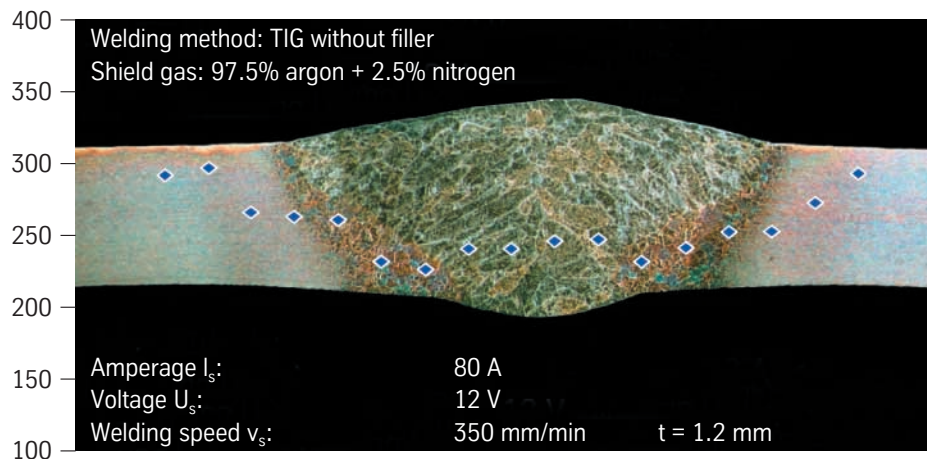
NIROSTA® 4362 can be welded by all known methods, including:

- Manual TIG welding
- TIG plasma welding
- TIG orbital welding
- Electron beam welding and
- Laser beam welding.

If a filler metal is needed, the overalloyed material Thermanit 22/09 is recommended. Due to its roughly 50% ferrite content, NIROSTA® 4362 is sensitive to hydrogen embrittlement. Filler metals must therefore be carefully dried. In addition, the addition of hydrogen to the welding gas, e.g. in TIG welding, is not possible.

Because of its alloy composition, NIROSTA® 4362 is susceptible to ferritization in the heat-affected zone (HAZ). However, heat treatment is not generally necessary. Optimum properties are achieved by brief annealing at 950°C to 1,050°C after welding, which also restores the desired 50:50 ferrite-austenite ratio in the heat-affected zone similar to the base metal.

## NIROSTA® 4362 weld, HV1 hardness (without heat treatment)



# Product range

## Hot and cold-rolled strip

Hot-rolled strip:

Thickness 5-8 mm,  
Width up to 1,250 mm,  
Coil weight 22 t  
Finish 1D (hot-rolled, heat-treated,  
descaled)

Cold-rolled strip:

Thickness 1.0-4.0 mm,  
Width 50-1,250 mm,  
Coil weight 22 t  
Finish 2B (cold-rolled, annealed, pickled,  
skin passed)

Cut-to-length sheets from hot or cold-  
rolled strip and other sizes on request.

### Typical chemical composition (mass %)

C	Cr	Ni	Mo	N
0.020	22	3.7	0.15	0.15

### Mechanical properties for cold-rolled sheets (solution annealed)

#### Strength properties

at RT	Typical values	at elevated temperatures				
Rp 0.2	≥ 500 N/mm <sup>2</sup>	T (°C)	100	150	200	250
Rm	700 N/mm <sup>2</sup>	Rp 0.2	330	300	280	265
		min. (N/mm <sup>2</sup> )				
A5	≥ 30 %					

### Physical properties

Density (g/cm <sup>3</sup> )	Modulus of elasticity at 20°C (10 <sup>3</sup> N/mm <sup>2</sup> )	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		Electrical resistivity	Magnetic	
100°C	200°C	300°C	at 20°C	
(10 <sup>-6</sup> m/m · K)		(Ohm · mm <sup>2</sup> /m)		
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
950-1150	Air

#### Heat treatment

°C	Hold time after reaching	Cooling
950-1050	core temperature	Water or air
	approx 2 min/mm	at adequate
	wall thickness	speed

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

### Standards

NIROSTA® 4362 meets the requirements of German and foreign standards in relation to composition and properties	<b>Germany:</b>	EN 10088-2	1.4362
	<b>Europe:</b>	EN 10088-2	1.4362
	<b>USA:</b>	ASTM/UNS	S 32304

## Corrosion resistance

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

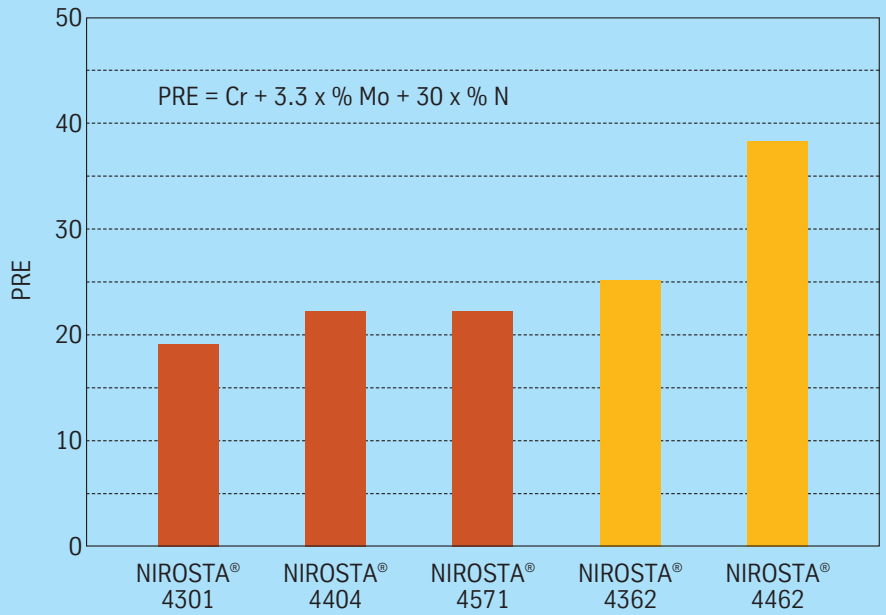
$$\text{PRE} = \text{Cr} + 3.3 \times \% \text{ Mo} + 30 \times \% \text{ N}$$

For NIROSTA® 4362 the pitting resistance equivalent is > 25.4. Theoretically, therefore, it matches the pitting resistance equivalent of the molybdenum-alloyed austenitics NIROSTA® 4401, NIROSTA® 4404 and NIROSTA® 4571.

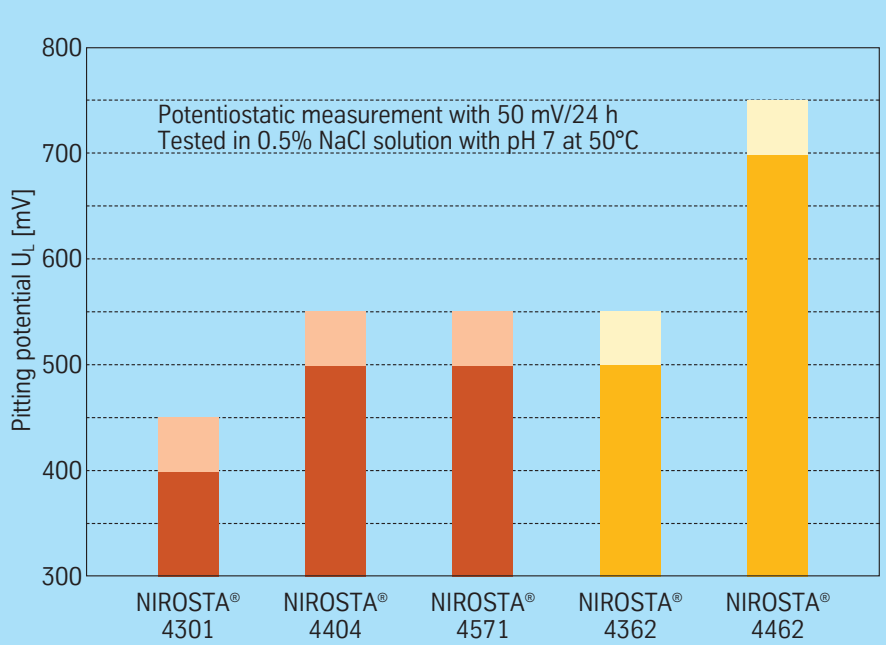
This calculated corrosion resistance is confirmed by laboratory tests. In a neutral 0.5 percent NaCl solution at a temperature of 50°C, the critical pitting potential for NIROSTA® 4362 is 500 to 550 mV. The same values are also achieved for the molybdenum-alloyed austenitics NIROSTA® 4401 and NIROSTA® 4571. In comparison, the critical pitting potential for NIROSTA® 4301 is only 400 to 450 mV, while that for the duplex steel NIROSTA® 4462 is 700 to 750 mV.

Due to its two-phase microstructure, NIROSTA® 4362 displays good resistance to stress corrosion cracking. NIROSTA® 4362 is resistant to intergranular corrosion in both the as-delivered and sensitized conditions.

PRE numbers of various stainless steels



Pitting resistance of duplex steels compared with austenitic steels



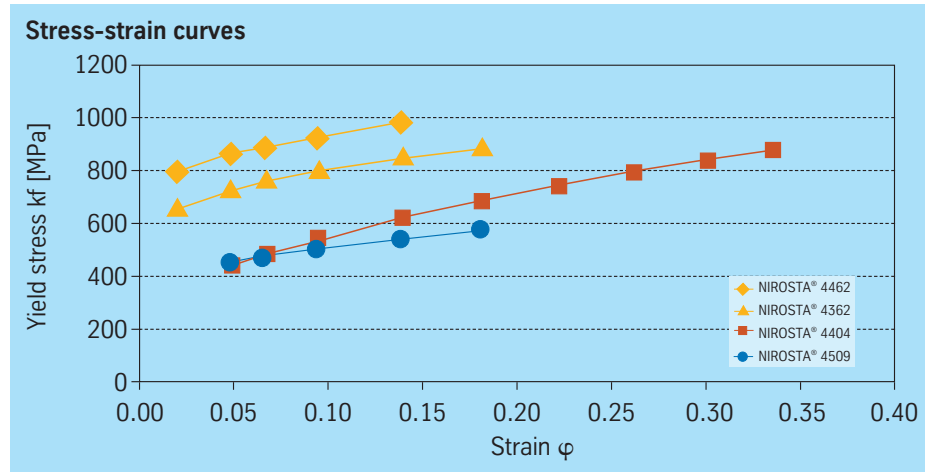
**Forming properties**

Due to its high strength values, the forming properties of NIROSTA® 4362 are

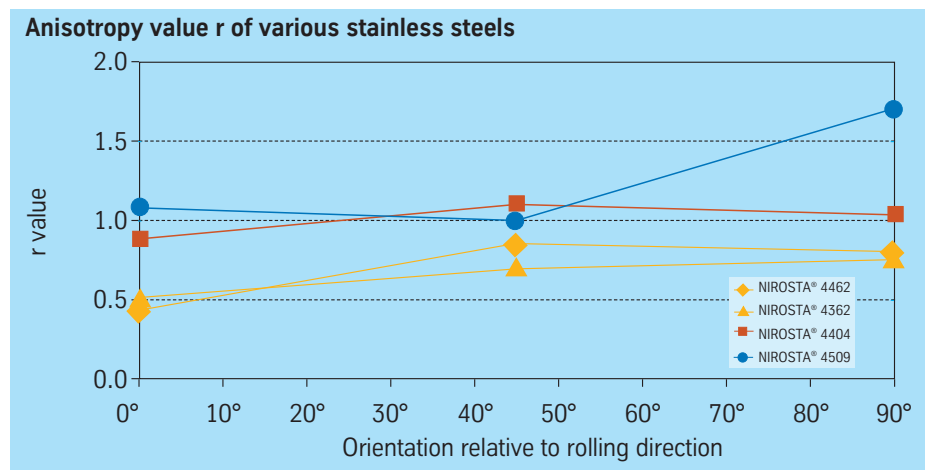
Strain hardening takes place with a strain hardening exponent  $n$  of around 0.3 and is therefore more pronounced than with the pure ferritic steels. On the other hand, the stress-strain curve of NIROSTA® 4362 rises less steeply than with purely austenitic steels, which have a strain hardening exponent of around 0.4.

naturally limited compared with austenitic steels. As a result of the ferritic-austenitic microstructure the forming properties of

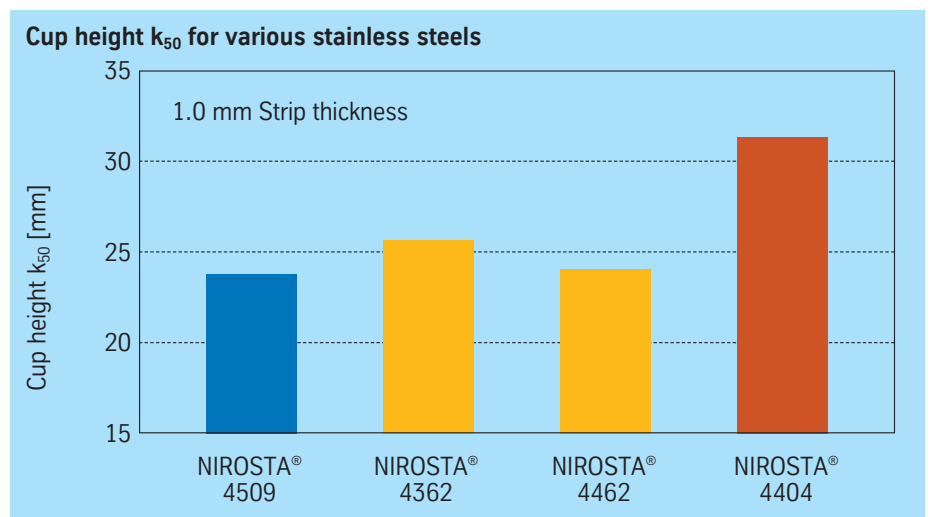
the material lie between those of a pure ferritic and a pure austenitic material.



The anisotropy value  $r$  of NIROSTA® 4362 is well below 1 for all orientations relative to rolling direction and thus indicates limited formability by deep drawing. Nevertheless, a maximum limiting draw ratio of 2.0 is achieved in cup drawing with NIROSTA® 4362.



In stretch forming, the forming properties of the duplex steel NIROSTA® 4362 lie between those of the ferritic steels and the outstanding formability of the austenitics.



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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.



Details of the properties or uses of materials and products are given for description purposes.  
Assurances relating to the presence of certain properties or a certain application are always subject to separate written agreements.

Photos:  
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