

# Struggling with **corrosion?**

Discover how Duplex 2205 stainless steel  
can extend the life of your components



Suzuki  
Garphyttan

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# Introduction

**Corrosion is a widespread and costly issue** for manufacturers across a broad spectrum of industries. Corrosion resistance is essential in harsh environments, as any issues can shorten component lifespan, leading to frequent maintenance or potential failure.

## Performance of traditional solutions

Coatings, inhibitors, and galvanised materials are often inadequate in very hostile environments. Coatings may wear off or degrade over time, particularly under continuous exposure to moisture, salts, or high temperatures. Corrosion inhibitors, while effective in mild to moderate conditions, may be insufficient in preventing corrosion in aggressive settings, requiring constant reapplication and monitoring.

Galvanized materials, which use a protective zinc layer to shield the underlying metal, are especially susceptible to wear in severe environments. In such settings, the zinc layer can erode rapidly, exposing the base metal to corrosion and significantly shortening the material's lifespan.

## Stainless steel as an alternative

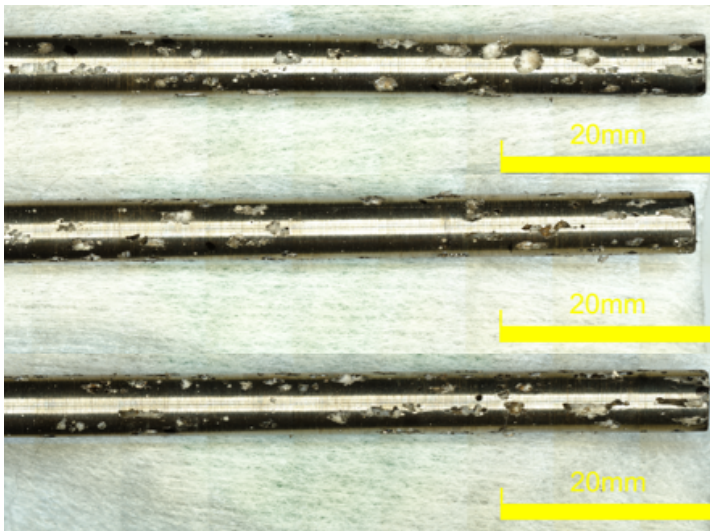
**In environments with high exposure to moisture, salt or chemicals,** stainless steels present a valuable alternative.



# Types of corrosion that affect steel components

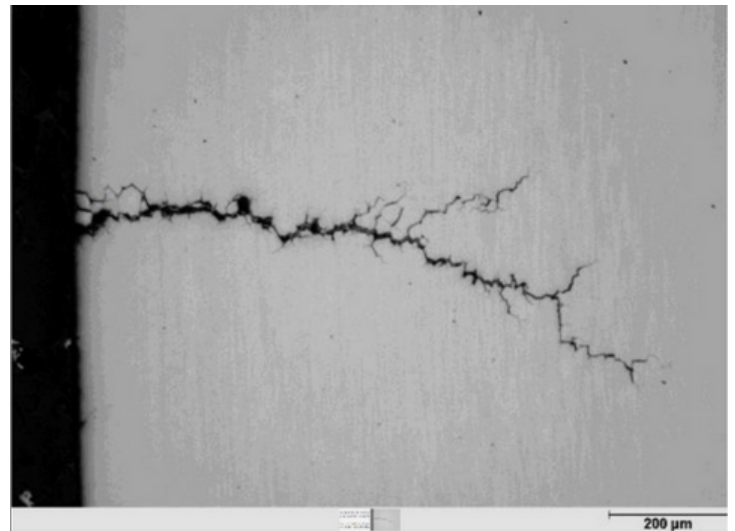
### 1. Pitting corrosion

This form of corrosion creates small cavities on the surface, often triggered by inclusions. Pitting can cause structural damage with minimal material loss, frequently leading to unexpected failures. It often occurs in chloride-rich conditions, such as seawater.



### 3. Stress corrosion cracking (SCC)

A dangerous form of corrosion where the combined influence of tensile stress and a corrosive environment leads to cracking. SCC is a serious issue where stress, high temperatures and chloride come together. As the cracking is not always visible, it can lead to sudden failures, po



### 2. Crevice corrosion

Similar to pitting corrosion, it occurs specifically in crevices and cracks, such as those found in joints, beneath deposits, or within incomplete welded details. Crevice corrosion can occur at lower temperatures and chloride concentrations compared to pitting corrosion.



# Stainless steel for corrosion resistance: Comparison of grades

Stainless steel represents an excellent choice for corrosion resistance due to its unique composition, which includes chromium.

Chromium forms a passive oxide layer on the surface, shielding the metal from further oxidation and helping it withstand harsh conditions like moisture, chemicals, and exposure to saltwater.

However, not all stainless steel grades offer the same level of corrosion resistance. Variations in alloying elements like molybdenum and nitrogen can significantly impact a grade's ability to resist specific forms of corrosion, such as pitting in chloride environments.

## Predicting corrosion with PREN

The Pitting Resistance Equivalent Number (PREN) is a valuable measure that helps identify and compare the pitting resistance among different stainless steel grades, guiding material selection for more demanding applications.

PREN is calculated based on the composition of key alloying elements that improve corrosion resistance, notably chromium (Cr), molybdenum (Mo), and nitrogen (N). The formula commonly used is:

$$\text{PREN} = \%Cr + 3,3*\%Mo + 16*\%N$$

A higher PREN value generally indicates greater pitting resistance, making it a valuable tool for selecting stainless steel grades suitable for aggressive environments where pitting corrosion is a risk.

## Our stainless steels

For more information on the grades below, visit the product page by clicking the product name.

Product name	Steel standard (EN ISO 6931-1)	Corrosion resistance (PREN)	Tensile strength at 2 mm [MPa]
<a href="#">GARBA 188</a>	EN 1.4310 / AISI 302	20	1700 - 1960
<a href="#">GARBA 188L</a>	EN 1.4301 / AISI 304	20	1445 - 1650
<a href="#">GARBA 178Mo</a>	EN 1.4310 / AISI 302	19	1850 - 2130
<a href="#">GARBA 11R51</a>	EN 1.4310 / AISI 302	19.5	
<a href="#">GARBA 177 (PH/PREMIUM/SUPREME)</a>	EN 1.4568 / AISI 631	17	1570 - 1800 (PH 1900 - 2160)
<a href="#">GARBA 1812Mo</a>	EN 1.4401 / AISI 316	24	1400 - 1610
<a href="#">GARBA 2205</a>	EN 1.4462	36	NS 1700 - 1960 HS 2000 - 2300

Note sure what level of corrosion resistance is suitable for your application? [Contact us](#) and we will gladly help you!



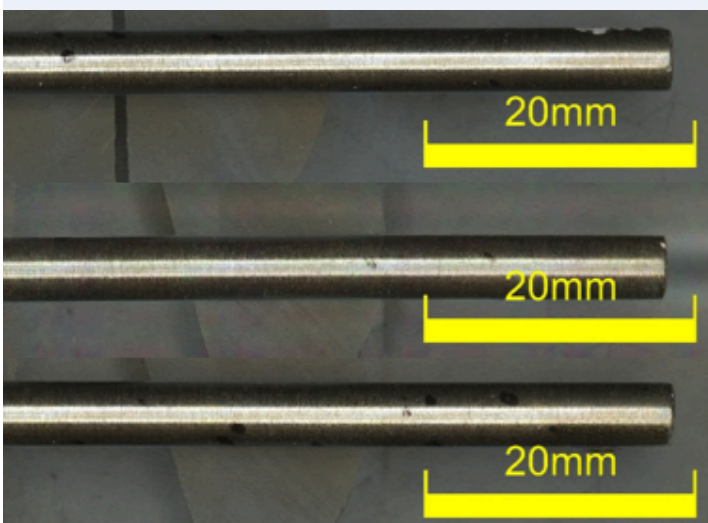
## Comparing Pitting resistance with ASTM G48 Method A: **Duplex 2205 vs. 302 Stainless Steel**

We conducted an ASTM G48 Method A test comparing the corrosion resistance of Duplex 2205 (GARBA 2205) and AISI 302 (GARBA 188) stainless steels. This method exposes wire samples to a ferric chloride solution under controlled conditions to assess their susceptibility to pitting corrosion.

The images below indicate how the respective alloys perform in aggressive environments.

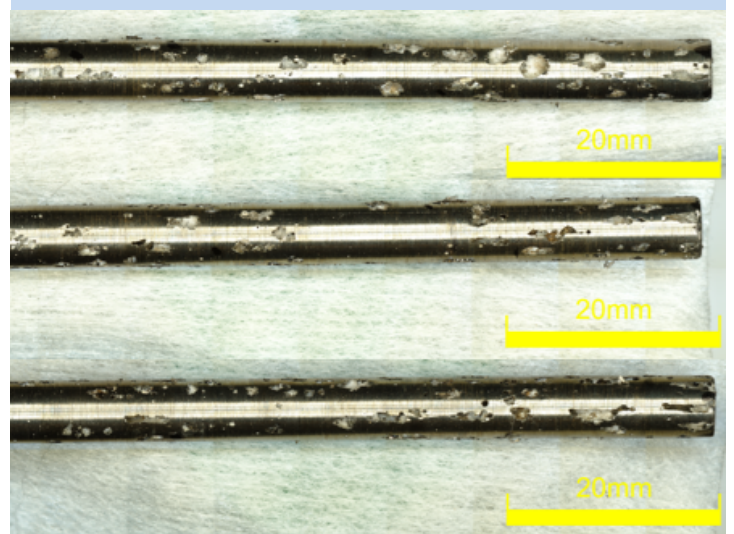
### **Duplex 2205 (GARBA 2205)**

Exposed to ferric chloride solution at 50 degrees celcius for 72 hours



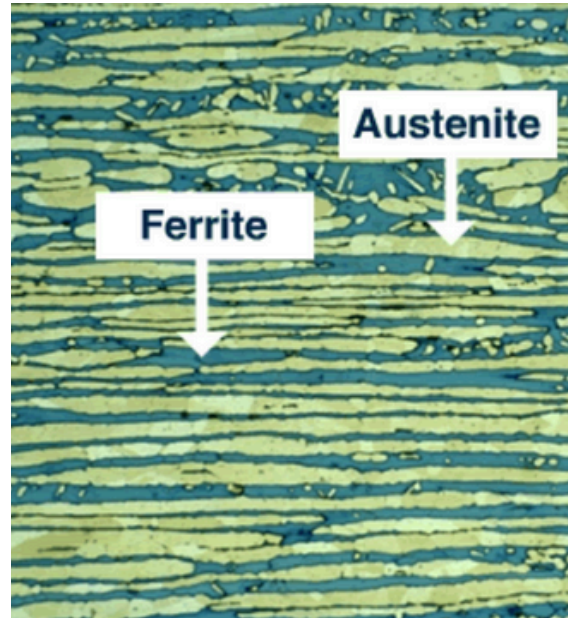
### **AISI 302 (GARBA 188)**

Exposed to ferric chloride solution at 50 degrees celcius for 72 hours



# Understanding Duplex 2205 stainless steel wire

Duplex 2205 stainless steel is a dual-phase alloy, meaning it consists of both austenitic and ferritic microstructures. This balance is the source of Duplex 2205's excellent properties: it combines the strength of ferritic stainless steels with the corrosion resistance of austenitic stainless steels.



## Key Elements of Duplex 2205's

### Chemical Composition:

- **Chromium** (21-23%): Provides excellent general corrosion resistance.
- **Molybdenum** (2.5-3.5%): Enhances resistance to pitting and crevice corrosion.
- **Nitrogen** (0.10-0.22%): Increases strength and further improves corrosion resistance.

This optimized composition allows Duplex 2205 to outperform traditional stainless steels like 304 and 316 in challenging conditions.

## GARBA 2205 Chemical composition

Element	Weight %
C	0.03%
Si	1.00%
Mn	2.00%
P max.	0.035%
S max.	0.015%
Cr	21.0 - 23.0%
Ni	4.5 - 6.5%
Mo	2.50 - 3.50%
N	0.10 - 0.22%

# Why Duplex 2205 is **ideal for spring and component manufacturing**

Duplex 2205 offers several key advantages over other stainless steel options, particularly for manufacturers of springs and components that must withstand tough environmental conditions. These advantages include:

## 1. Exceptional corrosion resistance

Duplex 2205 excels in resisting a variety of corrosion types:

- **General corrosion.** Outperforms common grades like 302 and 316L in most chemical and marine environments.
- **Pitting and crevice corrosion.** Resists these forms of localized corrosion better than standard stainless steels due to the addition of molybdenum and nitrogen.
- **Stress corrosion cracking.** Displays significant resistance in chloride-bearing solutions, a known vulnerability in austenitic steels like 304 and 316.
- **Microbial corrosion.** Its resistance to microbial attack in marine environments makes it ideal for shipping and offshore applications.

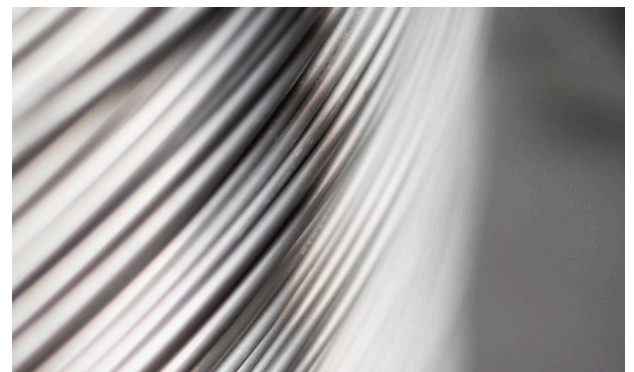
## 2. Tensile and yield strength

**904L is typically chosen for its corrosion resistance in aggressive environment, but it lacks good tensile strength, while Duplex combines high corrosion resistance with higher mechanical strength.**

In normal strength Duplex 2205, the tensile strength is similar to the tensile strength of 188 along with better corrosion resistance.

High strength Duplex 2205 can achieve even higher tensile strength, comparable to 177PH.

Furthermore, heat treatments like spring tempering can elevate the tensile strength of Duplex 2205 springs by up to 450 MPa. The recommended process involves batch tempering at 450°C for a duration of 1-3 hours.



### 3. Good fatigue strength

Duplex 2205 is also valued for its fatigue resistance under cyclic loading, making it ideal for springs and fasteners that endure repetitive stresses.

### 4. Improved weldability

While Duplex 2205 requires careful welding techniques to preserve its microstructure, it offers better weldability than ferritic grades. This makes it suitable for manufacturing complex components and ensures strong, durable welds.



# Use cases of Duplex 2205 across key industries

The versatile properties of Duplex 2205 is making it a popular choice across multiple industries where corrosion resistance and strength are critical. Below are some notable applications:

## 1. Spring Manufacturing

For manufacturers of springs, Duplex 2205 is ideal for use in demanding environments, such as:

- **Automotive**

The tensile strength and fatigue resistance of Duplex 2205 makes it a good candidate for springs in automotive suspension systems, brakes, and clutches, where components are subjected to continuous stress and corrosive elements.

- **Aerospace parts**

Springs manufactured from Duplex 2205 could find use in landing gear, control systems, and other critical components where weight reduction is crucial without compromising performance or reliability.

- **Marine environments**

When springs have to endure saltwater exposure and need superior corrosion resistance.

- **Medical**

Duplex is valuable for medical devices where size and weight are critical, as well as withstanding continuous cleaning using various acids.



### **What is the best choice for stainless automotive springs?**

If corrosion resistance is not the limiting factor, **GARBA 177 Supreme is the preferred choice** for high-performance automotive springs.

Engineered with Vacuum Arc Remelting (VAR) and featuring a shaved surface, it minimizes inclusions and imperfections, delivering superior fatigue resistance. Achieving tensile strengths up to 2525 MPa after heat treatment, GARBA 177 Supreme ensures reliability in gigacycle applications like fuel injection pumps, suspension, brakes, and clutches.

## 2. Chemical processing

Duplex 2205's resistance to general, pitting, and crevice corrosion makes it an excellent material for chemical processing equipment. It holds up well in aggressive environments, including those with chloride-rich chemicals or high temperatures.



## 3. Oil and gas industry

In the oil and gas sector, Duplex 2205 is frequently used for slicklines, pipelines, valves, and other components exposed to high pressures and corrosive substances. Its ability to withstand stress corrosion cracking is particularly important in offshore and subsea environments.



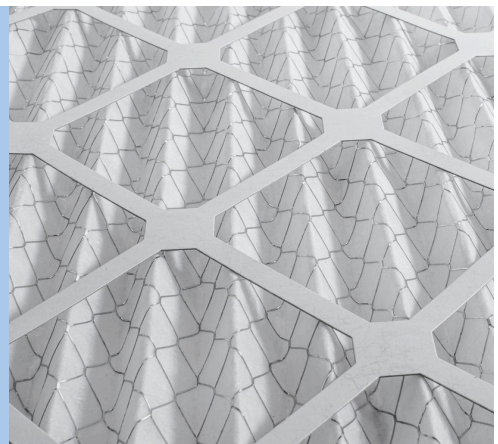
## 4. Marine applications

In marine environments, Duplex 2205's resistance to chloride-induced corrosion makes it ideal for offshore platforms, shipbuilding, and desalination plants. The material's longevity in these conditions ensures a reliable solution.



## 5. Pollution control equipment

For applications in pollution control, Duplex 2205's ability to resist corrosion in acidic or alkaline conditions makes it ideal for scrubbers, filters, and other equipment that handles harsh chemicals and gases.



# How to leverage Duplex 2205 for **maximum lifecycle cost savings**



## **Lower maintenance, higher reliability**

When conditions demand a material with superior corrosion resistance, Duplex 2205 significantly reduces maintenance by resisting corrosion in harsh environments. While AISI 302 might fail in such conditions, Duplex 2205 can last. Cutting downtime and repair costs.

Its durability means fewer replacements, reducing total ownership costs and improving operational efficiency in demanding applications.

## **Supports sustainability goals**

Long-lasting materials like Duplex 2205 reduce waste and production energy over time, aligning with sustainability objectives. By minimizing replacements, as well as avoiding hazardous coatings, it supports eco-friendly practices without compromising performance.

# Take action with Duplex 2205

Duplex 2205 stainless steel wire offers an optimal solution for addressing corrosion challenges while maintaining high strength and reliability. For spring and component manufacturers, adopting Duplex 2205 can lead to enhanced performance, reduced maintenance, and long-term cost savings.

## Ready to explore how Duplex 2205 can elevate your product line?

### Contact us today for:

- Expert advice on material selection and technical support for your specific applications.
- Detailed project consultations to help you maximize the benefits of Duplex 2205 in your manufacturing processes.
- Technical support for welding techniques and design optimization to ensure the highest performance and durability of your products.

Reach out to us via [our website forms](#), send an email to [info@sg-wire.com](mailto:info@sg-wire.com), or reach out directly to **your local sales representative:**



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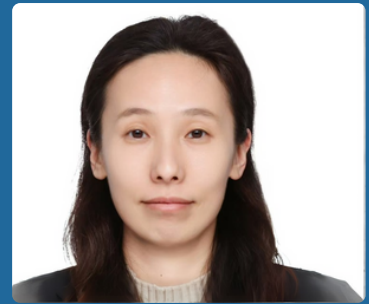
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# The company

- A globally present, world-leading supplier of advanced steel wire products
- 5 production units
- HQ in Garphyttan, Sweden since 1906
- Annual turnover >250 million EUR
- >70,000 tonnes of wire produced annually
- Part of the Japanese Nippon Steel Corporation, third largest steel supplier with an annual turnover of 35 billion EUR

 **NIPPON STEEL** | **NIPPON STEEL SG WIRE CO., LTD.**



● Production ● Sales office and Warehouse  
● Mother company, Nippon Steel Corporation



**>600** SG Group employees Worldwide

**"92% of our customers see us as their future partner"**

According to 2023 customer survey

## Sourcing



## Shape



## Condition



## Surface



## Delivery



We support the UN Sustainable Development Goals. The goals are an integral part of our ongoing sustainability efforts. We have decided to focus on the following goals.

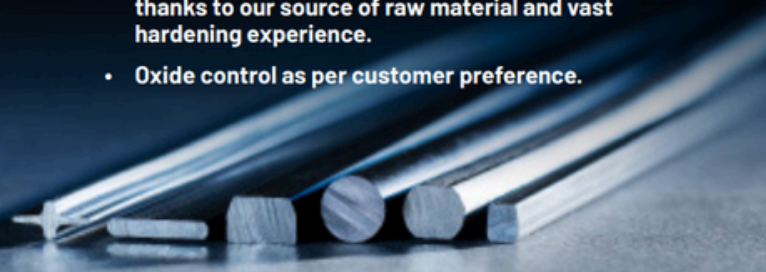


## Range of shapes

Our offer includes standard profiles as well as customade cross-sections.



- Able to meet high requirements for straightness.
- Superior mechanical properties and stability thanks to our source of raw material and vast hardening experience.
- Oxide control as per customer preference.



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Together for a  
better tomorrow

Suzuki Garphyttan is a world-leading  
supplier of advanced wire products  
and is part of Nippon Steel Corporation