



## WELDING PRODUCT PROGRAMME

# Duplex and Super Duplex stainless steel

- Customised formulations
- Consistent quality
- Single point source for complete range
- Technical expertise
- Experience in worldwide major projects
- Selectarc range covers a wide range of specifications

 **Selectarc**  
WELDING



**FSH** Welding Group works to ensure its customers to get the full benefit of its very extensive expertise.

Founded in 1952, Selectarc Industries' arc welding electrodes manufacturing plant has built up a reputation for leading expertise in the field, ranking it alongside the industry's key players both in France and on the export market.

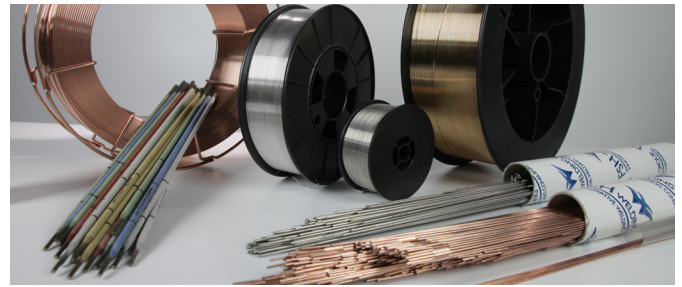


The impeccable quality and extensive range of its standard and customised products, along with its quality control processes, guarantee compliance with its clients' exacting specifications. Our aim is simple yet ambitious: to constantly improve to ensure the satisfaction of every single customer.

## Duplex stainless steel

- Duplex means «two». Duplex stainless steels consist of the two phases, Ferrite and Austenite and are often termed Ferritic-Austenitic stainless steels. Typically, duplex stainless steels have a microstructure consisting of approximately **50% ferrite and 50% austenite**.
- Ferrite gives high strength and some **resistance to stress corrosion cracking**, the austenite provides **good toughness**, and the two phases in combination give the duplex steels their **attractive corrosion resistance**.

The most important alloying elements of duplex stainless steels are **Cr, Ni, Mo and N**.



## Micro structure

Details Micrographs		
Base metal	Pure weld metal	HAZ
233-246	230-290	261-277
Hardness (Hv)		

## Applications :

- De-salination equipments
- Pumps, Pressure vessels, Tanks, Piping, and Heat exchangers in the Chemical processing industry
- Piping, Tubing, and Heat Exchangers for the handling of Gas and Oil
- Effluent scrubbing systems
- Pulp and Paper industry digesters, Bleaching equipment, stock-handling systems
- Rotors, Fans, Shafts, and Press rolls requiring combined strength and corrosion resistance
- Cargo Tanks for Ships and Trucks
- Food processing equipment



# Duplex stainless steel

## Properties / Advantages

- High general corrosion resistance
- Pitting and Crevice corrosion resistance superior to SS316L, 317L austenitic stainless steel
- High resistance to chloride stress corrosion cracking
- High resistance to corrosion fatigue and erosion
- Good sulfide stress corrosion resistance
- High strength
- Excellent toughness
- Lower thermal expansion and higher thermal conductivity than austenitic stainless steels
- Good workability and weldability

## Weldability of duplex stainless steel

Fabricating duplex stainless steels, special attention should be paid to heat treatment and welding. Unsuitable heat treatment can result in precipitation of inter-metallic phases and deterioration of toughness and corrosion resistance. Although most welding methods can be used to weld duplex steels, they require special procedures for the retention of properties after welding.

To avoid problems such as corrosion resistance, toughness, or post weld cracking, the welding procedure should focus on minimizing total time at temperature in the 'Red Hot' 500 - 790°C range for the whole procedure rather than managing the heat input for any one pass.

These are technically and economically optimal procedures!



## Welding procedure

### 1. Pre-heating treatment

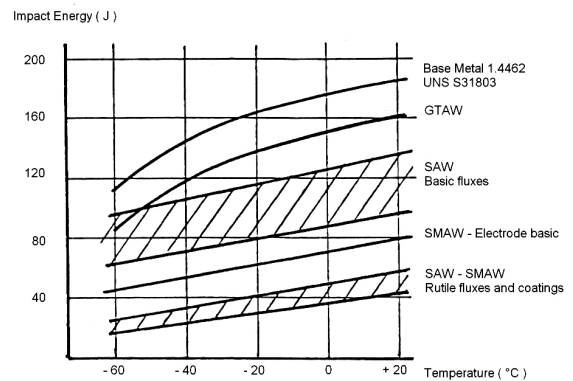
To respect certain parameters as heat input and interpass temperature:

- Preheating of Duplex Stainless Steels is not necessary and not recommended
- The temperature of the plates or pipes to be welded should be about 20°C

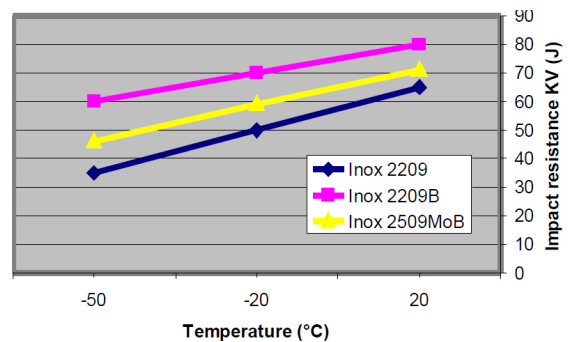
### 2. Welding

2.1. Choose the right filler metal and welding process to get the right weld metal toughness:

- TIG consumables give higher impact values than any other consumable;
- Basic coated/type consumables give better impact values than rutile/ acidic coating;



Influence of coating on Impact properties.



2.2. To guarantee a balanced Austenite-Ferrite ratio in weld deposit.

### Phase balance

Too much ferrite (> 70%)

- Ductility and toughness ↓
- Corrosion resistance (Nitrides) ↓

Too much austenite (> 80%)

- SCC resistance ↓
- Mechanical strength ↓

Typical requirements according to engineering specifications  
Ferrite content: 30-55% (30-60%)

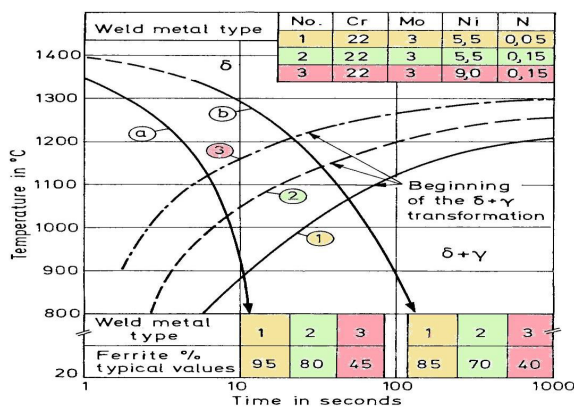


### Influence of Elements and Cooling rate on % Ferrite.

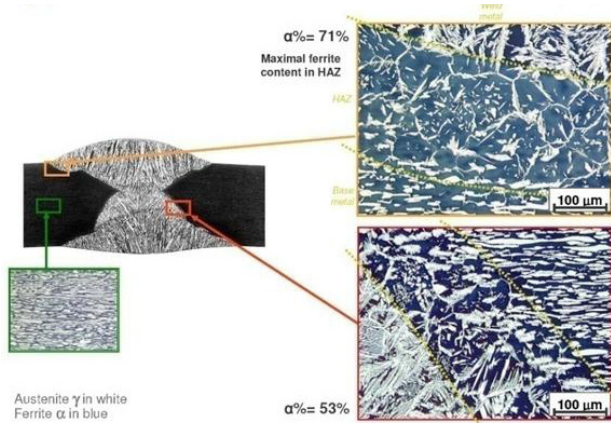
**Fast Cooling** — High Ferrite

**Slow Cooling** — Low Ferrite

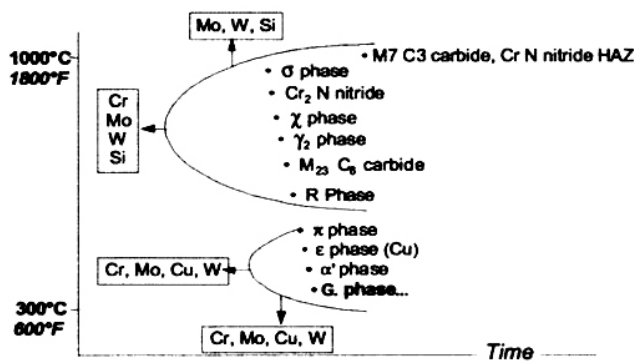
Influence of elements



### 2.3. To get required Austenite – Ferrite ratio in the heat affected zone (HAZ)



### 2.4. To prevent phase precipitations which will reduce corrosion as well as mechanical properties (ASTM A923)



### 2.5. Welding Parameters

Grade of Duplex	Advice
2304 / 1.4362	Heat input 0.5 - 2.5 kJ/mm
2205 / 1.4462	Interpass temperature <170°C
Grade of Super Duplex	Advice
1.4507	Heat input 0.4 - 1.5 kJ/mm
2507 / 1.4410	
1.4501	Interpass temperature <150°C

The linear heat input "**Es**" is calculated based on welding parameters:

$$Es = (V \times A) / S \times 60/1000$$

V= Arc voltage ( V );

A = Welding current ( A );

S = Welding speed ( mm / min )



### 3. Post Weld heat treatment

A post weld heat treatment (PWHT) is not recommended. For temperatures above 290°C it is dangerous as phase precipitations will occur.

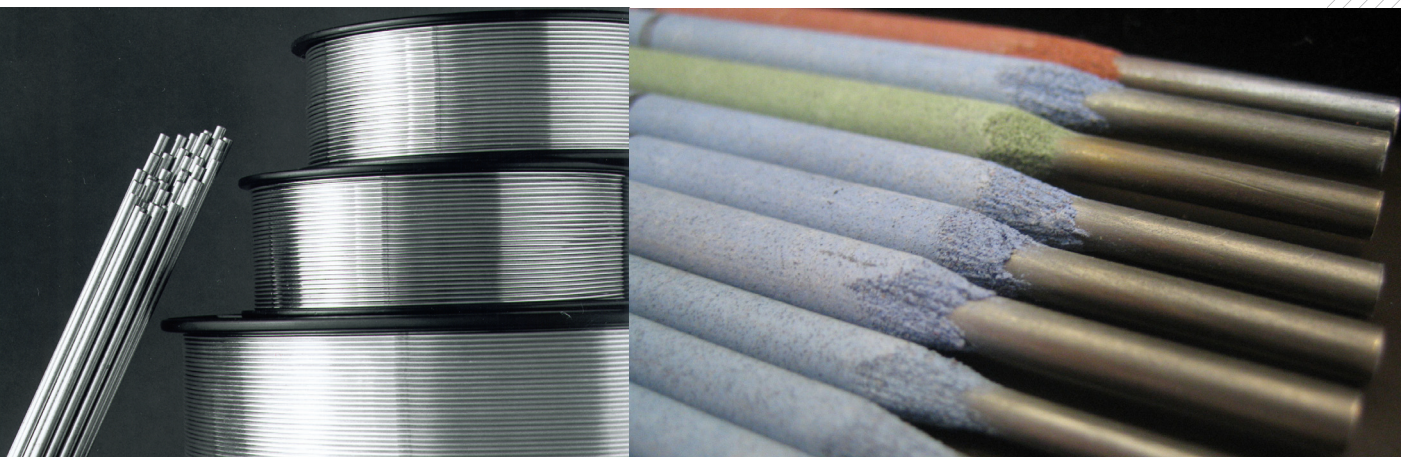
### 4. Cleaning, Pickling and Passivation

To obtain the best corrosion resistance, it is essential to remove oxide, tarnish, heat tint, and other surface contamination by mechanical or chemical methods, ideally both. Thorough washing must be done after pickling.

## Product range

Product name AWS/EN	Main features	Description
<b>Inox 2209</b> AWS A5.4: E2209-17 EN 1600 / ISO 3581-A: E 22 9 3 N L R 3 2	For Duplex steels / rutile	Rutile-basic electrode with a duplex structure. Easy to weld in all positions, except vertical down. Stable arc, regular drop transfer, easy slag removal, finely rippled weld beads. The weld metal can be applied for operation temperatures up to 250°C.
<b>Inox 2209B</b> AWS A5.4: E2209-15 EN 1600 / ISO 3581-A: E 22 9 3 N L B 4 2	For Duplex steels / basic	Basic coated electrode with a Duplex microstructure (duplex). The weld deposit is characterized by a high resistance against Pitting, Crevice and stress corrosion in chloride containing media, like sea water, combined with a very high tensile strength. Easy to weld with, stable arc, easy to remove slag, regular weld beads.
<b>Inox 2509MoB</b> AWS A5.4: E2594-15 EN 1600 / ISO 3581-A: E 25 9 4 N L B 4 2	For Super Duplex steels	Basic coated Super Duplex electrode (~ 40% ferrite). Weld metal is resistant in chloride containing medias against pitting as well as crevice and stress corrosion. Used for impellers and other components which require high strength combined with corrosion attack. Pitting index: > 40.
<b>Inox 2509MoWB</b> AWS A5.9: E2595-15 EN 1600 / ISO 3581-A: E 25 9 4 N L B 4 2	Basic coated / for Super Duplex stainless steels	Basic coated electrode with an austenitic - ferritic microstructure (duplex ~ 40% ferrite). Good resistant in chloride containing medias against pitting as well as crevice and stress corrosion. Electrodes are used for pumps, vessels, piping systems etc. attacked by chloride containing solutions. Pitting index: > 40.
<b>TIG/MIG D22/09</b> AWS A5.9: ER2209 EN ISO 14343-A: W 22 9 3 N L G 22 9 3 N L	For Duplex steels	Very low carbon content solid rod for GTAW / GMAW welding Duplex steels (austenitic-ferritic microstructure), such as Uranus 45N, 2205, 2304. Resistant in chloride containing media against pitting corrosion as well as crevice and stress corrosion.
<b>TIG/MIG D25/09</b> AWS A5.9: ER2594 EN ISO 14343-A: W 25 9 4 N L G 25 9 4 N L	For Super Duplex steels	Very low carbon content solid rod for GTAW / GMAW Duplex and Super Duplex Stainless Steels (austenitic-ferritic microstructure). Resistant in chloride containing media against pitting corrosion as well as crevice and stress corrosion. Pitting index (PREN): > 40.
<b>TIG/MIG D25/09W</b> AWS A5.9: ER2594 EN ISO 14343-A: G 25 9 4 N L W 25 9 4 N L	For Super Duplex steels	Very low carbon content solid GTAW rod for joining Duplex and Super Duplex Stainless Steels (austenitic-ferritic microstructure). Resistant in chloride containing media against pitting corrosion as well as crevice and stress corrosion. Pitting index (PREN): > 40.
<b>FCW D22/09-F</b> AWS A5.22 E2209T0-1/-4 EN ISO 17633-A: T 22 9 3 N L R M 3	For Super Duplex steels in flat positions	Flux cored wire to weld in flat positions with shielding gas protection with an austenitic-ferritic microstructure (Duplex). Stable arc, Less spatter and easy slag removal. Exist also with a basic slag : FCW D22/09-B.
<b>FCW D22/09-AP</b> AWS A5.22 E2209T1-1/-4 EN ISO 17633-A: T 22 9 3 N L P M 1	For Duplex steels in all positions	Flux cored wire to weld in all positions with shielding gas protection with an austenitic-ferritic microstructure (Duplex). Stable arc, Less spatter and easy slag removal.
<b>FCW D25/09-F</b> AWS A5.22 E2594T0/-4 EN ISO 17633-A: T 25 9 4 N L R M 3	For Super Duplex steels in flat positions	Flux cored wire to weld in flat positions with shielding gas protection with an austenitic-ferritic microstructure (Duplex). Stable arc, Less spatter and easy slag removal. Pitting index (PREN): > 40. Exist also in All Positions: FCW D25/09-AP.

Technical datasheets available on: [www.fsh-welding.com/en/datasheets.htm](http://www.fsh-welding.com/en/datasheets.htm)



# Welding of Dissimilar Metal



## Welding Consumables used for Dissimilar Metal Welding

Base Material	2304	2205	2507 Super duplex
Carbon Steel / Low Alloy Steel	Inox 2209 D22/09	Inox 2209 D22/09	Inox 2509MoB D25/09
304L / 347	Inox 2209 D22/09	Inox 2209 D22/09	Inox 2509MoB D25/09
316L / 318	Inox 2209 D22/09	Inox 2209 D22/09	Inox 2509MoB D25/09
309L / 309LMo	Inox 2209 D22/09	Inox 2209 D22/09	Inox 2509MoB D25/09
410	Inox 2209 D22/09	Inox 2209 D22/09	Inox 2509MoB D25/09
2304	Inox 2209 D22/09	Inox 2209 D22/09	Inox 2509MoB D25/09
2205	Inox 2209 D22/09	Inox 2209 D22/09	Inox 2509MoB D25/09
2507	Inox 2209 D22/09	Inox 2209 D22/09	Inox 2509MoB D25/09

Legend : In black MMA      In blue TIG/MIG Wires

## Services

### • Advice and assistance

A team of engineers and experienced welders help customers with selecting the materials and consumables that are best suited for each application.

### • Research and Development (R & D)

The R&D department carries out product tests (mechanical and non-destructive tests) in accordance with customer requests.

### • Customer Service

The sales department is available to respond quickly to any request.

## Quality

ISO 9001 certification



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