CENTRAVIS

Proudly engineered in Ukraine

NIKOPOLIUM®

NP 2205 and NP 2507

Duplex Reimagined: Mastering Corrosion, Optimizing Costs

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Product Overview

Nikopolium NP 2205 and NP 2507 are advanced Duplex and Super Duplex stainless steels developed by Centravis using proprietary grain boundary engineering. These materials combine high mechanical strength, superior corrosion resistance, and improved performance under extreme conditions, exceeding standard duplex grades and approaching the resistance of high-end nickel alloys at a significantly lower cost.

Key Features

- Enhanced pitting and crevice corrosion resistance (ASTM G48, G28)
- High impact strength at –60 °C
- Elevated application temperature limit up to 350 °C
- Fine-tuned austenite-ferrite microstructure for optimal SCC and erosion resistance
- Suitable for aggressive media including sulfuric acid, chlorides, and sour environments
- Cost-effective alternative to Nickel Alloys
- Sustainability through lower nickel content and energy-efficient processing

Application Areas

- Oil & Gas: OCTG, sour gas, CO_2-rich environments
- Chemical Processing: sulfuric acid, caustic soda, nitric acid systems
- LNG Plants: cryogenic piping and heat exchangers
- Offshore Structures: seawater-exposed components
- Pressure Vessels & Reactors: high-pressure, corrosive media
- Desalination and Pulp & Paper: chloride-bearing environments

Forms of supply

- Seamless hot and cold finished tubes and pipes
- Seamless cold finished U – tubes

Product range

- Hot finished:
  OD 60.33÷219.08 mm;
  WT 3.05÷23 mm;
  length max 15 m
- Cold finished:
  OD 6÷114.3 mm;
  WT 0.7÷10 mm;
  length max 16 m

Product standards

- ASTM A 789; ASTM A 790
- EN 10216-5
- Individual customers' specifications

Chemical Composition*

Grade	C	Mn	P	S	Si	Cr	Ni	Mo	N	Cu	**Pren
NP 2205	0.03	2.00	0.030	0.020	1.00	21–23	4.5–6.5	1.00	0.08–0.2		35
NP 2507	0.03	1.20	0.035	0.020	0.80	24–26	6.0–8.0	0.8	0.24–0.32	0.50	42

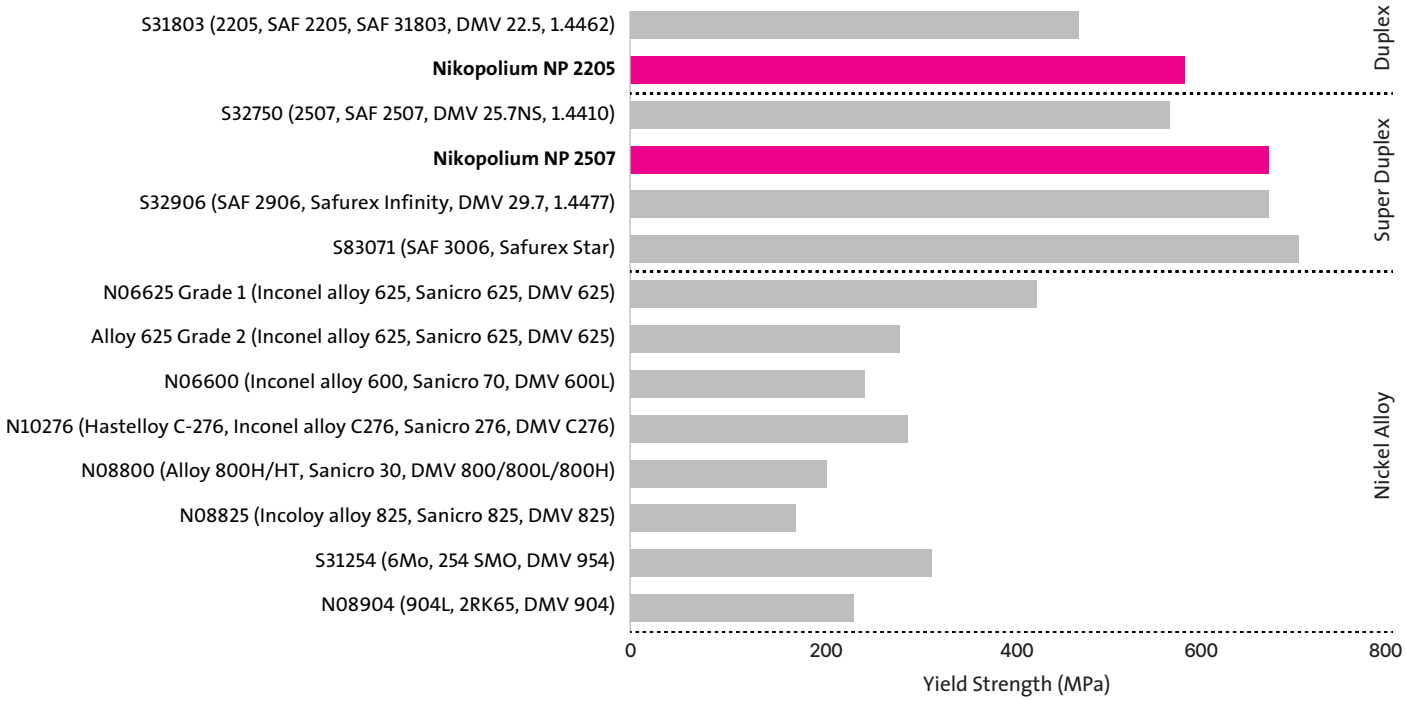
*Chemistry maximum, unless a range or minimum is indicated.

**PREN (Pitting Resistance Equivalent Number) = %Cr+3.3(%Mo+0.5%W) +16%N
PREN is a measure of the relative pitting corrosion resistance of stainless steel in a chloride-containing environment.

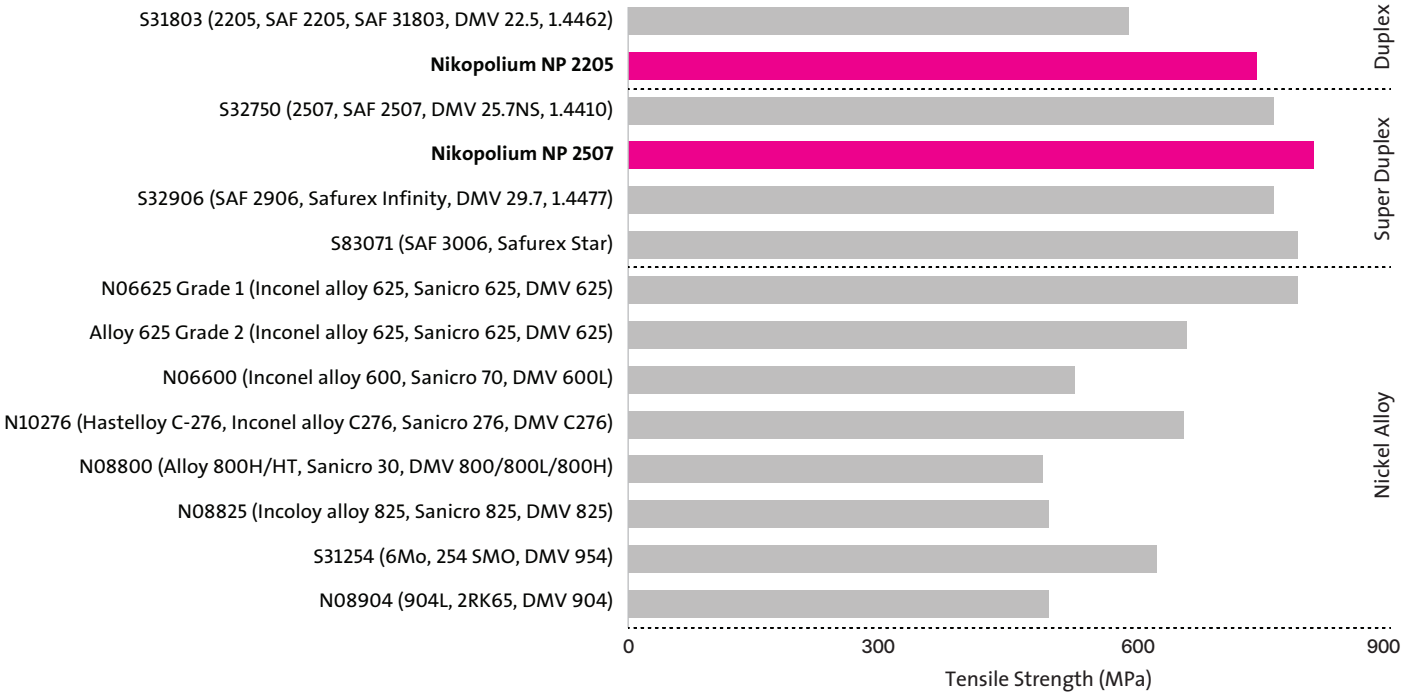
Mechanical Properties

Material Properties	Yield strength Rp0,2		Tensile strength Rm		Impact strength		Elongation	
	MPa	MPa	MPa	MPa	J	J	%	%
	20 °C	350 °C	20 °C	350 °C	at 20 °C	at –60 °C	at 20 °C	at 350 °C
S31803	>450	310	>620	560	150	90	>25	21
NP 2205	>565	551	>780	1000	168	158	>25	48.5
S32750	>550	365	>800	580	180	100	>15	18
NP 2507	>650	451	>850	741	210	188	>22	60

Yield strength Rp0,2 (MPa) at 20°C



Tensile strength Rm (MPa) at 20 °C



Charpy V-notch impact tests were conducted in accordance with UNI EN ISO 148-1:2016 using a 150 J pendulum. Testing was performed at:

- Room Temperature (RT, ~20 °C)
- Low Temperature (–60 °C)

These conditions simulate operational scenarios in both moderate and cryogenic environments. **Nikopolium NP 2205 and NP 2507** demonstrate outstanding impact strength across a broad temperature range, setting a new benchmark in their respective categories.

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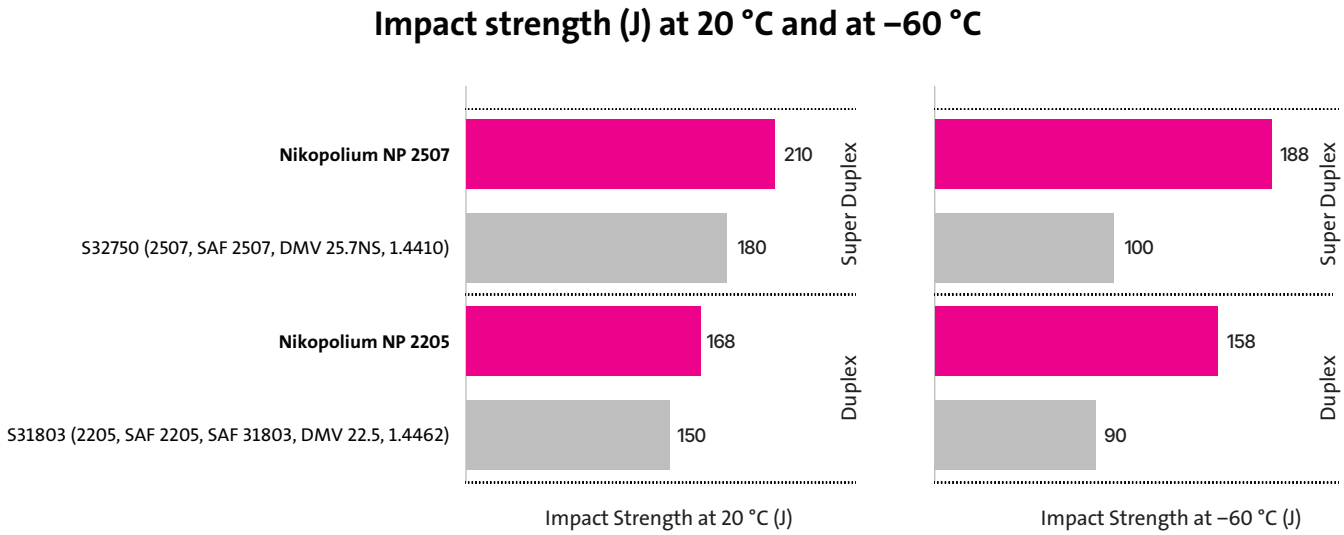
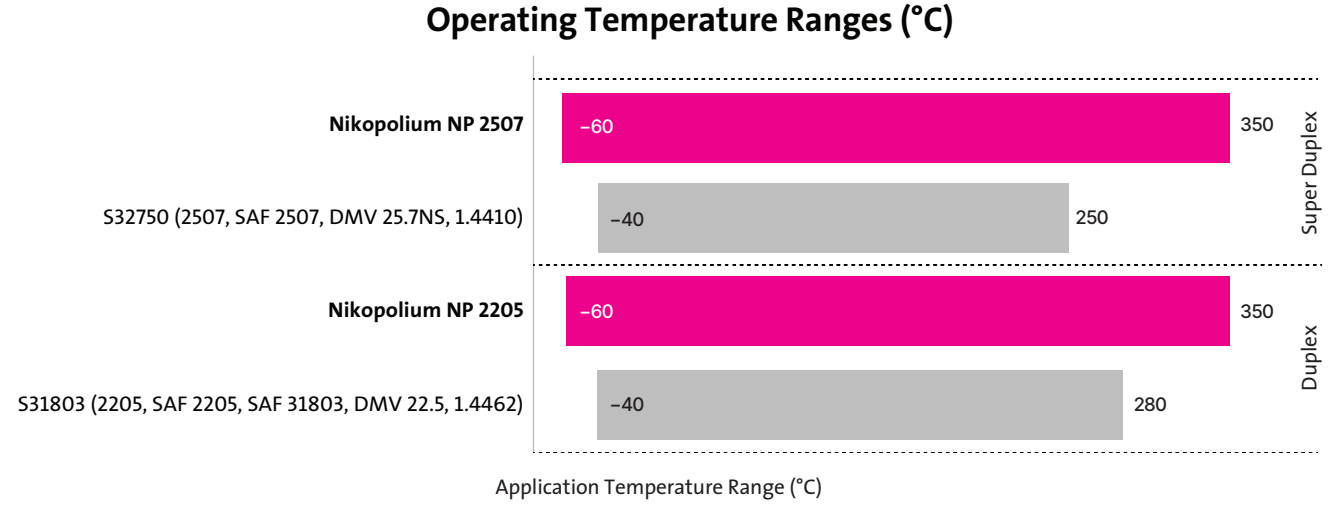


Application Temperatures

Standard Reference for Duplex & Superduex Stainless Steels: According to **EN 10216-5**;

VdTÜV Werkstoffblatt 418 and VdTÜV Werkstoffblatt 508 the recommended temperature limits for duplex & super duplex grades like S31803, S32750 are as follows:

- **Maximum Operating Temperature**: 250–280 °C in pressure-bearing applications. This restriction exists to avoid the formation of brittle intermetallic phases, such as sigma phase, which significantly deteriorate mechanical and corrosion properties.
- **Minimum Operating Temperature**: –40 °C, provided that the material demonstrates sufficient impact toughness at this level.



While traditional duplex and super duplex steel grades are **limited to 250–280 °C** in pressure service, **Nikopolium NP grades extend this upper limit by +100 °C**, opening new opportunities in high-temperature applications like **heat exchangers, reactors, and offshore gas dehydration systems**.

Similarly, the **lower application limit of –60 °C** makes Nikopolium an ideal candidate for cryogenic or arctic conditions (e.g., **LNG infrastructure and subsea applications**) where standard duplexes may require additional qualification.

This **widened operational envelope** is made possible by **proprietary grain boundary engineering**, which ensures phase stability and resistance to embrittlement over a broader thermal range.

Corrosion Resistance

Corrosion resistance is the defining feature of Nikopolium NP 2205 and NP 2507. Developed using Centravis proprietary grain boundary engineering and advanced heat treatment technology, these materials achieve **corrosion performance comparable to premium Nickel Alloys**, while maintaining the mechanical and economic benefits of duplex stainless steels.

1. Resistance to Pitting Corrosion – ASTM G48, Procedure A

ASTM G48, Pr. A is a critical immersion test that evaluates a material's resistance to localized corrosion in a 6% ferric chloride ($FeCl_3$) solution. The test is destructive and is carried out at incrementally elevated temperatures until visible pitting or excessive mass loss is observed.

Acceptance Criteria: The corrosion rate must be < 0.0001 g/cm².

Recommended Testing Temperatures:

- 22 °C for standard duplex (e.g., UNS S31803)
- 50 °C for super duplex (e.g., UNS S32750)

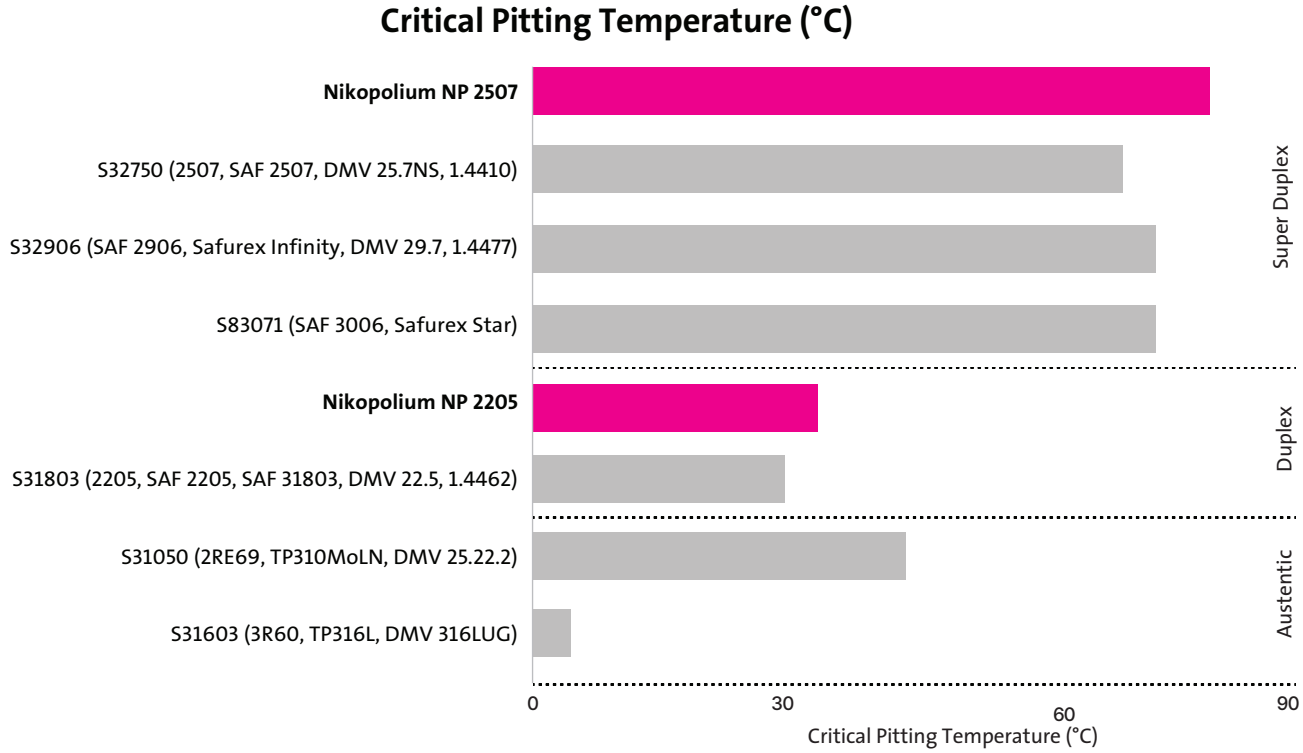
Material	Temperature (°C)	Corrosion Rate
S31803	max 25 °C	< 0.0001 g/cm²
NP 2205	35 °C	< 0.0001 g/cm²
S32750	max 50 °C	< 0.0001 g/cm²
NP 2507	55 °C	< 0.0001 g/cm²

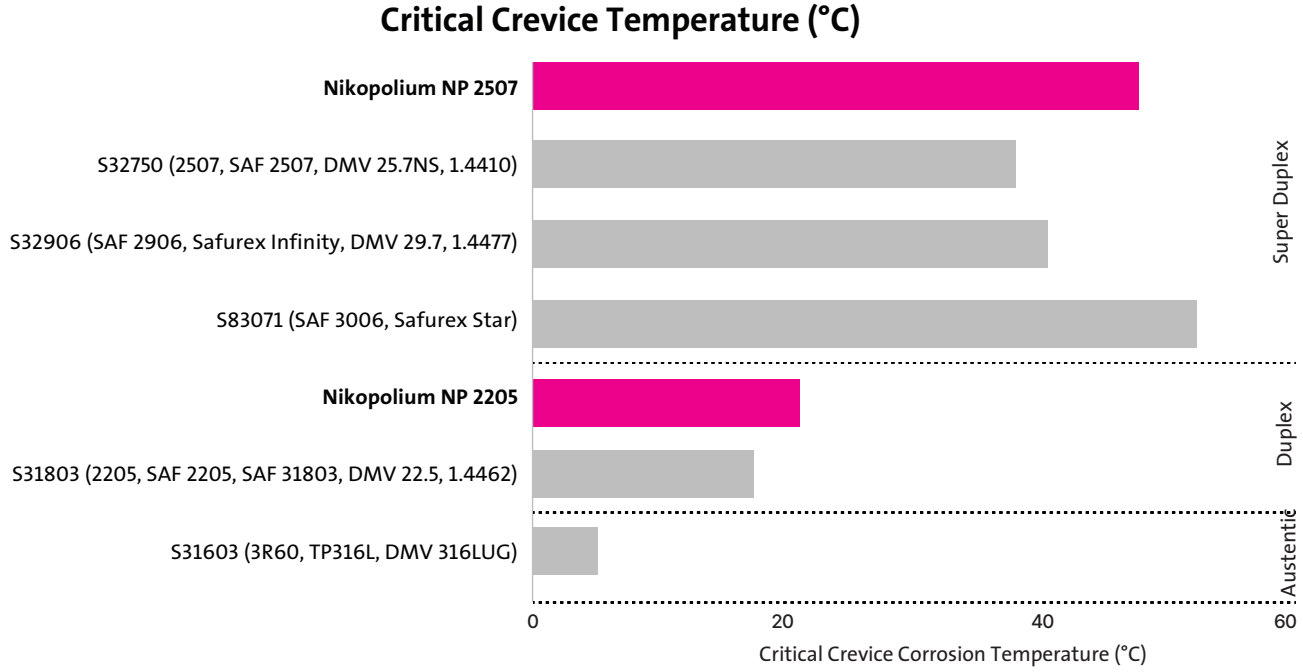
NP 2205 exceeds the standard requirement for S31803 by **10 °C**, indicating **enhanced pitting resistance**.
NP 2507 withstands **5 °C higher than S32750**, pushing performance boundaries in aggressive chloride-rich environments.

This performance increase provides **extended operational safety margins** in offshore, marine, and chemical process service where temperature and chloride loads can fluctuate unpredictably.

2. Pitting and Crevice Corrosion Resistance – ASTM G48, Method E and D

The resistance to localized corrosion (pitting and crevice) has been assessed using **ASTM G48, Method E and D** (6% $FeCl_3$ immersion). Nikopolium NP 2507 exhibits superior pitting and crevice resistance even in comparison to high-alloy super duplex, as validated in critical chloride environments.



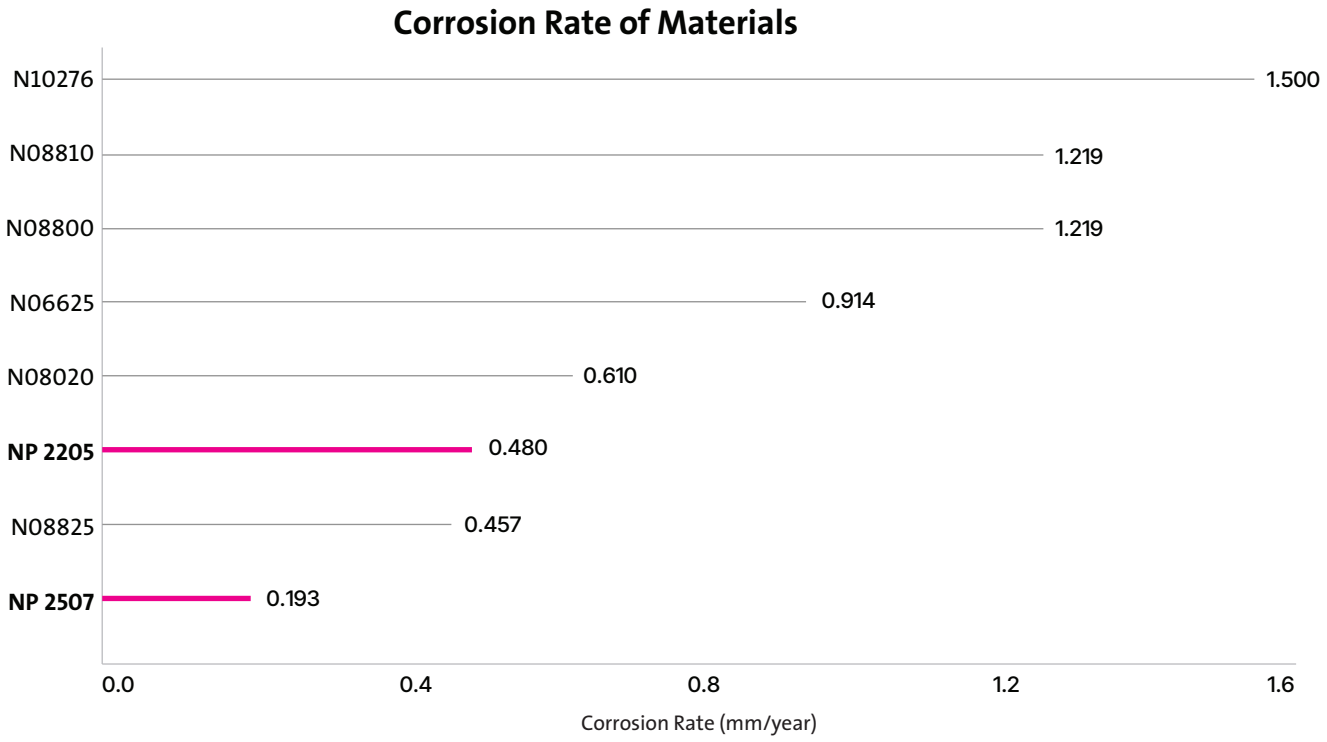


Calculated CPT and CCT values for NP 2205 and NP 2507 acc. to the procedure ASTM G-48, method E and D, based on the actual weight loss of the testing samples (<0,0001gr/cm²) and their chemical composition.

3. Intergranular Corrosion (IGC) – ASTM G28, Method A

Both Nikopolium grades meet and exceed acceptance criteria per **Aramco 01-SAMSS-047**, with corrosion rates **below 0.5 mm/year**, substantially outperforming commonly used nickel-based alloys. This test evaluates resistance to **intergranular attack** in boiling ferric **sulfate –50% sulfuric acid** solution for 120 hours.

Long-term immersion test designed to simulate real-world aggressive acid environments. Acceptance is based on corrosion rates remaining within thresholds suitable for sour gas, pressure vessel, and refinery conditions.



Cost efficiency

Nikopolium NP 2205 and NP 2507 combine high mechanical strength with enhanced corrosion resistance, enabling thinner wall designs, lower alloy consumption, and extended service life. These properties offer a cost-effective alternative to high-Ni austenitic grades and nickel alloys such as Alloy 625 or C-276.
The optimized composition and performance allow for:

- Reduced material and fabrication costs
- Lower total lifecycle cost
- Replacement of more expensive corrosion-resistant alloys in demanding applications

Centravis Nikopolium presents a technically validated and commercially viable alternative to traditional high-cost corrosion-resistant alloys. They enable end users to meet demanding service requirements while improving project economics and lifecycle value.

Microstructural Stability

The corrosion and mechanical performance of duplex stainless steels are strongly influenced by their phase balance and grain structure. Nikopolium NP 2205 and NP 2507 are designed under cutting-edge grain boundary engineering for Duplex Stainless Steels to deliver excellent microstructural stability, ensuring long-term reliability in demanding applications.

Microstructure characterization was conducted using:

- EBSD (Electron Backscatter Diffraction) – to assess grain boundary character, crystallographic orientation, and phase distribution
- SEM/EDS (Scanning Electron Microscopy / Energy Dispersive Spectroscopy) – to verify phase chemistry and morphology

Balanced Phase Distribution:

- NP 2205: 48% ferrite / 52% austenite
- NP 2507: 45% ferrite / 55% austenite

These values are near-optimal for duplex steels, supporting strength, toughness, and corrosion resistance.

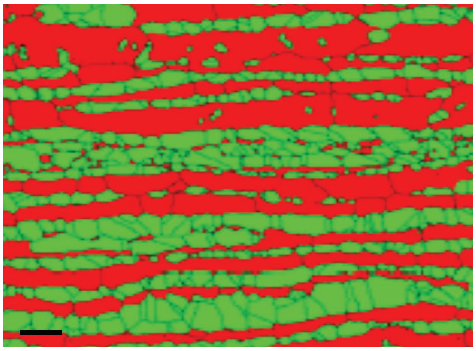
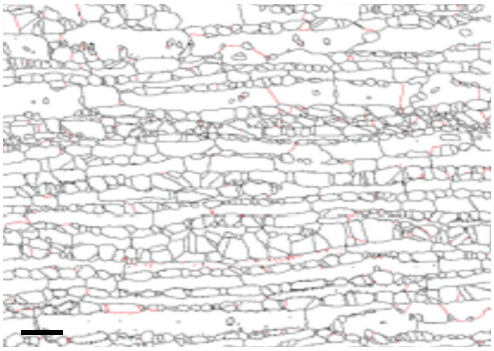
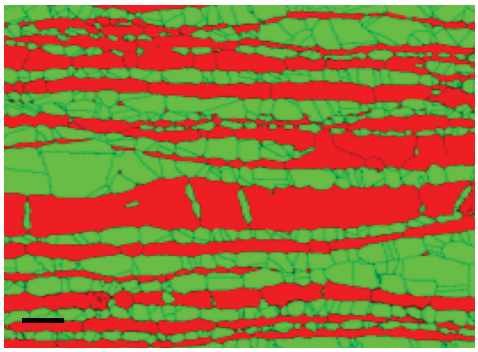
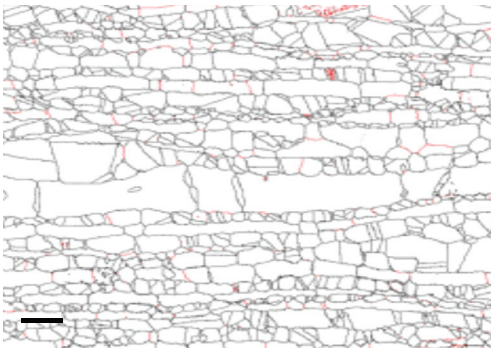
Recrystallized Microstructure

A high fraction of **high-angle grain boundaries (>15°)** was observed, indicating a stable recrystallized state. This structure resists phase transformation during fabrication and service, enhancing long-term material integrity.

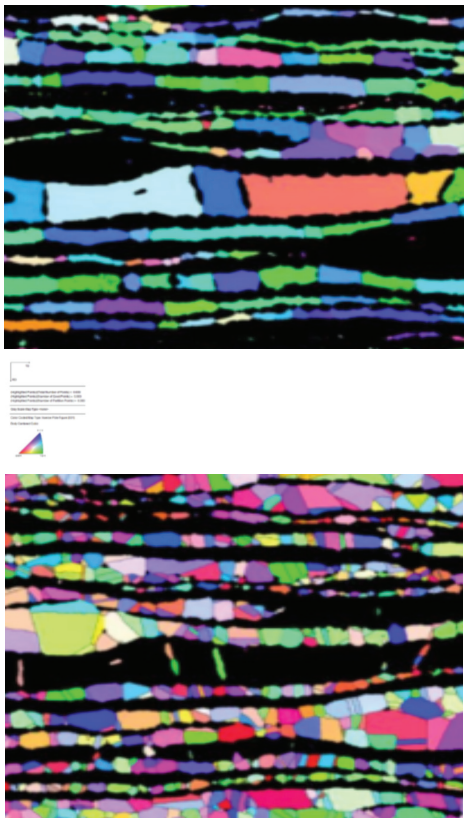
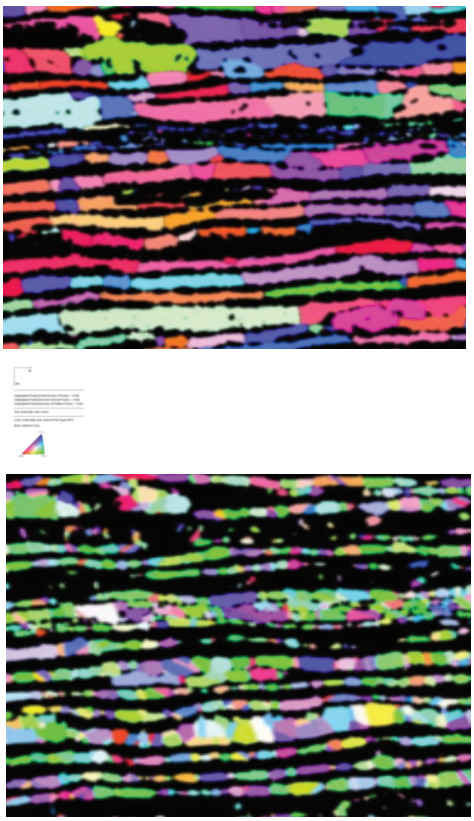
Fine Austenitic Grains

Finer austenitic grains promote resistance to pitting and intergranular corrosion by minimizing chromium depletion along grain boundaries. This refinement also improves toughness and facilitates uniform passive film formation.

The refined, well-balanced duplex microstructure with the improved austenitic phase of Nikopolium grades is a key differentiator. Supported by EBSD and SEM analysis, it ensures exceptional corrosion performance and thermal stability, even in aggressive environments or high-temperature service cycles.

Phase distribution	Grain boundary misorientation
	
Phase / Total Fraction / Partition Fraction Body Centered Cubic 0.523 0.523 Face Centered Cubic 0.477 0.477 **Boundaries Rotation Angle** Min 15° Max 180° Fraction 0.957 Number 63047 Length 3.15 cm	**Black:** misorientation >15° **Red:** misorientation ≤15°
	
Phase / Total Fraction / Partition Fraction Body Centered Cubic 0.452 0.452 Face Centered Cubic 0.548 0.548 **Boundaries Rotation Angle** Min 15° Max 180° Fraction 0.946 Number 51511 Length 2.58 cm	**Black**: misorientation >15° **Red:** misorientation ≤15°

Phase distribution maps, grain boundary misorientation maps.

Super Duplex steel (NP 2507)	Duplex steel (NP 2205)
	

Inverse Pole Figures of the Normal Direction for BCC (left) and FCC (right)

Surface Condition

Nikopolium NP 2205 and NP 2507 tubes and pipes are supplied with high-quality internal and external surface finishes tailored to meet the demands of aggressive and high-purity service environments. The surface condition is a critical aspect of corrosion resistance and cleanliness, particularly in chemical, offshore, and heat exchanger applications.

Available Surface Finishes

- **Pickled (P)** Tubes undergo acid pickling to remove surface oxides and scale after hot forming. This provides a clean, matte surface ideal for general industrial applications.
- **Bright Annealed (BA)** Cold finished tubes are **solution annealed and bright annealed** in a **high-purity hydrogen atmosphere**, ensuring:
  - Exceptionally smooth and metallic-bright internal and external surfaces
  - Minimal surface contamination
  - Optimized corrosion resistance, especially in heat exchanger, chemical processing, and ultra-clean service applications

Surface Quality Assurance

- Internal and external surfaces are **inspected visually and dimensionally** to ensure conformance with: **EN 10216-5**, ASTM A 789; ASTM A 790, specific customer requirements;
- **Cleanliness and integrity** of the surfaces are maintained throughout production and packaging to ensure readiness for welding, bending, and direct service exposure.

Note: Smooth and defect-free surface finishes contribute directly to improved pitting resistance, ease of cleaning, and longer equipment service life.

Forms of supply

- Seamless hot and cold finished tubes and pipes
- Seamless cold finished U – tubes

Heat Treatment

The tubes are delivered in the heat-treated condition under the Centravis technology

Formability and Weldability

- Good weldability with standard methods (TIG, GTAW)
- Low thermal expansion reduces residual stress
- Suitable for cold and hot forming; guidance available upon request

Sustainability

Nikopolium NP 2205 and NP 2507 are engineered to support environmental goals without compromising performance. By reducing material usage, energy consumption, and dependency on critical raw materials, these grades offer a sustainable alternative to traditional high-alloy systems.

Key Sustainability Advantages

- **Lower Nickel Content**: Significantly reduced nickel content compared to Ni-based alloys minimizes reliance on energy-intensive, high-impact raw materials.
- **Energy-Efficient Production**: Compatible with modern steelmaking methods such as Argon-Oxygen Decarburization (AOD), supporting lower CO_2 emissions per ton of steel produced.
- **Material Efficiency**: High mechanical strength enables thinner wall constructions, reducing total material input and associated embodied energy.