Austenitic Stainless Steel

# Aperam 201LN with Manganese and Nitrogen addition

## Chemical Composition

| Elements | C | N | Mn | Cr | Ni | Cu |
|---|---|---|---|---|---|---|
| % | 0.025 | 0.18 | 7.0 | 16.30 | 4.75 | 0.30 |

Typical values

| European designation [1] |
|---|
| X2CrMnNiN17-7-5 / 1.4371 |

[1] According to EN 10088-2

This grade complies with:

- Aperam Stainless Europe - Safety Information Sheet for Stainless Steel
- European Directive 2000/53/EC on end-of-life vehicles and later modifications
- NFA 36 711 standard "Stainless steel intended for use in contact with foodstuffs, products and beverages for human and animal consumption (non packaging steel)"
- Requirements of NSF/ANSI 51-2009 edition International Standard for "Food Equipment Materials" and of FDA (United States Food and Drug Administration) requirements regarding materials used for food contact
- French Decree No.92-631 dated 8 July 1992 and Regulation No. 1935/2004 of the European Parliament and the Council of 27 October 2004 on materials and articles intended to come into contact with food (and repealing Directives 80/590/EEC and 89/109/EEC)
- French regulatory paper dated 13 January 1976 relating to materials and articles made of stainless steel in contact with foodstuffs

## Key Features

- Elevated mechanical properties in annealed condition with high elongation
- High potential work hardening
- Very good resistance to intergranular corrosion
- Excellent weldability
- High ductility, strength and toughness at cryogenic temperatures

## Applications

- Railroad and transportation
- Cryogenic tanks, storage vessels and piping
- High performance welded structures, including those at sub-zero temperatures
- In general, all applications where austenitic grade 1.4318 (Type 301LN) is used, with 201LN having the added advantage of price stability due to its lower nickel content

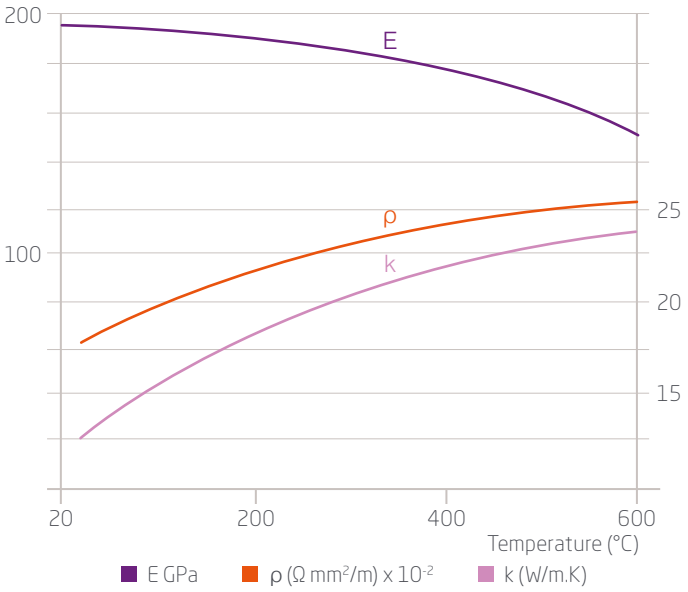
## Product Range

| | Coils | Sheets / Blanks |
|---|---|---|
| Thickness (mm) | 0.50 up to 13 | 0.50 up to 13 |
| Width (mm) | up to 2,000 | up to 2,000 |
| Finish | 1D / 2B / 2D / 2E | 1D / 2B / 2D / 2E |

# Physical Properties

## Cold rolled and annealed sheet

| | | | | |
|---|---|---|---|---|
| Density | d | kg/dm³ | 20°C | 7.8 |
| Melting temperature | - | °C | Liquidus | 1,420 |
| Specific heat | c | J/kg.K | 20°C | 500 |
| Thermal conductivity | k | W/m.K | 20°C | 15 |
| Mean coefficient of Thermal expansion | α | $10^{-6}$/K | 20-100°C<br>20-200°C<br>20-400°C | 17.0<br>17.5<br>18.5 |
| Electric resistivity | ρ | Ω mm²/m | 20°C | 0.7 |
| Magnetic permeability | μ | 0.8 kA/m DC or AC | 20°C | 1.05 |
| Young's modulus | E | GPa | 20°C | 200 |




# Mechanical Properties

## Test piece

Length = 80 mm (thickness < 3 mm)
Length = 5.65 * √So (thickness ≥ 3 mm)

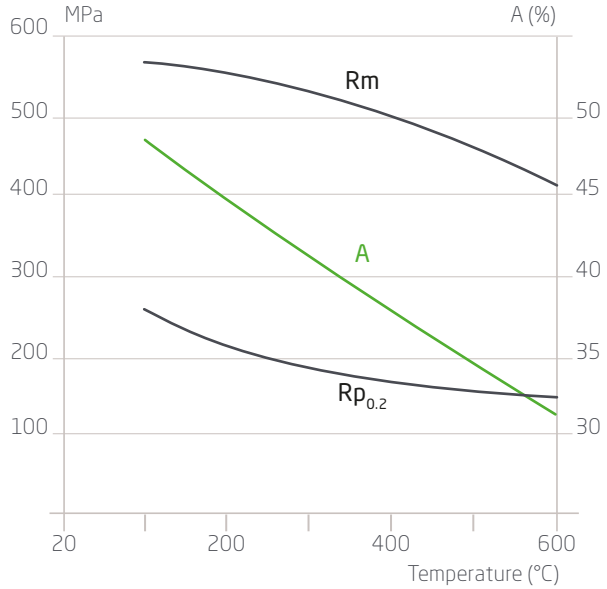
## In annealed or tempered condition

According to ISO 6892-1, part 1
Test piece perpendicular to rolling direction

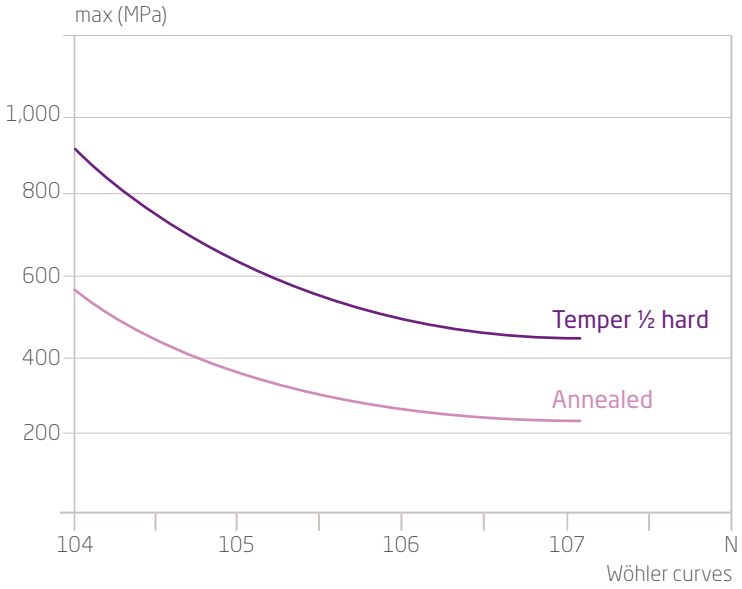
| Grades | European designation | ASTM A240 | Condition | $R_m$ (1) (MPa) | $Rp_{0.2}$ (2) (MPa) | A (3) (%) |
|---|---|---|---|---|---|---|
| 201LN | 1.4371 | 201LN | Annealed | 720 | 360 | 55 |
| 301L | 1.4318 | 301LN | Annealed | 765 | 360 | 50 |
| 316L | 1.4401/4404 | 316/316L | Annealed | 620 | 300 | 52 |
| DX2205 | 1.4462 | 2205 | Annealed | 840 | 620 | 29 |
| K44 | 1.4521 | 444 | Annealed | 520 | 370 | 29 |

1 MPa = 1 N/mm² - Typical values
(1) Ultimate Tensile Strength (UTS) - (2) Yield Strength (YS) - (3) Elongation (A)

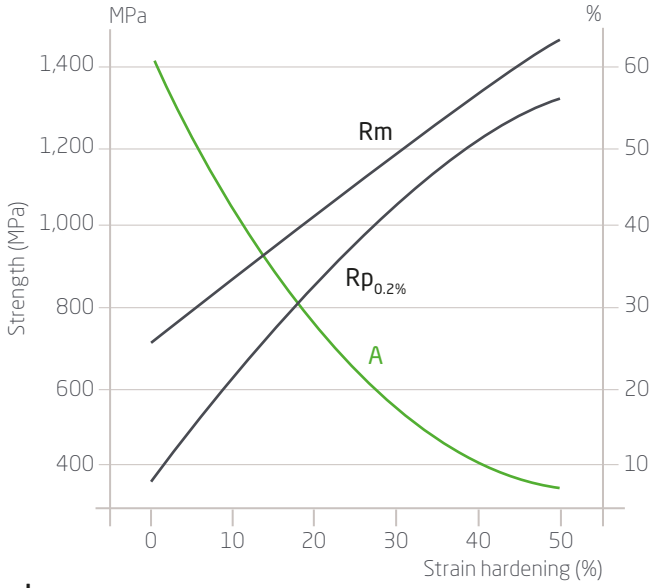
## At high temperatures

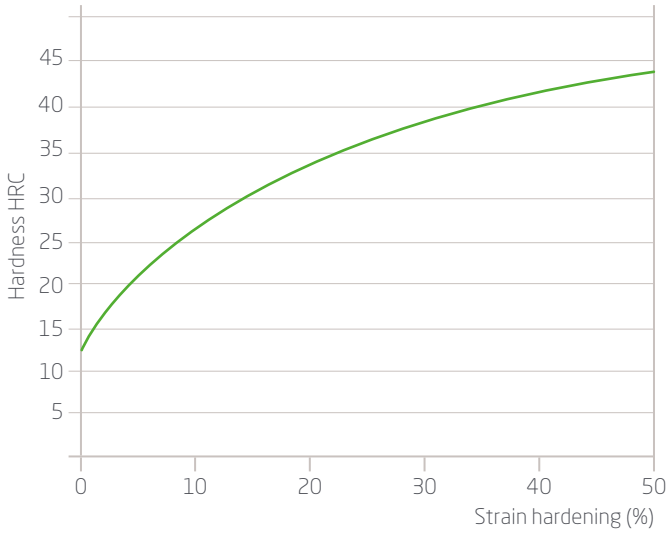



## Fatigue resistance

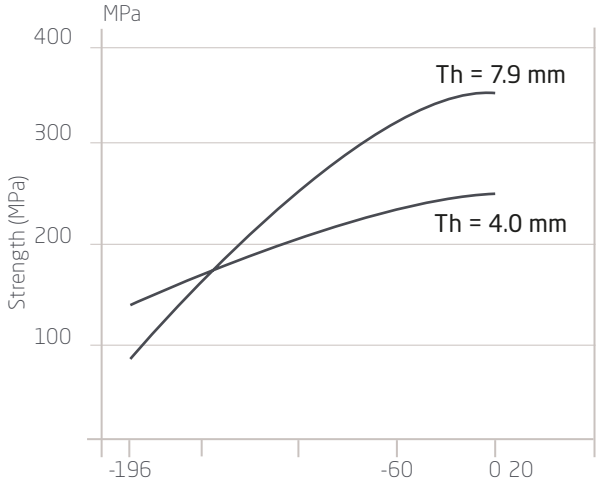


### Strength and hardness as a function of strain hardening




### Toughness




Average value in J/cm² for two different thicknesses (4.0 and 7.9 mm), corresponds to EN10088-2 specifications.

The toughness of our 201LN grade is higher than 75 J/cm² at a temperature of -196°C and higher than 230 J/cm² at a temperature of -60°C.

## Corrosion Resistance

Our 201LN grade has good resistance to common types of corrosion, nearly equivalent to that of our 304L grade (1.4307) in most environments. It is particularly well-suited for use whenever there is a risk of intergranular corrosion.

201LN has excellent atmospheric corrosion resistance in urban and rural environments.

### Corrosion in acids

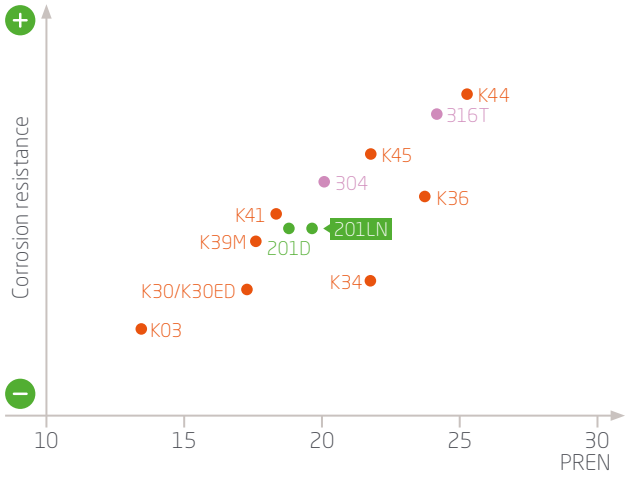
201LN is resistant to various acids:

- Phosphoric acid (all solutions) at room temperature
- Nitric acid (36° Baumé) at any temperature
- Formic and lactic acid at room temperature
- Cold organic acids when diluted

It is also resistant to salty solutions without chlorides and in foodstuffs.

### Pitting corrosion

- Pitting potential in NaCl 0.02M, pH = 6.6 aerated environment at 23°C is 440mV/SCE
- Critical corrosion current density in $H_2SO_4$ 2M at 23°C is 500 µA/cm²



### Crevice Corrosion

Crevice corrosion is a type of corrosion that can be divided into two processes. During the first process, called initiation, discrete pits are formed within the crevice region if the pH is below the depassivation pH of the grade locally.

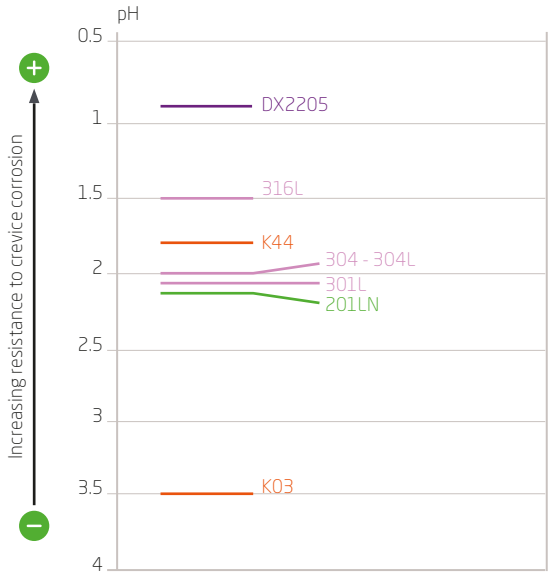
Propagation is the second process and involves the dissolution of metal. To slow this process down, molybdenum and nickel containing grades are preferred as both these elements help decrease the propagation rate.

### Intergranular corrosion

201LN is recommended whenever there is a risk of intergranular corrosion. This is because the grade meets the following requirements of the standard intergranular corrosion tests:

- AFNOR A 05159 (sensitizing treatments T1 and T2)
- EN 114-72
- INDRET (treatment R)

### Depassivation pH in a deaerated NaCl 2M environment at 23°C




## Forming

In the annealed condition, our 201LN grade can be readily cold formed using all standard processes, including bending, profiling, drawing, deep drawing, roll-forming, spinning, etc.

Due to its elevated mechanical properties and the fact that is nitrogen content means it can be hardened by cold-forming operations, 201LN grade requires larger forming efforts. It also induces a springback effect. Its forming behaviour is similar to that of 301L.

| Grades | European designation | ASTM - A240 | Condition | LDR* |
|---|---|---|---|---|
| 201LN | 1.4371 | 201LN | Annealed | 2.0 |
| 316L | 1.4401/4404 | 316/316L | Annealed | 2.01 |
| DX2205 | 1.4462 | 2205 | Annealed | 1.90 - 1.95 |
| K44 | 1.4521 | 444 | Annealed | 2.10 - 2.15 |

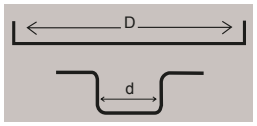
* Limiting Drawing Ratio – 0.8mm thick sheet
Lubricant = Mobilux EP00

### Deep drawing (Swift test)

The Swift test is a method to determine the Limiting Drawing Ratio (LDR). LDR is defined by the maximum ratio between the blank diameter (variable) and the punch diameter (fixed), for which the drawing operation can be performed successfully in one step.

Our 201LN grade has a good bending capacity of up to 180°, with very small bending radii for thicknesses below 0.8 mm.

For thicker gauges, a bending radius of at least half the thickness of the sheet is recommended. When bending the material, the elastic springback must always be taken into consideration.




$$LDR = \frac{D_{max}}{d}$$

## Welding

| Welding process | No filler material | With filler metal | | | Shielding gas |
|---|---|---|---|---|---|
| | Typical thicknesses | Thicknesses | Filler material | | |
| | | | Rod | Wire | |
| Resistance: spot, seam | ≤ 2 mm | | | | |
| TIG/PLASMA | < 1.5 mm | > 0.5 mm | ER 308 L [1]/G 19 9 L Si [2]<br>ER 316L / G 19 12 3 L Si<br>ER 2209 / G 22 9 3 N L Si | | Ar (I1) [3]<br>Ar + 5% H (R1)<br>Ar + He (I3) |
| MIG | | > 0.8 mm | | ER 308 L Si / G 19 9 L Si<br>ER 316 L Si / G 19 12 3 L Si<br>ER 2209 / G 22 9 3 N L | Ar + 2% $CO_2$ (M12)<br>Ar + 3% $CO_2$ + 1% $H_2$ (M11) |
| S.A.W. | | > 2 mm | | ER 308 L / S 19 9 L<br>ER 316 L / S 19 12 3 L<br>ER 2209 / S 22 9 3 N L | |
| Electrode | | Repairs | E 308 L - 15 / E 19 9 L B 2 2<br>E 308 L - 17 / E 19 9 L R 3 2<br>E 316 L - 15 / E 19 12 3 L B 2 2<br>E 316 L - 16 / E 19 12 3 L R 1 5<br>E 316 L - 17 / E 19 12 3 L R 3 2<br>E 2209 - 15 / E 22 9 3 N L B 2 2<br>E 2209 - 17 / E 22 9 3 N L R 3 2 | ER 308 L<br>ER 347 | $CO_2$<br>$H_2$ |
| Laser | < 5 mm | | | | He |

[1] AWS A5.9 - [2] EN ISO 14343 - [3] EN 439

## Welding (continued)

When using ER308L filler metal, tensile tests have shown that cracks can occur in the weld. To avoid this, Argon + $N_2$ gas can be used to enhance the weld's mechanical properties. Weldability is excellent and similar to that of our 1.4307 grade (Type 304LN). No heat treatment is necessary after welding.

To fully restore the grade's corrosion resistance properties, the welds must be chemically or mechanically descaled and subsequently passivated.

## Heat Treatment and Finishing

### Annealing

After cold forming (work hardening) and welding, an annealing treatment for a couple of minutes at 1,050 ±25°C, followed by quenching, restores the microstructure (recrystallisation and dissolution of carbides) and eliminates internal stresses.

After annealing, pickling, followed by passivation, is necessary.

### Pickling

- Nitric-Hydrofluoric acid mixture (10% $HNO_3$ + 2% HF) at ambient temperature or up to 60°C
- Sulfuric-nitric acid mixture (10% $H_2SO_4$ + 0.5% $HNO_3$) at 60°C
- Use descaling pastes for weld areas

### Passivation

- 20 - 25% $HNO_3$ solution (36° Baumé) at 20°C
- Use passivating pastes for weld areas

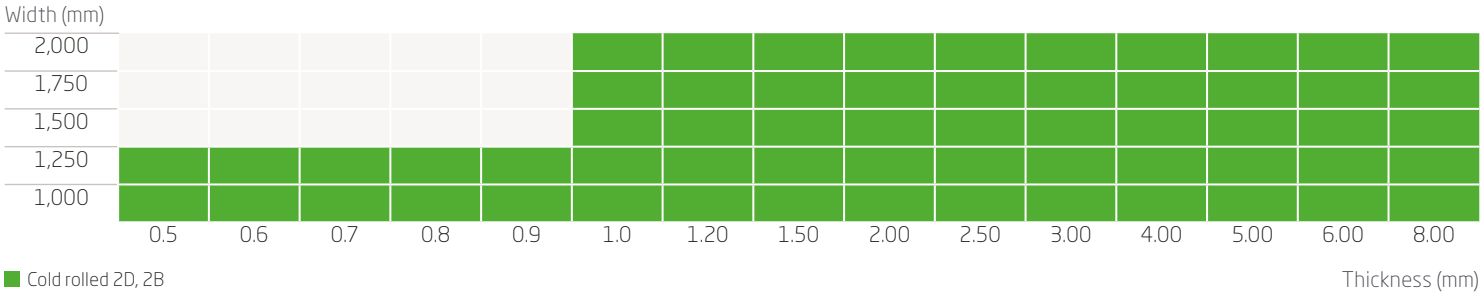
### Polishing

The surface of our 201LN is suitable for all kinds of polishing, brushing, buffing and satin finishing.

## Size Range

Our size range is based on our production capabilities. For the latest information per grades on our offer, please consult us.

### Cold Rolled




### Hot-Rolled and HRC