Austenitic stainless steel offer

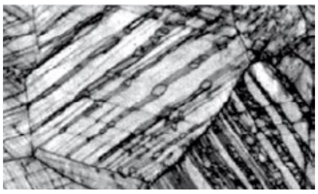
Aperam 301M 301M

Chemical analysis

Grade designation	EN	C	Si	Cr	Ni	Mo	Mn
	1.4310	0.05 0.15	<2	16 19	6 9.5	<0.8	<0.2
301M	1.4310	0.1	0.6	17.3	7.3	-	0.9

European designation	American designation
X10CrNi18-8/1.4310	Type 301

- Austenitic grades are fully constituted by face centered cubic austenite. Cold deformation of austenitic grade may induce a transformation of the austenite into martensite (temper C1000 grade - TRIP effect). The standard annealing treatment for the austenite is performed at 1050°C followed by a quenching.



Deformed austenite GG 8-9ASTM

This grade complies with:

- Stainless Europe Material Safety Data Sheet n°1 (European Directive 2001/58/EC).
- European Directive 2000/53/EC on end-of-life vehicles and later modifications.

General characteristics

The principal features of our grade 301M (17-7C) are:

- The 301/1.4310 series is characterized by relatively low nickel content.
- High mechanical characteristics are promoted by high carbon level.
- A very low sulphur content combined with the chromium content, guaranteeing pitting corrosion resistance close to that of grade 1.4301, Type 304.
- Good formability without risk of delayed cracking after deep drawing.
- Good weldability.
- Good polishing ability.
- A dimensional offer identical to the grade 1. 4301, Type 304.

Applications

The grade 301M is very well known for the stability of its austenitic phase and its capacity to be easily work hardened to achieve a high level of mechanical strength > 950 MPa. For this reason 301M can be used in multiple applications where safety is required, such as rolling stock, pressure cooker closure systems, safety shoe reinforcement, cylinder head gaskets, etc.

Product range

Forms: Sheets, blanks, coils

Thicknesses: from 0.4 mm up to 2 mm

Widths: from 40 mm to 1250 mm

Finishes: Annealed 2B

Tempered condition C850 - C1300: consult us

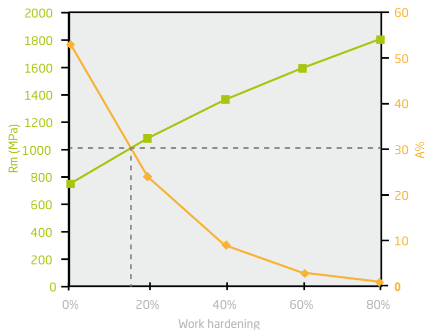
Physical properties

Thermal conductivity	Specific heat	Thermal expansion	Specific weight	Young Modulus	Poisson ratio
$W.m^{-1}.K^{-1}$ 20°C	$J.kg^{-1}.K^{-1}$ 20°C	$10^{-6}.K^{-1}$ 20 to 100°C	kg/dm^3 20°C	GPa 20°C	20°C
15	500	16	7.9	200	0.3

Mechanical properties

Grade designation		Rm MPa	Rp0.2% MPa	A %
	A pillar target	950-1100	650-800	>26
301M	C1000	1000	740	30

The high work hardening sensitivity makes 301M available on a wide range of mechanical properties. An ultimate tensile strength UTS of 1000 MPa has been chosen to fulfil sufficient yield strength and elongation. 30% elongation allows the manufacture of difficult parts.



Fatigue resistance properties

Wöhler, Manson-Coffin curves are generally available on demand.
Endurance upper limit is estimated from the tensile strength (45% of Rm).

Stress ratio	R=-1	R=0.1
σ_e at 2.10^6 (20Hz) MPa	480	700

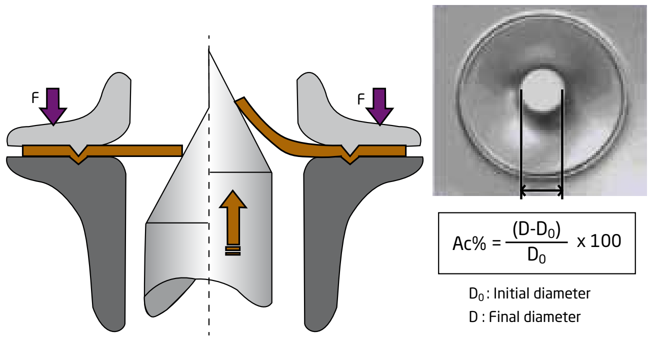
R = ratio sigma max/sigma min

Expansion mechanical characterization

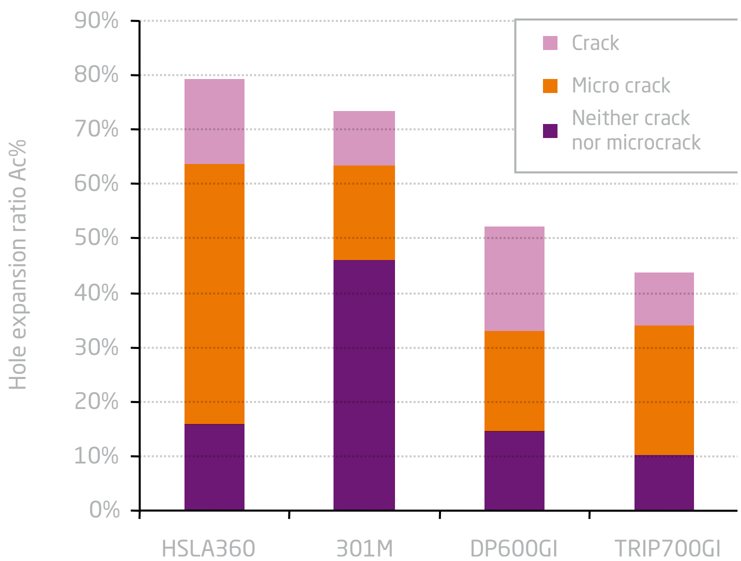
The tests here below are related to expansion mechanical characterization.

Hole expansion

The hole expansion behaviour is an important parameter when deep drawing is done after cutting.



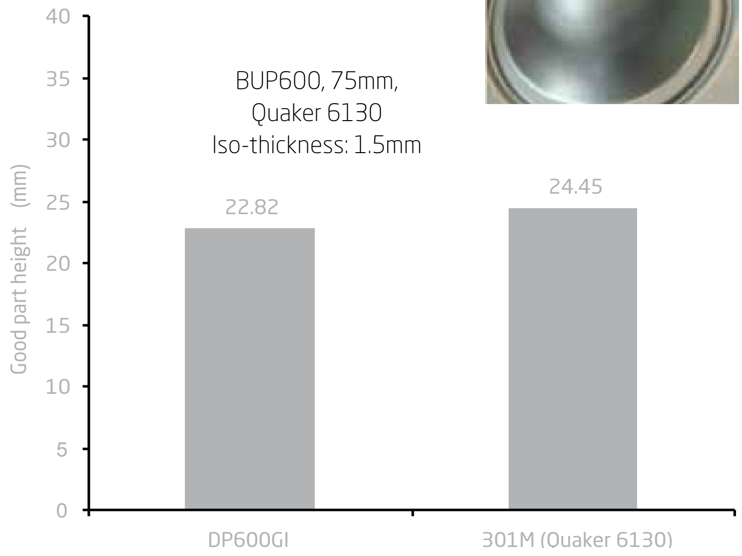
The hole expansion behaviour of the 301M stainless steel is better than DP600GI and TRIP700GI steels.
According to the ISO method, the hole expansion ratio is slightly higher for the HSLA360 steel, but micro cracks appear after ~45% in the 301M stainless steel compared to ~15% in the HSLA360 steel.



In addition crash tests are necessary to follow complete grade characterization for automotive applications.
Therefore bending and compression crashes have been carried out.
According to the ArcelorMittal statistical model, the 301M stainless steel allows a weight reduction of ~ 30% compared to a mild steel and 10% compared to TRIP700.

Erichsen test

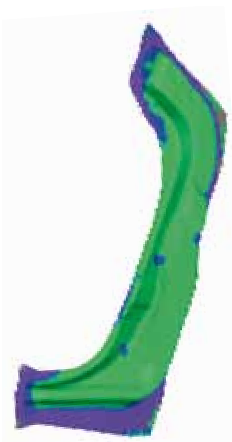
In expansion, the part height is higher in 301M stainless steel than in the DP600 steel for a «standard» lubrification.

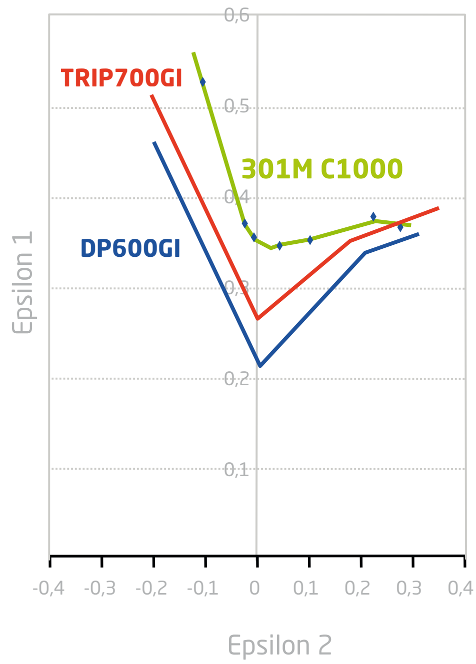


Forming Limit Curves

The forming limit curve helps to predict forming behaviour in all deformation modes.
For 301M (1.5 mm) ➪ experimental Nakazima FLC
For TRIP700GI and DP 600GI (1.5 mm) ➪ predictions of the ArcelorMittal V9.2 model

Epsilon 1	Epsilon 2
0.527	-0.105
0.372	-0.020
0.355	-0.006
0.345	0.044
0,351	0.101
0.378	0.226
0.365	0.277

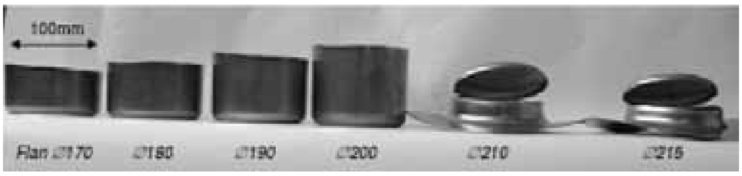




The forming limit curve of 301M is significantly higher than TRIP700 and DP600 (plane tensile state especially).

Deep Drawing - Cup test (Swift test)

Cup tests are also implemented on 301M C1000 first to evaluate the drawing capacity, this test is also used to qualify delay cracking sensitivity.



Swift tests help us to determine the limit drawing ratio LDR. LDR value is equal to 2.02 which is the level of austenitic stainless steel.

Swift tests allow also to characterize the delay cracking sensitivity. 301M C1000 chemical composition has been optimized to prevent delay cracking sensitivity.
Delay cracking occurs for high drawing ratios near the limits recorded for LDR.

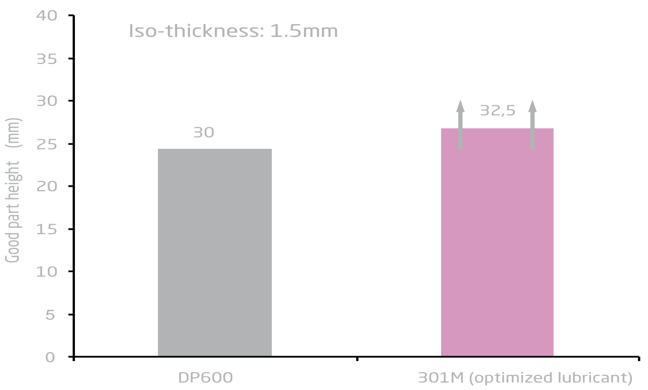
No delay cracking has been observed in air for drawing ratio up to 1.9.

Cross tool

Cross tools test is less common but remains helpful to complete our conventional mechanical tests with realistic samples showing both drawing and expansion. Cross tool testing first highlight the deep drawability with dissymmetric shape but also the ability to fit the geometry for cold stamping.

Results show a very good formability.

Deep drawing behaviour of 301M is at the same level of DP600 with standard tools and lubricants.



It can be improved with dedicated tools as shown on the figure above with Teflon foils.

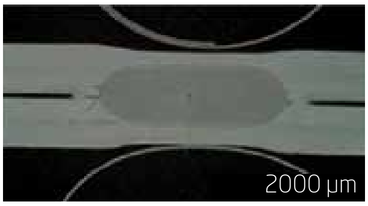
Welding behaviour

The grade 301M C1000 condition can be joined by welding with carbon steel using different techniques: laser for tailored blank; spot welding and MIG for BIW; electrode for repairing. Here below are shown the most relevant examples.

Laser welding

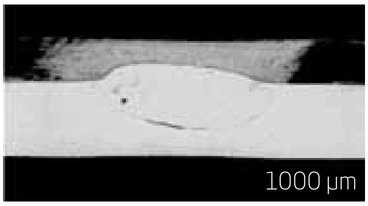
Laser welding is commonly achieved for taylor blanking. 1.4310 like other austenitic grades do not present difficulties regarding galvanized carbon steel.

Resistance spot welding



Molten nuggets 301M / 301M

In resistance spot welding, there is no problem with homogeneous assembly, for example a joining of 2 x 1.5 mm with 450daN electrode force, a large latitude of current of 1.16 kA is achieved.



Molten nuggets 301M / AM04 Zn

The homogeneous welding tensile strengths are from 1200 to 1400 daN and no really significant difference between shear tensile (STT) and pure tension (CTT).

Molten nuggets 301M / DP600

In mixed assemblage with a carbon steel zinc coated, DP600, the latitude is 1.32 kA.
In mixed assembly, the tensile strength (STT) are 800 (beginning of domain) to 1600 daN (ending of domain).

In the table here below are given the conditions for MIG welding.
No heat treatment is necessary after welding. In order to fully restore the corrosion resistance of the metal, the welds must be mechanically or chemically pickled, then passivated.
However, depending on the application, this operation may not be essential.

Welding process	With filler metal			Specific weight
	Thickness	Filler metal		
		Rods	Wires	
MIG	>0.8 mm		ER 308 L (Si) ER 308	Argon + 2% CO_2 Argon + 3% CO_2 +1%H_2 Argon + 2% CO_2 + 5%H_2

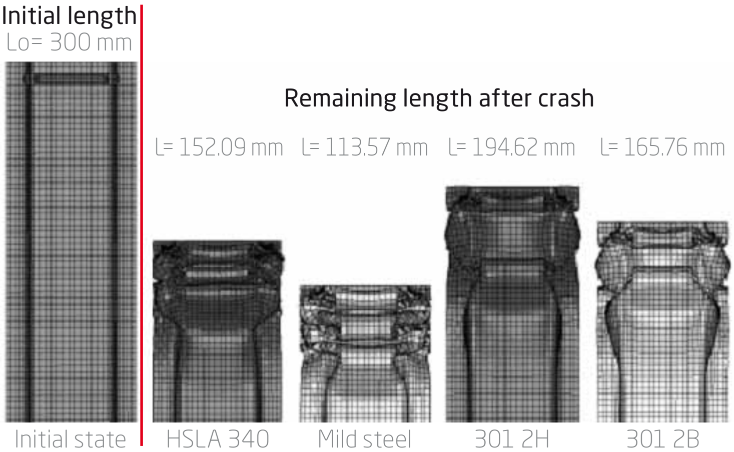
In case of repairing, an electrode E308 can be used.

Crashworthiness - Shock absorption capacity

The strain hardening coefficient n of stainless steel up to 0.6 for 301L is an advantage over aluminium and carbon steel: the faster a loading is applied, the more the alloy (ie stainless) resists to deformation.
This is extremely advantageous with crashes, where loads are applied rapidly by definition.

Impactor weight: 70kg,
Impactor velocity: 13,9m/s,
Energy: 6.8KJ

The figure here below shows the result on omega shape with spot welded joints for HLSA, mild steel and stainless steel 301 type (301L) 2B and temper rolled conditions.

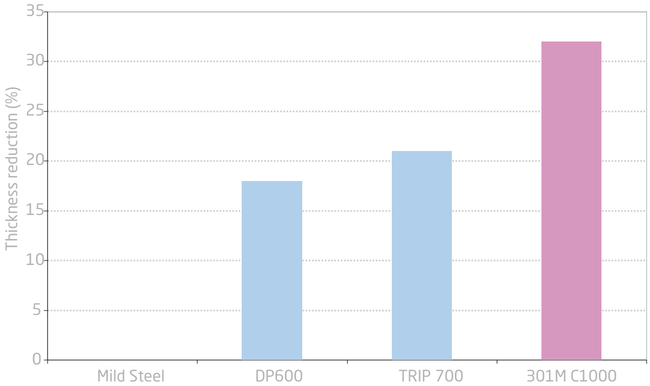


Saving weight and safety are the two mains arguments for 301M C1000 implementation in vehicle. The advantage of this grade is demonstrated through dynamic crash tests in bending and compression.

Crash performances for 1.5 mm thick

In compression

Predictive thickness reduction in compression compared to mild steel



Test conditions (axial compression) on catapult speed = 16m/s and 8m/s; mass = 350 kg; specimen geometry = 60 x 80 x 300 mm

*Average filtered data: 3 specimen

Absorbed Energy* (Joules)	Ultimate Force* (kN)	Average Force* (kN)	Crush* (mm)
13694	248	91.29	150

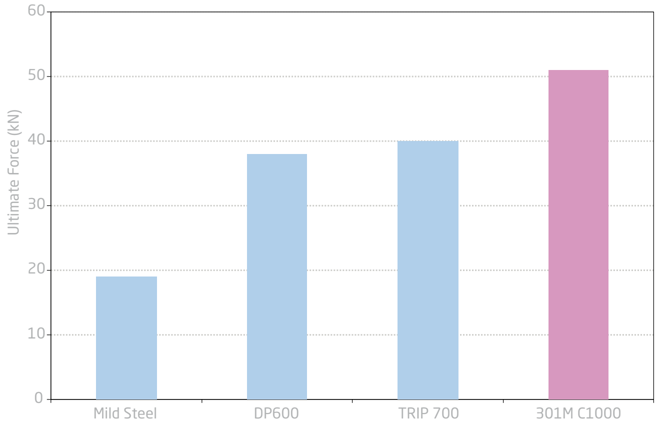
Same conclusions as the bending test can be reported meaning that large weight saving can be recorded by the use of 301M.

made for life

In bending

Bending tests have been conducted with omega shape samples at 30 Km/H speed with V shape and round 350 kg projectile.
Absorption of 50 kN max. strength is in accordance with those calculated by the ArcelorMittal statistical model.

Predictive thickness reduction in bending compared to mild steel



Figures show that more than 30% in weight saving is expected compared to mild steel and 10 % compared to Trip 700.

A few achievements

Illustration of high formability level of 301M on **A pillar:**

Just after stamping operation ...

... and after cutting and trimming operations