Technical Data Sheet

ATI 201 HP™/ATI 201L HP™

Stainless Steel: Austenitic

(UNS S20100 and S20103)

GENERAL PROPERTIES

ATI 201 HP™ and ATI 201L HP™ austenitic stainless steels belong to the 200 series of Cr-Mn-Ni stainless alloys, which are similar to the 300 series of Cr-Ni stainless alloys, but contain less nickel.

Composition Range Per ASTM A240		
Element	**ATI 201 HP™**	**ATI 201L HP™**
Carbon	0.15 Max	0.03 Max.
Manganese	5.50/7.50	5.50/7.50
Silicon	1.00 Max.	0.75 Max.
Chromium	16.00/18.00	16.00/18.00
Nickel	3.50/5.50	3.50/5.50.
Nitrogen	0.25 Max.	0.25 Max
Iron	Balance	Balance

Types ATI 201 HP™ and ATI 201L HP™ are comparable to chromium-nickel types 301, 304, 304L in many respects, but they can provide some advantages over the 18-8 grades in certain applications. Lower cost manganese and nitrogen additions are partial substitutes for nickel in types ATI 201 HP™ and ATI 201L HP™, making them more economical alloys. Because they possess a very desirable combination of economy plus good mechanical properties and corrosion resistance, they have been used in a wide variety of consumer and transportation applications, as illustrated in the following table.

Typical Applications For Types ATI 201 HP™ and ATI 201L HP™	
Formability	**Structural Strength**
Cookware Bodies/Lids	Transit Car Structural Members
Hose Clamps	Transit Car Roofing/Siding
Piston Rings	Thermal Window Spacers
Washing Machine Baskets	Air Bag Containers
	Truck Trailer Posts and Door Frames

ATI 201 HP™ and ATI 201L HP™ alloys are available in plate, sheet, and strip product forms and are listed in ASTM A240.

ATI 201 HP™ alloy has properties similar to type 301, providing excellent mechanical properties in the annealed condition (i.e., strength and formability). Because of its high work hardening rate, it exhibits a high uniform elongation for improved stretchability for severe forming applications such as washing machine baskets.

ATI 201L HP™ alloy is a low carbon version of ATI 201 HP™ and maintains satisfactory intergranular corrosion resistance in applications involving welding, particularly for heavier-gage material.

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Balancing of alloying elements (austenitizers versus ferritizers) in types ATI 201 HP™ and ATI 201L HP™ produces an austenitic structure in the annealed condition even at sub-zero temperatures. This austenitic structure achieves significant strengthening through cold working of the material to produce partial transformation to a stronger martensitic structure. Thus types ATI 201 HP™ and ATI 201L HP™ can display a wide range of mechanical strengths starting from the annealed condition and increasing with increasing degrees of cold working to levels of strength which are necessary for several applications such as transit cars or truck trailer components.

CORROSION RESISTANCE

ATI 201 HP™ alloy is resistant to a wide variety of mild to moderately corrosive media. Generally speaking, type ATI 201 HP™ alloy has proven to be entirely adequate for many applications where type 301 has been satisfactory and has been successfully substituted for type 304 in a variety of mild environments.

General Corrosion

ATI 201 HP™ alloy and types 301, and 304 exhibit comparable corrosion behavior in an organic acid environment.

Corrosion Resistance in Boiling Solution

Corrosion Rate In Mils / Year (mm/y)			
Boiling Test Solution	**ATI 201 HP™**	**Type 301**	**Type 304**
20% Acetic Acid	0.11	0.06	0.07
	(.0028)	(.0016)	(.0018)

* Annealed material tested as duplicate samples for five 48-hour test periods.

The low carbon in type ATI 201 HP™ alloy contributes to its resistance to precipitation of chromium carbides, which increases its resistance to intergranular corrosion.

Unlike the standard carbon grades, the low-carbon ATI 201L HP™ alloy and type 304L did not show increased corrosion rates or cracking in the sensitized condition when compared to an annealed version or as-welded version of that grade.

Intergranular Corrosion Tests

Tests Per ASTM A262	Corrosion Rate Mils Per Year (mm/y)				
	ATI 201 HP™	**ATI 201L HP™**	**Type 301**	**Type 304**	**Type 304L**
Practice B	**Boiling Ferric Sulfate-50% Sulfuric Acid**				
Annealed	56.6 (1.439)	68.2 (1.733)	31.7(0.805)	20.8 (0.527)	20.4 (0.518)
As Welded*	59.1 (1.501)	66.5 (1.689)	32.2 (0.813)	22.4 (0.570)	20.5 (0.521)
Sensitized**	dissolved	70.5 (1.791)	**6105 (155.0)**	**1654 (42.0)**	26.6 (0.675)
Practice C	**65% Nitric Acid, Boiling**				
Annealed	13.3 (0.337)	23.9 (0.607)	13.1 (0.332)	10.2 (0.259)	9.12 (0.232)
As Welded*	12.6 (0.321)	23.3 (0.593)	13.8 (0.350)	10.0 (0.253)	7.44 (0.189)
Sensitized**	**2379 (35.0)**	38.7 (0.982)	**1717 (28.4)**	**441 (11.20)**	17.3 (0.439)
Practice E	**Copper/16% Copper Sulfate/Sulfuric Acid, Boiling**				
Annealed	no cracks	no cracks	no cracks	no cracks	no cracks
As Welded*	no cracks	no cracks	no cracks	no cracks	no cracks
Sensitized**	cracked	no cracks	cracked	cracked	no cracks

* TIG welded material. ** Samples heat treated at 1250°F(677°C) for one hour and air cooled. Results in bold letters are for tests that were discontinued because of high corrosion rates

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Localized Corrosion

The crevice corrosion behavior of ATI 201 HP™, 301, and 304 alloys in a sodium chloride solution are comparable. Susceptibility to crevice corrosion in chlorides increases with increases in temperature.

Chloride Crevice Corrosion Resistance*

Grade	Test Temperature °F (°C)	Average Corrosion Weight Loss g/cm^2
ATI 201 HP™	100 (38)	0.0000
Type 301	100 (38)	0.0000
Type 304	100 (38)	0.0000

* Based on ASTM G48 Test Method, modified by testing duplicate samples in a 3.5% sodium solution with an adjusted pH of 4.0.

OXIDATION RESISTANCE

ATI 201 HP™ alloy possesses good resistance to oxidation and is comparable to type 301 up to about 1550°F (840°C); but it scales more rapidly above this temperature. For intermittent service, particularly when rapid cooling is involved, ATI 201 HP™ is not recommended for service conditions where temperatures above 1500°F (815°C) are encountered. Since the rate of oxidation is affected by the atmosphere to which the metal is exposed, by the heating and cooling cycle, and by the structural design, it is impossible to present data which would be applicable to all service conditions.

PHYSICAL PROPERTIES

Melting Range, °F (°C)	2550-2650 (1400-1455)
Density, lb/in^3 (g/cm^3)	0.284 (7.86)
Specific Gravity	7.86
Electrical Resistivity, (microhm-cm)	67 @ 68°F (20°C)

Mean Coefficient of Thermal Expansion

Temperature Range		Mean Coefficient of Thermal Expansion	
°C	°F	cm/cm/°C	in./in./°F
20-100	68- 212	16.6 x 10^{-6}	9.2 x 10^{-6}
20-316	68- 600	18.0 x 10^{-6}	10.0 x 10^{-6}
20-538	68-1000	19.6 x 10^{-6}	10.9 x 10^{-6}
20-871	68-1600	20.3 x 10^{-6}	11.3 x 10^{-6}

Thermal Conductivity

Temperature Range		W/m·K	Btu/(hr·ft·°F)
°C	°F		
20-100	68-212	16.3	9.4

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Specific Heat

Temperature Range		J/kg·K	Btu/lb./°F
°C	°F		
0-100	32-212	502	0.12

Magnetic Permeability

Properly annealed ATI 201 HP™ and ATI 201L HP™ alloys are fully austenitic materials and have a magnetic permeability generally less than 1.02. Cold working promotes the formation of martensite which results in an increase in magnetic permeability. This increase is dependent upon the exact alloy composition within the specified range, as well as on percent cold reduction. The data below illustrates the increase in magnetic permeability with cold rolling.

Magnetic Permeability

Percent Cold Reduction	D. C. Permeability (μ at 200 H)	
	ATI 201 HP™	ATI 201L HP™
Annealed	1.004	1.008
5	1.014	1.008
10	1.048	1.235
20	1.96	3.42
30	3.95	9.61
40	7.07	22.0
50	13.8	30.0
60	16.0	36.0

MECHANICAL PROPERTIES

ATI 201 HP™ and ATI 201L HP™ alloys are used both in the fully annealed condition and in the cold rolled (temper rolled) condition. The mechanical properties of ATI 201 HP™ and ATI 201L HP™ alloys vary considerably depending upon the amount of cold work introduced. The response to cold work can be controlled to a certain extent by a balance of alloying elements.

These grades develop higher tensile strengths than other more stable austenitic grades and for this reason have found a wide field of application in structural assemblies. ATI 201 HP™ and ATI 201L HP™ alloys may be cold rolled to very high strength levels as indicated in the tables below and the graphs on page 6.

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Effect of Cold Reduction on Room Temperature Mechanical Properties of Sheet (Longitudinal)

Percent Cold Reduction	Tensile Strength ksi (MPa)		Yield Strength (0.2% Offset) ksi (MPa)		Elongation Percent in 2" (50.8mm)		Hardness HRC	
	ATI 201 HP™	ATI 201L HP™	ATI 201 HP™	ATI 201L HP™	ATI 201 HP™	ATI 201L HP™	ATI 201 HP™	ATI 201L HP™
Annealed	101.0 (696)	114.0 (785)	43.6 (301)	57.5 (396)	56.0	56.0	85.0 (HRB)	93.0 (HRB)
5	118.0 (814)	125.4 (865)	78.8 (543)	84.0 (579)	42.5	43.3	99.5 (HRB)	25.0
10	130.8 (902)	138.8 (957)	98.3 (678)	97.4 (672)	32.5	33.0	28.5	31.0
20	156.4 (1044)	165.3 (1140)	121.4 (837)	122.2 (843)	22.3	22.3	34.5	38.0
30	176.2 (1214)	178.1 (1228)	152.3 (1050)	160.7 (1108)	14.0	17.3	39.0	41.0
40	183.3 (1264)	212.8 (1467)	158.3 (1091)	205.8 (1419)	13.3	8.3	42.5*	44.5
50	216.9 (1495)	235.7 (1625)	198.4 (1368)	223.5 (1541)	3.8	3.0	45.5*	48.5*
60	246.7 (1701)	256.2 (1766)	239.2 (1649)	246.1 (1697)	3.5	3.5	47.0*	49.0*

Samples from cold rolled sheet were tested at ambient temperature

* HR30N test values were converted to HRC values per ASTM E140

Effect of Cold Reduction on Room Temperature Mechanical Properties of Sheet (Transverse)

Percent Cold Reduction	Tensile Strength ksi (MPa)		Yield Strength (0.2% Offset) ksi (MPa)		Elongation Percent in 2" (50.8mm)		Hardness HRC	
	ATI 201 HP™	ATI 201L HP™	ATI 201 HP™	ATI 201L HP™	ATI 201 HP™	ATI 201 HP™	ATI 201 HP™	ATI 201 HP™
Annealed	99.4 (685)	—	42.4 (292)	—	62.5	—	85.0 (HRB)	—
5	113.6 (783)	124.1 (856)	82.5 (569)	86.7 (598)	38.0	43.0	99.5 (HRB)	25.0
10	124.1 (856)	136.1 (938)	93.5 (645)	103.8 (716)	31.3	32.8	28.5	31.0
20	151.5 (1045)	162.8 (1123)	115.3 (795)	132.7 (915)	17.5	18.0	34.5	38.0
30	177.5 (1224)	181.7 (1253)	144.5 (996)	158.5 (1093)	11.5	14.3	39.0	41.0
40	188.5 (1300)	217.4 (1499)	156.4 (1078)	187.4 (1292)	11.3	7.8	42.5*	44.5
50	220.7 (1522)	236.6 (1631)	180.2 (1242)	200.3 (1381)	4.8	3.5	45.5*	48.5*
60	252.7 (1742)	255.5 (1762)	251.0 (1731)	235.4 (1623)	1.5	3.3	47.0*	49.0*

*HR30N test values were converted to HRC values per ASTM E140.

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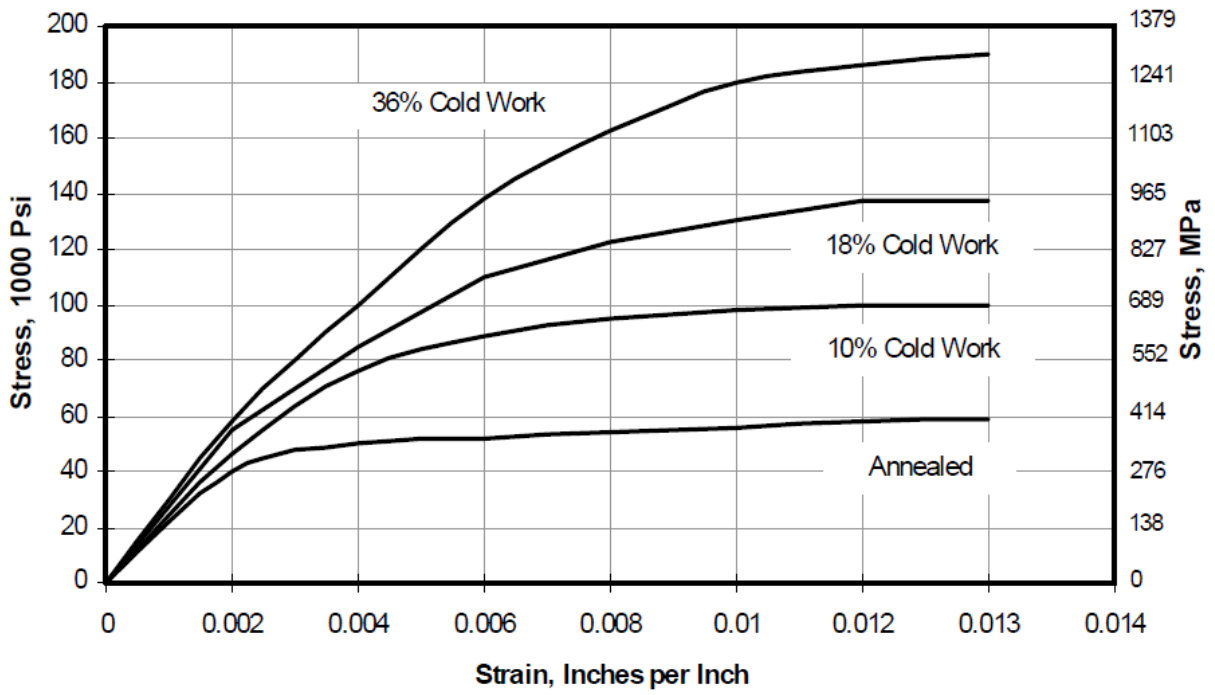
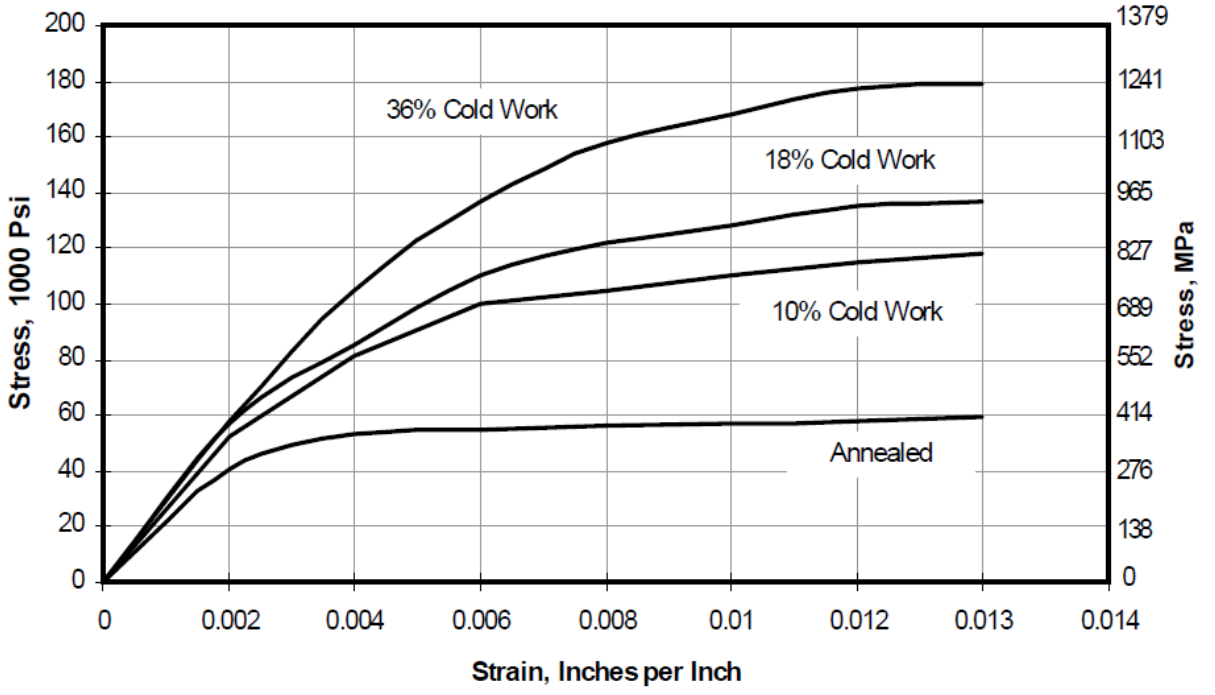
Longitudinal Tension



Transverse Tension



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Like other austenitic stainless steels, ATI 201 HP™ alloy does not exhibit a well defined transition from the elastic to the plastic range. For this reason, its yield strength is conventionally defined as the stress at which a line drawn with the initial slope of the stress-strain curve and the offset 0.2% on the abscissa intercepts the stress-strain curve. Cold rolled ATI 201 HP™ alloy shows slightly different properties in the direction of rolling and at right angles to this direction. There is also a considerable difference in yield strength in compression and in tension as is shown in the following data.

Transverse Mechanical Properties of ATI 201 HP™ alloy in Tension and Compression

Percent Cold Reduction	Tension				Compression			
	Yield Strength (0.2% Offset)		Modulus 10^6 psi		Yield Strength (0.2% Offset)		Modulus 10^6 psi	
	ksi	MPa	ksi	GPa	ksi	MPa	ksi	GPa
Annealed	50.0	345	30.0	207	53.0	365	30.0	207
10	90.0	621	30.4	210	64.0	441	28.3	195
20	121.7	839	27.8	192	73.0	503	27.5	190
40	164.0	1131	26.6	183	86.7	598	26.8	185

The data shown below illustrate the effect of stress relieving at 800°F (427°C) on material from the same heat used to obtain the preceding data. Stress relieving in the range of 600 to 900°F (315-482°C) can reduce the differences in modulus induced by cold rolling, increase the yield strength, and minimize the differences in longitudinal and transverse properties. This tendency increases with increasing cold reduction as a general rule. Compressive yield strength in the longitudinal direction is most affected by such stress relief treatments.

Effect of Stress Relieving on ATI 201 HP™ Alloy Transverse Mechanical Properties

Percent Cold Reduction	Tension				Compression			
	Yield Strength (0.2% Offset)		Modulus 10^6 psi		Yield Strength (0.2% Offset)		Modulus 10^6 psi	
	ksi	MPa	ksi	GPa	ksi	MPa	ksi	GPa
10	100.0	689	29.5	203	92.8	640	29.8	205
20	130.2	898	27.6	190	123.2	850	29.0	200
40	181.8	1253	28.4	196	154.5	1065	30.0	207

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ELEVATED TEMPERATURE STRENGTH PROPERTIES

Typical Short Time Tensile Properties

Test Temperature °F	(°C)	Yield Strength 0.2% Offset ksi	(MPa)	Tensile Strength ksi	(MPa)	Elongation Percent in 2" (50.8mm)
68	20	53.0	365.8	117.3	808.6	55.5
200	93	38.9	268.1	97.6	673.2	62.5
400	204	30.9	213.0	81.4	561.0	46.5
600	316	27.4	188.6	79.0	545.0	44.0
800	427	26.2	180.7	76.5	527.7	45.5
1000	538	23.4	161.4	69.5	479.4	33.0
1200	649	20.5	141.2	47.6	328.3	28.5
1400	760	18.2	125.4	27.2	187.6	27.5
1600	871	14.0	96.7	18.9	130.5	55.0

The short time high temperature properties of a representative heat of ATI 201 HP™ Alloy in the annealed condition are shown. Above 800°F (427°C), design should be based on creep and stress-rupture properties.

Typical Stress Rupture Properties

Test Temperature °F	(°C)	Rupture Stress, psi (MPa)						Elongation Percent in 2" (50.8mm)	
		100 hrs		1,000 hrs		10,000 hrs		100 hrs	1,000 hrs
1200	649	29,000	200	22,000	152	16,500	114	14	14
1350	734	15,000	103	10,000	69	6,600	45	16	22
1500	816	7,400	51	4,000	28			35	42

HEAT TREATMENT

ATI 201 HP™ and ATI 201L HP™ alloys are annealed between 1850-2000°F (1010-1093°C). Annealing practices applied to type 301 are, in general, suitable for ATI 201 HP™ and ATI 201L HP™ alloys, although it is recommended that annealing temperatures do not exceed 2000°F (1093°C) to avoid excessive oxidation. The primary purposes of annealing are to relieve strain, recrystallize the material if it has been cold worked, and take carbides into solution. For ATI 201 HP™ alloy, rapid cooling through the carbide precipitation range is necessary to keep carbides in solution. For thin sections, air cooling is usually sufficient, while heavier sections should be water quenched. If the work can be cooled to “black” within 3 minutes by air cooling, this practice is preferred.

When properly annealed, ATI 201 HP™ and ATI 201L HP™ alloys are predominantly austenitic. However, they may contain small amounts of delta ferrite. Cold rolling promotes the formation of martensite. Exposure to the temperature range 800-1500°F (427-816°C) results in grain boundary carbide precipitation.

FABRICATION

Welding

ATI 201 HP™ and ATI 201L HP™ can be welded by all conventional methods applied to 18 percent chromium, 8 percent nickel steels. Filler wire or electrodes of the conventional chromium-nickel analyses can be used. Like other chromium-nickel 300 series austenitic stainless steels where carbon is not controlled below 0.03%, ATI 201 HP™ alloy is sensitive to intergranular corrosion in the weld heat affected zone.

Hot Working

ATI 201 HP™ and ATI 201L HP™ alloys have hot working characteristics similar to that of 300 series stainless steels. The normal hot working range for ATI 201 HP™ and ATI 201L HP™ alloys are 2100-2250°F(1150-1230°C).

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Cold Forming
In most applications where ATI 201 HP™ and ATI 201L HP™ alloys have been used, bending, forming and drawing operations have been successfully carried out following essentially the same practice as employed for type 301.

SPECIFICATIONS

ASTM A240

ASTM A480

ASTM A666

ASTM A262

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