Technical Data Sheet

ATI 301™

Stainless Steel: Austenitic

(UNS S30100)

GENERAL PROPERTIES

ATI 301™ (S30100) is an austenitic stainless steel with a nominal composition of 17 percent chromium and 7 percent nickel. The high strengths of this grade of steel in the six available conditions or tempers, its resistance to atmosphere corrosion and its bright, attractive surface make it an excellent choice for decorative structural applications.

Automobile molding and trim, wheel covers, conveyor belts, kitchen equipment, roof drainage systems, hose clamps, springs, truck and trailer bodies, railway and subway cars are some of the major applications for this versatile grade. By varying the chemical composition within the limits set by the ASTM specifications and by temper rolling, a broad range of magnetic and mechanical properties can be obtained for a variety of applications.

ATI 301™ stainless steel is available as cold rolled strip, sheets, and plates from ATI.

CHEMICAL COMPOSITION

Represented by ASTM A240 and A666

Element	Percent by Weight Maximum Unless Range is Specified
Carbon	0.15 maximum
Manganese	2.00 maximum
Phosphorus	0.045 maximum
Sulfur	0.030 maximum
Silicon	0.75 maximum
Chromium	16.00-18.00
Nickel	6.00-8.00
Nitrogen	0.10 maximum

Allegheny Technologies Incorporated
1000 Six PPG Place
Pittsburgh, PA 15222-5479 U.S.A.
www.ATImetals.com

CORROSION RESISTANCE

ATI 301™ stainless is resistant to a variety of corrosive media. However, the corrosion properties are not as good as the 18-8 chromium-nickel steels. Its susceptibility to carbide precipitation during welding restricts its use in many applications in favor of ATI 304 or ATI 304L alloys.

OXIDATION RESISTANCE

ATI 301™ alloy possesses good resistance to oxidation at temperatures up to 1550°F (840°C). At 1600°F (871°C), ATI 301™ alloy exhibits an oxidation weight gain of 10mg/cm^2 in 1,000 hours. Therefore, this stainless steel is not suggested for use at 1600°F or above. As the rate of oxidation is greatly affected by the atmosphere to which the metal is exposed by the heating and cooling cycle, and by the structural design, no data can be presented which will apply to all service conditions.

PHYSICAL PROPERTIES

The values reported below are representative for average composition in the annealed condition.

Melting Range 2550-2590°F (1399-1421°C)

Density 0.29 lb/in^3 (8.03g/cm^3)

Specific Gravity 8.03

Modulus of Elasticity

in Tension 28 x 10^{6}psi (193 GPa)*

* In the cold worked condition, the modulus is lowered.

Linear Coefficient of Thermal Expansion

Temperature Range		Coefficients	
°C	°F	cm/cm/°C	in/in/°F
20-100	62-212	16.6 x 10^{-6}	9.2 x 10^{-6}
20-300	68-572	17.6 x 10^{-6}	9.8 x 10^{-6}
20-500	68-932	18.6 x 10^{-6}	10.3 x 10^{-6}
20-700	68-1292	19.5 x 10^{-6}	10.8 x 10^{-6}
20-871	68-1600	19.8 x 10^{-6}	11.0 x 10^{-6}

Since the expansion coefficient is higher than that of many other metals and alloys, this characteristic should be considered in the design of equipment involving ATI 301™ alloy and other materials of construction.

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Thermal Conductivity

Temperature Range		W/m•K	Btu/ft2/ hr/° F/ft
°C	°F		
20-100	68-212	16.3	9.4
20-500	68-932	21.4	12.4

°C	°F	J/kg•K	Btu/lb/°F
0-100	32-212	500	0.12

Magnetic Permeability

Properly annealed ATI 301™ alloy is completely austenitic and magnetic permeability is 1.02 maximum at 200H. Cold working promotes the formation of martensite and the magnetic permeability is increased. The amount of martensite formed depends on the amount of cold rolling, temperature of cold rolling, and composition. Figure 1 shows the increase in magnetic permeability with cold rolling at room temperature. The composition of the steels used in these determinations are:

Steel	C	Mn	Si	Cr	Ni	N
A	0.12	1.57	0.56	17.51	7.52	0.043
B	0.10	0.67	0.33	17.19	7.20	0.035

Electrical Resistivity

°C	°F	Microhm-cm	Microhm-in.
20	68	72	28.3
100	212	78	30.7
200	392	86	33.8
400	752	100	39.4
600	1112	111	43.7
800	1472	121	47.6
900	1652	126	49.6

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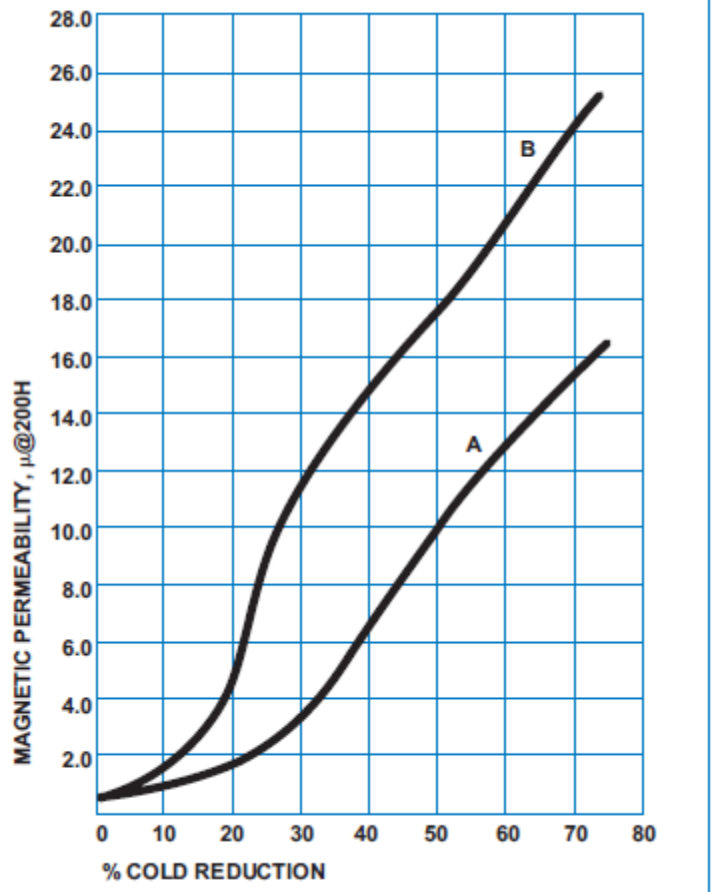
Figure 1 - Magnetic Permeability



MECHANICAL PROPERTIES

ATI 301™ alloy is used in the annealed and cold-rolled conditions. In the work-hardened condition, ATI 301™ alloy develops higher tensile strength than the other stable austenitic grades. Minimum properties for plate, sheet and strip per ASTM A240 and A666 follow.

Minimum Room Temperature Mechanical Properties, ASTM A240and A666 Specifications

Condition	Tensile Strength, Min. Ksi	(MPa)	0.2% Yield Strength, Min. Ksi	(MPa)	Elong. In 2" (50mm) %, Min.
Annealed	75	(515)	30	(205)	40
1/4 Hard	125	(862)	75	(517)	25
1/2 Hard	150	(1,034)	110	(758)	18*
3/4 Hard	175	(1,207)	125	(931)	12*
Full Hard	185	(1,276)	140	(965)	9*

*Value shown for thickness greater than 0.015 in. (.038mm).

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The properties can be controlled to a certain extent by proper balance of chemical composition. Figure 2 shows the effect of cold rolling on the tensile properties of a representative ATI 301™ composition. Figure 3 shows stress-strain curves and yield strength of annealed and 1/4 hard ATI 301™ stainless. Cold rolled ATI 301™ stainless shows slightly anistropic properties in the direction of cold rolling (longitudinal) and at right angles to this direction (transverse). The difference becomes quite pronounced in compression. A more isotropic material can be produced by a stress relieving heat treatment in the 700 to 1000°F (371-538°C) temperature range for a period of five minutes to five hours. Use of lower temperature and shorter times minimizes carbide precipitation. The table below illustrates the as-rolled and stress-relieved mechanical properties of ATI 301™ alloy in tension and compression.

Temper	Condition	Tension			
		Longitudinal		Transverse	
		.2% Y.S. Ksi (MPa)	Elastic Modulus 10^6 psi (GPa)	0.2% Y.S. Ksi (MPa)	Elastic Modulus 10^6 psi (GPa)
Annealed 1/4 Hard	As annealed As rolled Stress relieved	36 (248) 80 (552) 77 (531)	31.0 (214) 28.0 (193) 28.7 (198)	36 (248) 84 (579) 79 (545)	30.6 (211) 28.6 (197) 27.0 (186)
1/2 Hard	As rolled Stress relieved	122 (841) 128 (883)	26.8 (185) 27.9 (192)	123 (848) 130 (896)	28.1 (194) 28.6 (197)
3/4 Hard	As rolled Stress relieved	142 (979) 155 (1,069)	25.8 (178) 27.3 (188)	145 (1,000) 155 (1,069)	27.5 (190) 28.8 (199)
Full Hard	As rolled Stress relieved	160 (1,103) 175 (1,207)	25.2 (174) 28.4 (196)	163 (1,124) 181 (1,248)	28.4 (196) 30.5 (210)
		Compression			
Annealed 1/4 Hard	As annealed As rolled Stress relieved	38 (262) 50 (345) 73 (503)	30.6 (211) 28.2 (194) 28.8 (199)	38 (262) 91 (627) 84 (579)	30.3 (209) 28.2 (194) 30.6 (211)
1/2 Hard	As rolled Stress relieved	90 (621) 111 (765)	27.5 (190) 29.2 (201)	142 (979) 144 (993)	27.5 (190) 29.8 (205)
3/4 Hard	As rolled Stress relieved	100 (690) 133 (917)	26.5 (183) 27.5 (190)	170 (1,172) 176 (1,213)	27.9 (192) 29.5 (203)
Full Hard	As rolled Stress relieved	115 (793) 169 (1,165)	24.6 (170) 27.7 (191)	191 (1,317) 209 (1,441)	29.4 (203) 29.6 (204)

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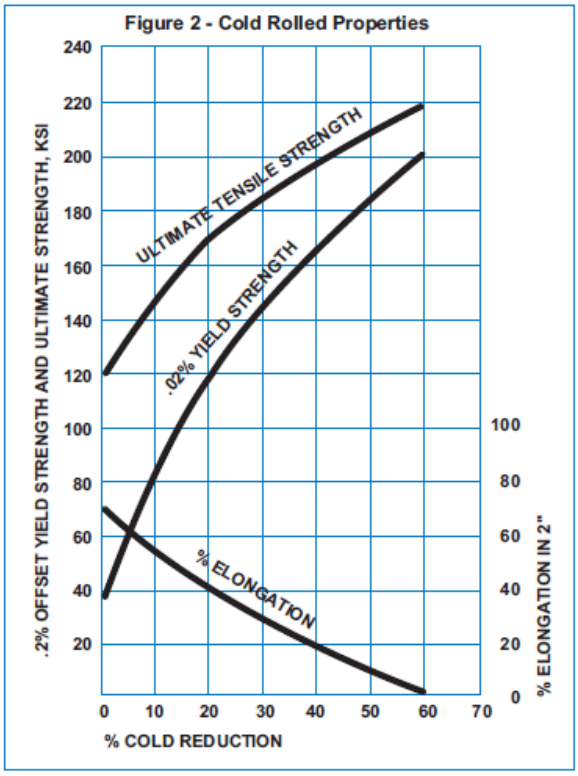

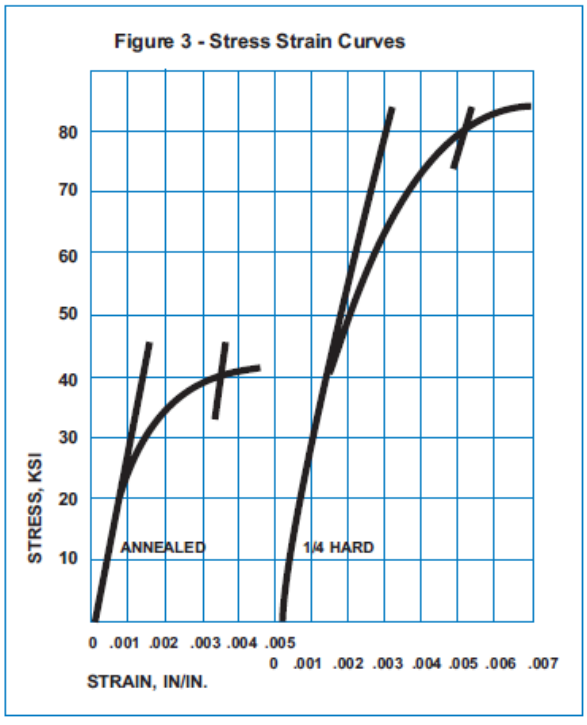

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Typical Elevated Temperature Tensile Properties

Temperature		Tensile Strength, Ksi (MPa)						Yield Strength, 0.2% Offset, Ksi (MPa)						% Elongation in 2" (50mm)		
°F	(°C)	Annealed		1/8 Hard		1/2 Hard		Annealed		1/8 Hard		1/2 Hard		Annealed	1/8 Hard	1/2 Hard
Room Temp.		105.0	(724)	129.0	(889)	165.0	(1138)	40.0	(276)	73.0	(503)	112.0	(772)	55.0	43.5	28.5
400	(204)	80.0	(552)	90.6	(625)	127.0	(876)	22.0	(152)	61.5	(424)	106.0	(731)	46.0	23.0	9.0
600	(316)	70.4	(485)	86.2	(594)	122.7	(846)	19.4	(134)	59.8	(412)	95.2	(656)	40.0	20.0	6.5
800	(427)	67.2	(463)	81.7	(563)	116.9	(806)	19.5	(134)	54.7	(377)	85.5	(590)	39.0	17.5	7.0
1000	(538)	58.2	(401)	69.4	(479)	78.0	(538)	18.3	(126)	51.2	(353)	67.3	(464)	34.0	16.5	7.0
1200	(649)	40.9	(282)	51.0	(352)	57.5	(396)	15.4	(106)	40.0	(276)	48.0	(331)	36.0	20.0	10.0
1400	(760)	29.6	(204)	36.0	(248)	35.0	(241)	14.4	(99.3)	27.0	(186)	31.0	(214)	30.0	17.0	10.0
1600	(871)	15.8	(109)	19.4	(134)	16.4	(113)	9.5	(65.5)	15.4	(106)	13.9	(95.8)	29.0	15.0	12.5

Typical Low Temperature Tensile Properties

Condition	Test Temperature °F	(°C)	Yield Strength 0.2% Offset Ksi	(MPa)	Ultimate Tensile Strength Ksi	(MPa)	% Elongation in 2" (50 mm)	Notched to Unnotched Tensile Strength Ratio
Annealed	78	(25)	40	(276)	105	(724)	60	–
	32	(0)	43	(297)	155	(1,069)	53	–
	-40	(-40)	48	(331)	180	(1,241)	42	–
	-80	(-62)	50	(345)	195	(1,351)	40	–
	-320	(-196)	75	(517)	275	(1,896)	30	–
1/4 Hard	78	(25)	95	(655)	150	(1,034)	54	–
	32	(0)	98	(676)	170	(1,172)	46	–
	-40	(-40)	101	(696)	188	(1,296)	38	–
	-80	(-62)	105	(724)	205	(1,413)	37	–
	-320	(-196)	116	(800)	290	(1,999)	25	–
3/4 Hard	78	(25)	171	(1,179)	190	(1,310)	17	1.05
	-100	(-73)	154	(1,062)	224	(1,544)	19	0.96
	-320	(-196)	193	(1,331)	290	(1,999)	20	0.90
	-423	(-253)	–	–	317	(2,186)	14	0.92
Full Hard*	78	(25)	183	(1,262)	205	(1,413)	6	1.01
	-320	(-196)	215	(1,482)	302	(2,082)	20	0.90
	-423	(-253)	250	(1,724)	340	(2,344)	15	0.87

Typical short time high temperature tensile properties of ATI 301™ alloy in the annealed and cold-rolled state are shown in the table above.

The high temperature short-time tensile properties can be used for design purposes only up to 700 or 800°F. Above this temperature, design is based on creep and stress-rupture data. There is no significant difference in the creep strength of ATI 301™ alloy and the other 18-8 grades and the data given for these grades can also be used for ATI 301™ alloy. Stress-rupture and creep-strength curves are shown in Figures 4 and 5.

Typical low temperature properties for ATI 301™ alloy are given above.

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1000 Six PPG Place
Pittsburgh, PA 15222-5479 U.S.A.
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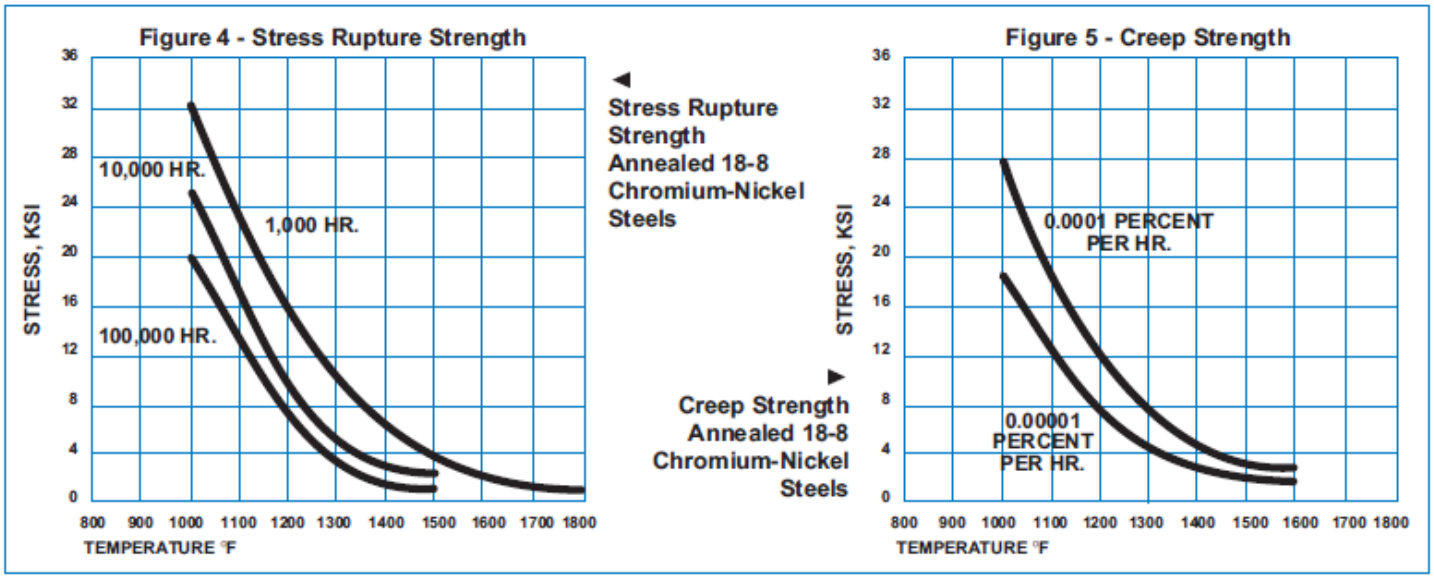
Hardness

Typical hardness values for annealed and cold-rolled ATI 301™ alloy are given in the following table:

Temper	Brinell Hardness	Rockwell Hardness
Annealed	165	85 Rb
1/4 Hard	255	25 Rc
1/2 Hard	297	32 Rc
3/4 Hard	342	37 Rc
Full Hard	382	41 Rc



Impact Resistance

Annealed austenitic stainless steels exhibit high resistance to impact even at low temperatures. This property, in combination with strength and fabricability, has led to their use in cryogenic applications. Typical impact properties for ATI 301™ alloy are shown below.

Temperature		Charpy V-Notch Energy Absorbed	
°F	°C	Foot-pounds	Joules
75	23	110	150
-100	-73	110	150
-320	-196	110	150

Fatigue Strength

The endurance limit of annealed ATI 301™ alloy is 30-45 percent of the tensile strength. Cold rolling increases the endurance limit as compared with annealed material. Stress relieving increases the endurance limit of cold rolled material.

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Typical endurance limits for ATI 301™ alloy are shown in the following table:

	Endurance Limit	
Condition	Ksi	MPa
Annealed	35	(241)
1/4 Hard	44	(303)
1/2 Hard	55	(379)
Full Hard	80	(552)

HEAT TREATMENT

Forging Treatment

Initial: 2000-2200°F (1093-1204°C)

Finishing: 1700°F (927°C)

Annealing Temperature

1850-2050°F (1010-1121°C)

The primary purposes of annealing are to remove the stresses, recrystallize the structure if the material has been previously cold worked, and to take the carbides into solution. Rapid cooling through the carbide precipitation range is necessary to keep the carbides into solution. For thin sections, air cooling is sufficient for this purpose while heavier sections have to be water quenched.

Structure

When properly annealed, ATI 301™ stainless is austenitic. It is possible that small quantities of delta ferrite are present. Cold rolling promotes the formation of martensite and exposure in the 800-1500°F (427-816°C) range results in grain boundary carbide precipitation.

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