ATI

Technical Data Sheet

ATI 304 DA™

Stainless Steel: Austenitic

GENERAL PROPERTIES

ATI 304DA tri-ply composite consists of a dual stabilized, low carbon steel center “sandwiched” between Type 304 stainless steel. The top and bottom stainless steel surfaces (cladding), each representing approximately 20% of the product thickness, are bonded to the carbon steel core during hot rolling, thereby providing a metallurgical bond which remains sound during subsequent cold forming operations. This composite product provides the excellent corrosion resistance of ATI 304 stainless steel along with the good heat transfer characteristics of carbon steel. ATI developed this proprietary composite which is covered by U.S. Patent Nos. 5,370,946 and 5,529,644. This patented material has excellent cold forming properties. Carbon from the core does not migrate into the stainless steel cladding during hot processing, and thereby enhances formability by eliminating the possibility of “hook cracks” caused by carbide precipitation at the stain-less/carbon steel interface.

COMPOSITION (WT%)

Element	Type 304	Stabilized Carbon Steel
Carbon	0.08 maximum	0.01/0.025
Manganese	2.00 maximum	residual
Phosphorus	0.045 maximum	residual
Sulfur	0.030 maximum	residual
Chromium	18.00/20.00	residual
Nickel	8.00/10.50	residual
Nitrogen	0.10 maximum	0.005 maximum
Titanium	residual	0.07/0.09
Columbium	residual	0.02/0.04
Iron	balance	balance

APPLICATIONS

The major use for ATI 304DA material is in conventional cookware because of its corrosion resistance, safety in food contact, attractive appearance, ease of cleaning, oxidation resistance, ease of fabrication, good heat distribution characteristics, and durability. ATI 304DA may also be used as induction heating cookware.

Other applications for ATI 304DA material might include the chemical or food processing industries where Type 304 is used.

PRODUCT FORM

ATI 304DA composite is available as sheet, strip coils and circles.

CORROSION RESISTANCE

ATI 304DA material exhibits excellent corrosion resistance to mildly corrosive chemical environments, atmospheric corrosion, and potable water because of its ability to form a tightly-adherent, corrosion-resistant, oxide film. Exposure of Type 304 to chlorides in

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every day kitchen activities is generally satisfactory when proper precautions are taken. Type 304 has been approved for use in contact with food by government and industrial organizations and it has been used successfully for many years in the food and food preparation, meat processing, brewery, wine, juice, soft drink, and related industries.

PHYSICAL PROPERTIES

The values reported below are typical for ATI 304DA material in the annealed condition.

Property	AL 304DA	Type 304
Specific Gravity	7.86	7.90
Density Lbs / in^3	0.284	0.285
Specific Heat Btu/lb/°F (212°F) J/kg• °K (100°C) Btu/lb./°F (932°F) J/kg• °K (500°C)	 0.117 490 0.152 640	 0.119 500 0.149 620
Thermal Conductivity Btu/ft.• hr °F (212°F) W/m• K (100°C) Btu/ft.• hr• °F (932°F) W/m• K (500°C)	**IP/TT*** 25.44/16.19 44.0/28.0 20.24/18.50 35.0/32.0	 9.25 16 13.30 23
Electrical Resistivity Micro-ohm-in (212°F) Micro-ohm-cm (100°C) Micro-ohm-in (932°F) Micro-ohm-cm (500°C)	 10.1 25.6 27.7 70.4	 32.1 81.4 41.5 105
Coefficient of Linear Expansion in/in°F (68-932°F) cm/cm/°C (20-500°C)	 8.73 15.72	 10.21 18.39

*IP/TT means in-plane and through-thickness, respectively.
Note the thermal conductivites of ATI 304DA material are greater than those for T304

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MECHANICAL PROPERTIES

The ATI 304DA clad composite is an austenitic stainless steel with a core of low alloy carbon steel. The mechanical properties of ATI 304DA material are a weighted function of those for annealed Type 304 stainless steel and also for stabilized C-1006 carbon steel.

Room Temperature Tensile Properties

Nominal room temperature properties of ATI 304DA material in the annealed condition are included below as a fabricating guide for drawing and forming.

Yield Strength: 38,000 psi (260 MPa)
0.2% Offset

Tensile Strength: 73,000 psi (500 Mpa)

Percent Elongation: 46
(in 2" or 51 mm)

Bend (180°, r = 1/2T): no surface fissures at 10X

Hardness (HRB): 76

Modulus of Elasticity: 29 x 10^6 psi (200 Gpa)

Structure

When ATI 304DA material is properly annealed the Type 304 clad is austenitic. Residual quantities of ferrite may or may not be present. The carbon steel core is primarily ferrite with columbium carbonitrides. The grain size of the Type 304 components is typically as follows:

Component	ASTM Grain Size
Clad	7-9
Core	7-9

Elevated Temperature Tensile Properties

The following short time tensile properties were observed for ATI 304DA composite (0.050” thickness)

Test Temperature °F (°C)	Yield Strength, 0.2% Offset psi (MPa)	Tensile Strength psi (MPa)	Percent Elongation in 2" (51 mm)
68 (20)	37,650 (260)	72,750 (502)	45.6
200 (93)	32,300 (223)	62,750 (433)	38.0
400 (204)	31,550 (218)	59,500 (410)	30.0
600 (316)	28,100 (194)	57,250 (395)	27.8
800 (427)	24,850 (171)	51,150 (353)	31.8
1000 (538)	22,200 (153)	42,550 (293)	29.0
1200 (649)	18,000 (124)	37,650 (260)	29.3
1400 (760)	12,650 (87)	21,150 (146)	35.8
1600 (871)	7,150 (49)	10,700 (74)	39.5

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The following short time tensile properties are typical for Type 304 sheet and strip.

Test Temperature °F (°C)	Yield Strength, 0.2% Offset psi (MPa)	Tensile Strength psi (MPa)	Percent Elongation in 2" (51 mm)
68 (20)	35,000 (240)	90,000 (620)	60
400 (204)	23,000 (160)	70,000 (485)	50
800 (427)	19,000 (130)	66,000 (455)	43
1200 (649)	15,500 (105)	48,000 (230)	34
1500 (815)	13,000 (90)	23,000 (160)	46

At elevated temperatures up to 1200°F, the short time yield strength of ATI 304DA material is greater than that of Type 304 at corresponding temperatures. However, the tensile strengths of Type 304 are superior to those of ATI 304DA material.

FABRICATION

Heat Treatment

ATI 304DA materials are heat treated to remove the effects of cold forming or to dissolve precipitated chromium carbides. The heat treatment consists of an anneal followed by a rapid cool. The temperature range of the anneal is 1800°F to 1950°F (980°C to 1075°C) and the rapid quench can be an air cool or water quench depending on the thickness. The cooling rate employed when cooling from the annealing temperature should be high enough to avoid dwell time in the carbide precipitation range 1000°F to 1500°F (540°C to 820°C) and be slow enough to avoid forming bainite and/or Widmanstätten ferrite.

Forming

ATI 304DA composite exhibits many of the excellent cold forming characteristics associated with Type 304. This is evident in their values listed below for the strain hardening exponent “n”, the average strain ratio R, and the limiting drawing ratio (LDR).

Percent Elongation in 2" (51 mm)	Formability Values					
	n_1/n_2		R		LDR	
	AL 304DA™	Type 304	AL 304DA™	Type	AL 304DA™	Type 304
0.030	0.20/0.27	0.33/0.49	1.06	0.96	2.03	2.01
0.050	0.23/0.29	0.32/0.49	1.03	0.99	2.06	1.97
0.072	0.26/0.32	0.29/0.43	1.02	0.97	----	----

The ferritic microstructure of the core leads to a strain hardening exponent n1 of 0.23 which is similar to low carbon steels and other ferritic stainless steels such as Types 409 and 439. This translates into similar stretch formability for ATI 304DA material. The strain hardening exponent n2, which is normally used to evaluate austenitic stainless steels and reflects the upper portion of the stress strain curve, shows a much lower capability for stretch forming than Type 304 and should be recognized in the manufacture of parts. The average strain ratio (R) of 1.03 and Limiting Drawing Ratio (LDR) of 2.06 indicates that the drawability of ATI 304DA material is good, in common with that of Type 304.

Spot Welding

Type 304 stainless steel is resistance spot welded by techniques that are similar to those used for carbon steels. The magnetic nature of the core may require more input energy. Spot welding techniques have been used for years for making attachments to ATI 304DA composite. The chemical composition of the carbon steel core present in ATI 304DA material yields ductile welds.

As noted above under "Heat Treatment", the corrosion resistance of Type 304 can be impaired by the formation of chromium carbides, if it is exposed to temperatures around 1200°F for an excessive amount of time. However, the normally short weld time in spot welding and the good heat distribution of the carbon steel core would suggest that deleterious chromium carbide precipitation is not likely to occur.

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Surface Preparation

Despite their corrosion resistance, stainless steels need care in fabrication and use to maintain their surface appearance even under normal conditions of service. The surface preparation of stainless steels is one of the most important requirements for satisfactory application of ATI 304DA material and should receive careful consideration. For maximum corrosion resistance to chemical environments, it is essential that the stainless steel surface be free of all heat tint, weld splatter, or oxide formed during welding, annealing, or heat treating. All surfaces of parts must be ground and polished to remove any traces of oxide, flux, scale, forming compounds, etc., in order to avoid any localized corrosion around these surface contaminants. A warm solution of dilute nitric acid can be used to remove any residual iron. A thorough water rinse should follow this acid treatment.

Scale that forms from welding processes can be removed with a stainless steel wire brush. Normal carbon steel wire brushes will leave carbon steel particles on the surface which will eventually produce surface rusting. For more severe applications, welded areas can be treated with a descaling solution such as a mixture of nitric and hydroflouric acids. These should be subsequently washed off with clean water.

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