



ATI 17-7™

Precipitation Hardening Stainless Steel

(UNS S17700)

INTRODUCTION

ATI 17-7[™] Precipitation Hardening Alloy (S17700) is a chromium-nickel-aluminum precipitation hardening stainless steel used for applications requiring high strength and a moderate level of corrosion resistance.

The S17700 alloy has been available for many years and has found application in aerospace and many spring type applications requiring high strength.

ATI 17-7 precipitation hardening alloy may be formed in a soft austenitic condition and hardened to a high strength level by low temperature heat treatments. The low temperature allows minimum distortion compared to conventional quench and temper hardening processes. In addition to material produced by the standard refining procedures, material which has been vacuum arc or electroslag remelted is available for further increase in resistance to fatigue, for those applications subject to cyclic stresses.

SPECIFICATIONS & CERTIFICATES

The ATI 17-7 Precipitation Hardening Alloy (S17700) is covered by the following specifications.

Specification	Product Form		
AMS 5528	Sheet, Strip and Plate		
AMS 5529	Sheet and Strip, Cold Rolled		
AMS 5568	Welded Tubing		
AMS 5644	Bars and Forgings		
AMS 5678	Wire		
AMS 5824	WeldingWire		
ASTM A 313	Spring Wire		
ASTM A 564	Bar, Wire, and Shapes		
ASME SA 564	Bar, Wire and Shapes		
ASTM A 579	Forgings		
ASTM A 693	Plate, Sheet and Strip		
ASME SA693	Plate, Sheet and Strip		
ASTM A705	Forgings		
ASME SA705	Forgings		

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Typical Analysis				
Carbon	0.09 max			
Manganese	1.00 max			
Phosphorus	0.040 max			
Sulfur	0.030 max			
Silicon	1.00 max			
Chromium	16.00-18.00			
Nickel S	6.50-7.75			
Aluminum	0.75-1.50			
Iron	Balance			

PRODUCT FORMS

ATI 17-7 precipitation hardening alloy is furnished as plate, sheet and strip from ATI. In all forms, the material is furnished in the annealed condition. In strip form, the material may be provided in a cold rolled condition suitable for direct precipitation hardening heat treatment at 900°F (482°C).

PHYSICAL PROPERTIES

	l star star star star st	Condition A	Condition RH 950	Condition TH 1050
a star star star star star star star sta	Density Ib/in ³ kg/m ³	0.282 7810	0.276 7640	0.277 7670
Linear Coefficient of Thermal Expansion Units of 10 ⁻⁶ /°F (10 ⁻⁶ /°C) Temperature Range:	70-200°F (21-93°C)	8.5 (15.3)	5.7 (10.3)	5.6 (10.1)
Magnetic Permeability 🖉 🧹		Weakly Ferromagnetic	Strongly Ferromagnetic	Strongly Ferromagnetic
		Strongly Ferromagne	tic in Conditions R and	
Thermal Conductivity		Approximately 9.5 Btu-ft/hr-ft ² -°F (16.5 W/m-K) in the hardened conditions in the range 70-300°F(20-150°C)		
Electrical Resistivity		Approximately 80 microhm-cm in annealed or hardened conditions		

MECHANICAL PROPERTIES

Elastic Modulus and Modulus of Rigidity(Typical Values)				
	and stand stand stand stand	Condition A	Condition RH 950	Condition TH 1050
Modulus of Elasticity Units of	10 ⁶ psi	29	29	29
	(GPa)	(200)	(200)	(200)
Modulus of Rigidity Units of	10 ⁶ psi	11	11	11
	(GPa)	(75)	(75)	(75)

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Room Temperature Properties (Typical Values) (Sheet and Strip)				
and an	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	Condition A	Condition RH 950	Condition TH 1050
0.2% Yield Strength	psi (MPa)	50,000 (345)	200,000 (1380)	175,000 (1205)
Ultimate Tensile Strength	psi (MPa)	120,000 (825)	225,000 (1550)	195,000 (1345)
Elongation (percent)		30	7.	8
Hardness Rockwell Hardness Scale	and an	85 B	47 C	42 C

Condition CH 900

The room temperature tensile properties of ATI 17-7 precipitation hardening alloy are greatly affected by cold rolling before aging. The properties attainable in CH 900 sheet and strip are summarized in AMS 5529. These properties are listed below:

Condition	Minimum Yield Strength psi (MPa)	Minimum Tensile Strength psi (MPa)	
Sheet & Strip Cold Rolled to Condition	175,000	200,000	
C	(1205)	(1380)	
Sheet & Strip Cold Rolled and Aged to	230,000	240,000	
Condition CH 900	(1585)	(1655)	

CORROSION RESISTANCE

Tests have shown that the corrosion resistance of ATI 17-7 alloy is comparable to that of Type 304 stainless steel in most media. In general, the corrosion resistance of ATI 17-7 alloy is superior to that of the hardenable 400 series stainless steels.

WELDABILITY

The ATI 17-7 precipitation hardening alloy is weldable by conventional inert gas methods. The precipitation hardening reaction in the alloy is dependent on the presence of aluminum, a reactive element. For this reason, inert gas methods are used to protect against the loss of aluminum.

As-welded ATI 17-7 alloy will be substantially austenitic and will exhibit mechanical properties which are roughly equivalent to annealed (Condition A) material. The ductility of the weld eliminates the need for preheating and postweld annealing procedures required for the conventional and age hardenable martensitic alloys. To produce high strength welds, however, full post-weld heat treatment (solution annealing plus austenitic conditioning, transformation and precipitation hardening) is necessary.

HEAT TREATMENT

Typically the ATI 17-7 precipitation hardening alloy is furnished is the annealed condition, Condition A. In this condition, the material possesses an austenitic structure. As an austenitic material, the ATI 17-7 precipitation hardening alloy possesses a relatively low strength. This is the condition in which formability is easiest.

To develop the high precipitation hardened strength of the alloy by heat treatment, starting from Condition A, heat treatments are done to accomplish two necessary steps. The first is a heat treatment which allows the relatively stable austenite of Condition A to transform to martensite (Austenite Conditioning and Transformation). The second is a precipitation hardening heat treatment to further strengthen the material. The austenite is easier to transform to martensite using a lower temperature heat treatment. For this reason, Condition TH 1050 uses a 1400°F (760°C) heat treatment to produce a martensite transformation around room

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temperature, and this is followed by a precipitation hardening heat treatment at $1050^{\circ}F$ (565°C). If Condition RH 950 is desired, the austenite conditioning heat treatment is conducted at 1750° (955°C). In this case, the martensite transformation is not complete until the material is held for some time at -100°F (-73°C). When the transformation is complete, the material is precipitation hardened at 950°F (510°C) to Condition RH 950.

Because the precipitation hardening reaction can be driven past peak strength by high temperature or excessive time at the aging temperature, higher temperature or longer time precipitation hardening heat treatments produce lower strength levels.

When ATI 17-7 precipitation hardening alloy with an austenitic structure is cold worked by substantial deformation, a transformation to martensitic structure results from the deformation. In this condition, Condition C, the material may be precipitation hardened directly by heat treatment at 900°F (482°C) to condition CH 900.

During heat treatment, ATI 17-7 alloy expands approximately 0.004 in/in from Condition A to the RH or TH Conditions. The heat

treatments used for the ATI 17-7 precipitation hardening alloy are summarized on Page 5.

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Summary of Heat Treating AL 17-7[™] Precipitation Hardening Alloy



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