ATI Allegheny Ludlum
Allegheny Technologies

TECHNICAL DATA
BLUE SHEET

Stainless Steel AL 17-7™ Precipitation Hardening Alloy

(UNS Designation S17700)

GENERAL PROPERTIES

AL 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.

AL 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.

FORMS AND CONDITIONS

AL 17-7 precipitation hardening alloy is furnished from Allegheny Ludlum as plate, sheet and strip. 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).

SPECIFICATIONS

The AL 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	Welding Wire
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 SA 693	Plate, Sheet and Strip
ASTM A 705	Forgings
ASME SA 705	Forgings

Typical Analysis	
Carbon	0.07
Manganese	0.50
Phosphorus	0.020
Sulfur	0.002
Silicon	0.25
Chromium	17.0
Nickel	7.0
Aluminum	1.25
Iron	Balance

CORROSION AND OXIDATION RESISTANCE

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

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PHYSICAL PROPERTIES

		Condition A	Condition RH 950	Condition TH 1050
Density	**lb/in³** **kg/m³**	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 Ferromagnetic in Conditions R and T		
Thermal Conductivity		Approximately 9.5 Btu-ft/hr-ft²-°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)				
		Condition A	**Condition RH 950**	**Condition TH 1050**
Modulus of Elasticity Units of	**10^6 psi** **(GPa)**	29 (200)	29 (200)	29 (200)
Modulus of Rigidity Units of	**10^6 psi** **(GPa)**	11 (75)	11 (75)	11 (75)

Room Temperature Properties (Typical Values) **(Sheet and Strip)**				
		Condition A	**Condition RH 950**	**Condition TH 1050**
0.2% Yield Strength	**psi** **(MPa)**	45,000 (310)	200,000 (1380)	160,000 (1100)
Ultimate Tensile Strength	**psi** **(MPa)**	130,000 (900)	220,000 (1520)	190,000 (1310)
Elongation (percent)		30	9	10
Hardness **Rockwell Hardness Scale**		85 B	46 C	42 C

Condition CH 900

The room temperature tensile properties of AL 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 C	175,000 (1205)	200,000 (1380)
Sheet & Strip Colled Rooled and Aged to Condition CH 900	230,000 (1585)	240,000 (1655)

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Welding and Brazing

The AL 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 AL 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 post-weld 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 AL 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 AL 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 temperature, and this is followed by a precipitation hardening heat treatment at 1050°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 AL 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, AL 17-7 alloy expands approximately 0.004 in/in from Condition A to the RH or TH Conditions.

The heat treatments used for the AL 17-7 precipitation hardening alloy are summarized on Page 4.

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

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