ATI 425®-MIL *Alloy*

Technical Data Sheet

INTRODUCTION
ATI 425®-MIL Alloy is a high strength, titanium alloy available in a variety of product forms, including ballistic grade plate and cold-rolled coil or sheet. ATI 425®-MIL Alloy was originally developed for ballistic armor applications and exceeds both the ballistic requirements and strength requirements of MIL-DTL-46077 titanium armor plate. ATI 425®-MIL Alloy is characterized as a class 4 armor plate by MIL-DTL-46077.

ATI 425®-MIL Alloy is an alpha-beta titanium alloy that uses iron and vanadium as beta stabilizers as well as aluminum as an alpha stabilizer. The lower aluminum and vanadium contents and higher oxygen and iron contents give ATI 425®-MIL Alloy a unique combination of ductility and tensile strength.

The combination of strength and ductility found in ATI 425®-MIL Alloy makes it useful for applications that require bending and forming. Those parts can be easily manufactured while still having superior strength compared to parts made with similarly formable low alloy grades of titanium or comparable strength to titanium ballistic plate with less formability.

ATI 425®-MIL Alloy in the cold-rolled titanium coil or sheet product forms provides advantages that come from continuous processing that are not available in pack-rolled sheet. For example, ATI 425®-MIL Alloy cold rolled product has better gauge tolerance and surface finish than pack rolled sheet and is available in lengths ranging from cut sheet to coil. Tight gauge tolerances available in rolled coil could reduce part-to-part variation in production compared to using pack-rolled sheet. Coil length products are generally not available in other titanium alloys with tensile strength exceeding 130 ksi (896MPa) and ductility exceeding 10% elongation.

FORMABILITY
ATI 425®-MIL Alloy can be both hot and cold worked. The excellent ductility can permit forming at room temperature. Ballistic grade plate is capable of being formed to a 1T bend factor at 1 inch (25mm) thick if sufficient process controls and parameters are used.

WELDABILITY
ATI 425®-MIL Alloy is easily welded in the annealed condition using methods typically applied to titanium, such as TIG, MIG, EB, and plasma. Precautions must be taken to prevent oxygen, nitrogen, and hydrogen contamination. Fusion welding can be done in inert gas filled chambers, or using inert gas shielding of the molten metal and the adjacent heated zones. Spot, seam, and flash welding can be performed without resorting to protective atmospheres.

CORROSION
ATI has evaluated the corrosion resistance of ATI 425®-MIL Alloy in a variety of media. ATI 425®-MIL Alloy performs similarly to Ti-6AL-4V (6-4 titanium) and Ti-3Al-2.5V (3-2.5 titanium) in marine environments and many media of the chemical process industry.

SUPERPLASTIC FORMABILITY
ATI 425®-MIL Alloy coil or sheet can be processed so that it has good superplastic formability at 1425°F – 1650°F (774°C – 899°C).

SPECIAL PRECAUTIONS
As with other alpha-beta titanium alloys, ATI 425®-MIL Alloy can be subject to excessive contamination by hydrogen during improper heat treatment or pickling and by oxygen, nitrogen, and carbon pick-up during forging, heat treating, brazing, etc. This contamination could adversely affect mechanical properties and formability.

SPECIFICATIONS AND CERTIFICATIONS
MIL-DTL-46077G – Armor Plate, Titanium Alloy, Weldable

ATI 425®-MIL Alloy is designated titanium grade 38 by ASTM and covered by ASTM specifications B265, B338, B348, B381 and B861.

ATI 425®-MIL Alloy has been Board Approved for use in the ASME Boiler and PV Code 650F, making ATI 425®-MIL Alloy the highest temperature ASME code approved titanium alloy in the B&PV. ASME Boiler Code Case 2532-2 states that ATI 425®-MIL Alloy can be used for parts requiring strength up to 700°F (371°C).

ATI 425®-MIL Alloy can be welded using ERTI-38 weld wire, which is produced in accordance with AWS 5.16/A5.16M.

Additional industry and customer specifications are being developed.

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

ATI 425®-MIL *Alloy*

Technical Data Sheet

PRODUCT FORMS
ATI 425®-MIL Alloy is available in a variety of titanium product forms, including: sheet, plate, Precision Rolled Strip® and foil, seamless tube, shapes and rectangles, ingot, castings and forgings.

POTENTIAL APPLICATIONS
The unique combination of high tensile strength and high ductility of ATI 425®-MIL Alloy makes it a potential candidate for a wide variety of defense applications. High ductility is beneficial when bending or cold drawing is required. Good hot workability combined with high strength makes ATI 425®-MIL Alloy a candidate for large, monolithic sections of armor plate that require forming during manufacturing. Producing larger parts can improve manufacturing efficiency by reducing the number of welds compared to parts made from a less formable alloy. Good hot workability also facilitates manufacturing of near net shape forgings. The availability of ATI 425®-MIL Alloy cold-rolled titanium sheet and coil in long lengths facilitates its use in manufacturing methods such as roll forming and may allow structures to be designed with fewer joints and fasteners. The tight gauge tolerance of ATI 425®-MIL Alloy cold rolled titanium sheet and coil compared to pack rolled sheet offers opportunities for weight reduction through use of nominally lighter gauge product. In addition, final part fabrication of ATI 425®-MIL Alloy sheet will enable less part to part variability as it offers superior gage control over the entire length of rolled coil over most pack rolled sheet within individually finished sheets. The excellent surface finish and corrosion resistance makes ATI 425®-MIL Alloy sheet and coil a candidate for use in an uncoated condition.

CONTACT INFORMATION
For Aerospace application inquiries contact ATI425.Aerospace@ATImetals.com

For Defense application inquiries contact ATI425.Defense@ATImetals.com

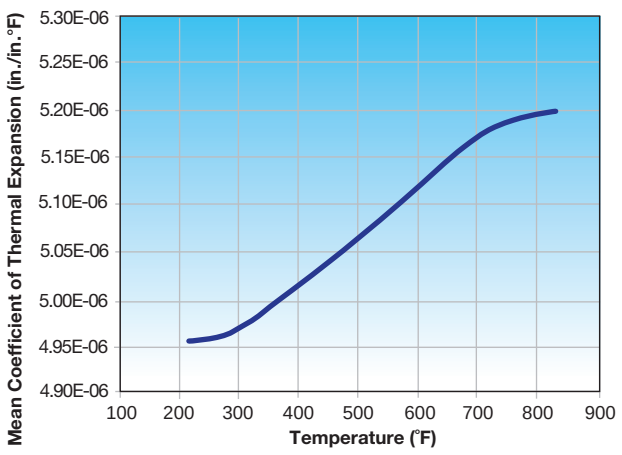
www.ATI425alloy.com

TYPICAL COMPOSITION

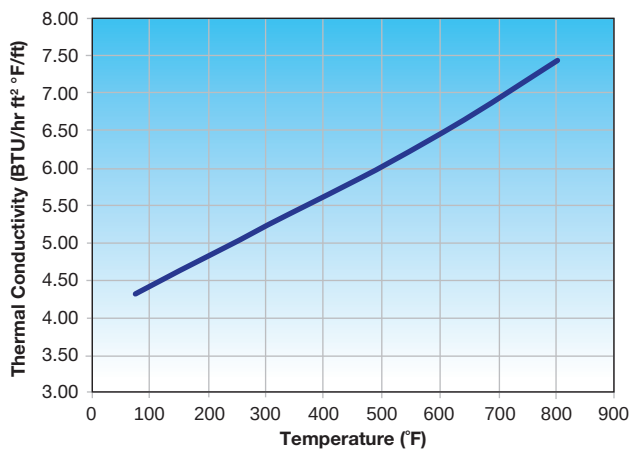
Element	Al	V	Fe	O	C	N	H	Other (each)	Other (total)	Ti
Min (wt.%)	3.5	2.0	1.2	0.2	–	–	–	–	–	Bal.
Max (wt.%)	4.5	3.0	1.8	0.30	0.08	0.03	0.015	0.10	0.30	

PHYSICAL PROPERTIES
Density: 0.161 lb/in^3 (4.452g/cm^3)
Beta Transus Temperature: 1780°F ± 25° (971°C ± 14°)

Mean Coefficient of Thermal Expansion



Thermal Conductivity



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

COLD-ROLLED COIL AND SHEET TYPICAL MECHANICAL PROPERTIES – MILL ANNEAL CONDITION

Test Direction	Tensile Stress (ksi)	Tensile Stress (MPa)	Yield Stress (ksi)	Yield Stress (MPa)	Elongation (%)
Longitudinal	152	1048	132	911	13
Transverse	163	1123	158	1090	14

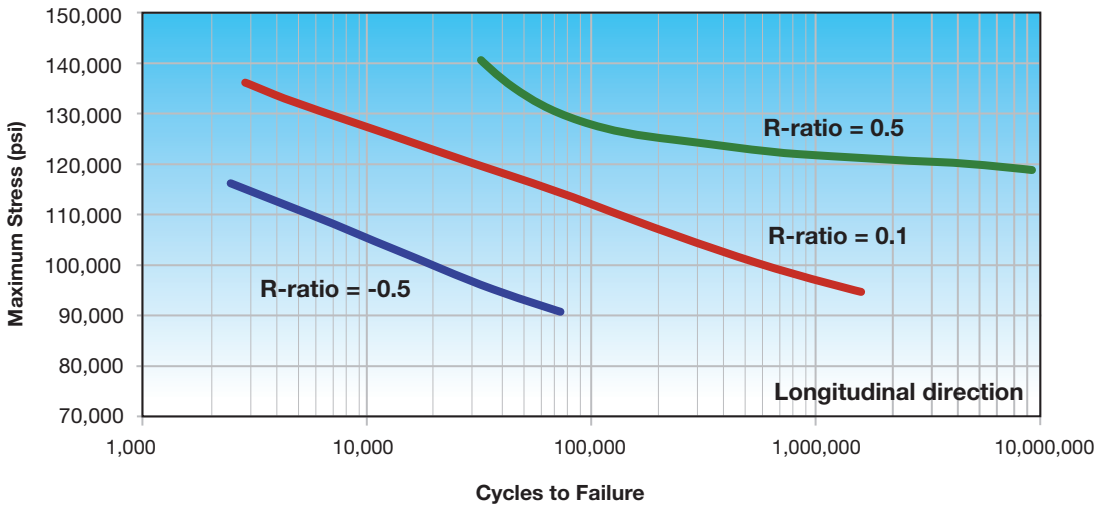
From product with a range of thickness from 0.01 – 0.143 in. (0.25 – 3.6 mm)

Test Direction	Bearing Ultimate Strength e/D=1.5		Bearing Ultimate Strength e/D=2.0		Bearing Yield Strength e/D=1.5		Bearing Yield Strength e/D=2.0	
	ksi	MPa	ksi	MPa	ksi	MPa	ksi	MPa
Longitudinal	224	1545	227	1907	197	1357	227	1562
Transverse	248	1713	310	2136	201	1387	252	1736

Test Direction	Compression Yield Strength		Ultimate Shear Strength		Compression Elastic Modulus		Tension Elastic Modulus	
	ksi	MPa	ksi	MPa	Msi	GPa	Msi	GPa
Longitudinal	139	958	95*	659	16.3	113	15.3	105
Transverse	187	1292			18.8	129	18.5	128

*Shear Strength measured in L-T direction
Data from product with a range of thickness from 0.04 – 0.133 in. (1 – 3.4 mm)

Room Temperature Uniaxial Fatigue Cold Rolled Coil



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

HOT-ROLLED SHEET & PLATE AVERAGE MECHANICAL PROPERTIES – MILL ANNEAL CONDITION

Test Direction	Tensile Stress (ksi)	Tensile Stress (MPa)	Yield Stress (ksi)	Yield Stress (MPa)	Elongation (%)
Longitudinal	151	1041	131	903	17
Transverse	157	1082	142	979	17

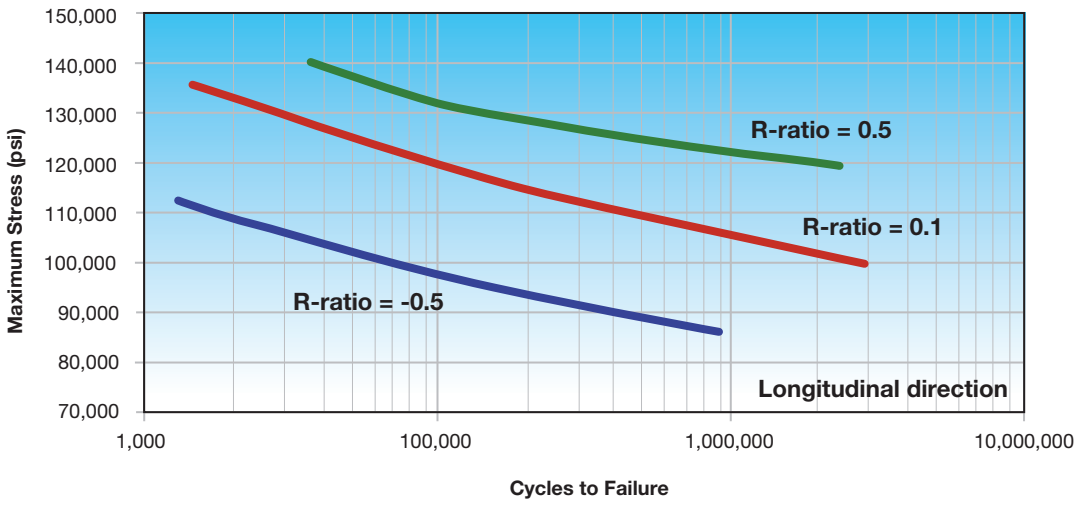
From product with a range of thickness from 0.188 – 2.0 in. (4.8 – 51 mm)

Test Direction	Bearing Ultimate Strength e/D=1.5		Bearing Ultimate Strength e/D=2.0		Bearing Yield Strength e/D=1.5		Bearing Yield Strength e/D=2.0	
	ksi	MPa	ksi	MPa	ksi	MPa	ksi	MPa
Longitudinal	240	1654	300	2071	205	1413	245	1689
Transverse	250	1720	315	2172	205	1413	255	1759

Test Direction	Compression Yield Strength		Ultimate Shear Strength		Compression Elastic Modulus		Tension Elastic Modulus	
	ksi	MPa	ksi	MPa	Msi	GPa	Msi	GPa
Longitudinal	135	931	105	724	17	117	17	119
Transverse	150	1034	109	754	18	126	18	126

From product with a range of thickness from 0.188 – 2.0 in. (4.8 – 51 mm)

Room Temperature Uniaxial Fatigue Hot Rolled Sheet and Plate



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

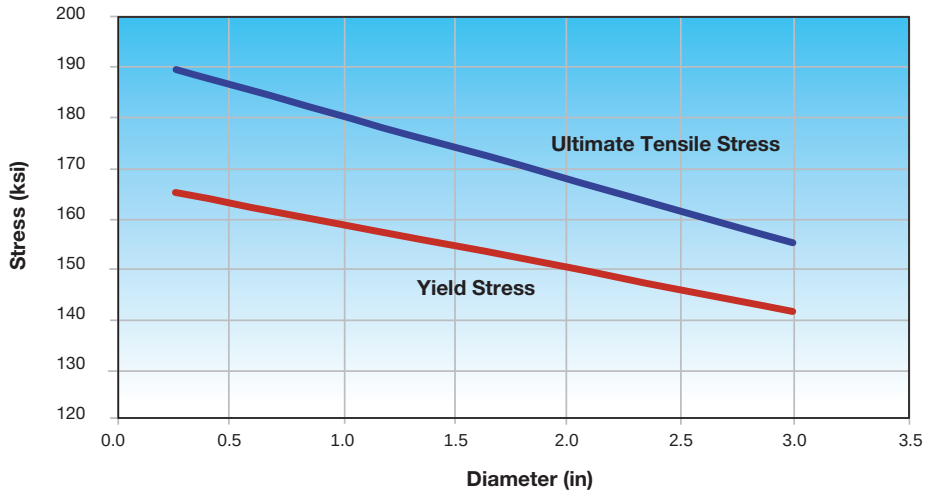
HOT WORKED BAR AND BILLET TYPICAL MECHANICAL PROPERTIES – MILL ANNEAL CONDITION

Test Direction	Tensile Stress (ksi)	Tensile Stress (MPa)	Yield Stress (ksi)	Yield Stress (MPa)	Elongation (%)
Longitudinal	146	1007	135	931	21
Transverse	153	1055	147	1014	18

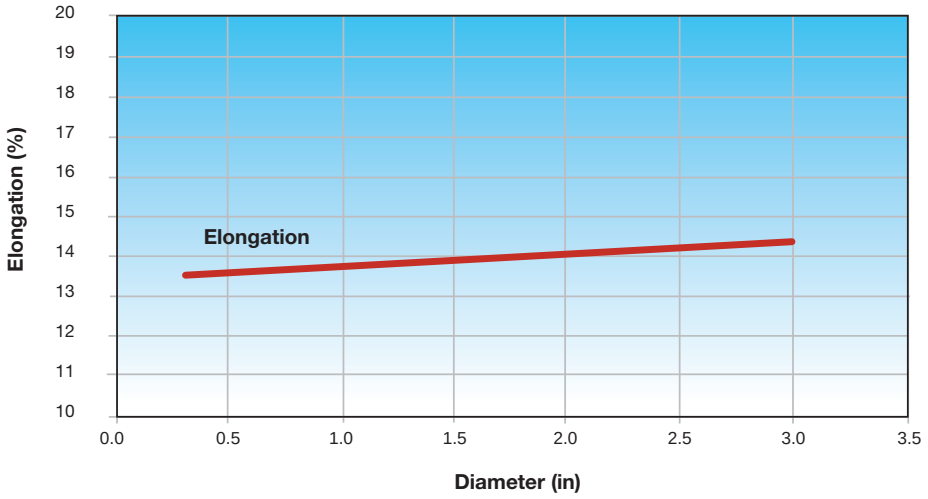
From product with a range of thickness from 0.188 – 2.0 in. (4.8 – 51 mm)

HOT WORKED BAR AND BILLET TYPICAL MECHANICAL PROPERTIES – SOLUTION TREATED AND AGED CONDITION

Typical Tensile Properties of Solution Treated and Aged Bar



Typical Elongation Properties of Solution Treated and Aged Bar



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