HAMILTON PRECISION METALS | AMETEK SPECIALTY METAL PRODUCTS

TITANIUM STRIP AND FOIL

Ti GRADES 1, 2, 4, AND 9

Precision titanium strip and foil engineered to your exact specifications for critical medical implant applications.

Custom sizes, custom surface finishes, controlled mechanical properties, and the thinnest gauges - down to 1.5 microns.

- **Fine Grain Size** - Improves drawability
- **Highly Ductile** - Reduces processing steps
- **Surface Finish** - Eliminates splitting and mitigates cosmetic issues to improve yields
- **Gauge Control** - Repeatability in the stamp / draw process

HAMILTON PRECISION METALS / AMETEK SPECIALTY METAL PRODUCTS

CP TITANIUM
(UNS R50250, UNS R50400, UNS R50700)

CP Titanium is selected for its favorable strength to weight ratio and excellent corrosion resistance. Three levels of purity permit a choice of finish strength.

GENERAL INFORMATION

The alloy can be formed from the annealed temper. Severe forming may be aided by an intermediate stress relief at 1000°F. Stress relieving may be appropriate after severe cold forming. Welding with active gases, coating or fluxes must be avoided to prevent embrittlement.

AVAILABILITY

CP Titanium is available from Hamilton Precision Metals as strip product from 0.0005" to 0.025" (0.0127 mm to 0.635 mm) and widths up to12.0" (304.8 mm).

A foil product is available as thin as 0.00006" (1.5 micron) and widths of 4.0" (101.6 mm) maximum.

AVAILABLE PRODUCT FORMS
STRIP
FOIL

MATERIAL DESIGNATIONS
ASTM TI GRADE 1, TI GRADE 2, TI GRADE 4
UNS R50250, R50400, R50700
EN TI CP
DIN 3.7025, 3.7035, 3.7065

TYPICAL MANUFACTURING SPECIFICATIONS		
ASTM F67	ASTM B265	AMS 4902
Also individual customer specifications.		

TYPICAL APPLICATIONS
MEDICAL IMPLANTABLE SHIELDS
CHEMICAL
INDUSTRIAL

TECHNICAL DATA

TYPICAL ANNEALED MINIMUM MECHANICAL PROPERTIES [1]			
Temper	GRADE 1 ANNEALED KSI (MPa)	GRADE 2 ANNEALED KSI (MPa)	GRADE 4 ANNEALED KSI (MPa)
Ultimate Tensile Strength	35 (240)	50 (3456)	80 (550)
Yield Strength (0.2% Offset)	20 (138)	40 (275)	70 (483)
Elongation in 2" *	24%	20%	15%

*The measured elongation will be less as thickness decreases to 0.002" and less. For thicknesses below 0.012", mechanical properties are to be negotiated.

[1] These values may be adjusted by control of process variables – consult HPM for desired values.

PHYSICAL PROPERTIES [2]	
Density	0.163 lbs/cu.in.
Melting Point (Approx.)	1660°C
Electrical Resistivity @ R.T.	56 Microhm · cm
Thermal Expansion Coefficient (0 to 100°C)	8.6 x 10^{-6}/°C
Thermal Expansion Coefficient (0 to 315°C)	9.2 x 10^{-6}/°C
Thermal Conductivity @ R.T.	16.0 W/m · K
Magnetic Attraction	None

[2] Typical values to guide alloy selection but are not a guarantee of minimum or maximum.

NOMINAL COMPOSITION (% by weight)	
Grade 1	Maximum
Oxygen	0.18
Iron	0.20
Carbon	0.08
Hydrogen	0.015
Nitrogen	0.03
Grade 2	
Oxygen	0.25
Iron	0.30
Carbon	0.08
Grade 4	
Oxygen	0.40
Iron	0.50
Carbon	0.08

HAMILTON PRECISION METALS / AMETEK SPECIALTY METAL PRODUCTS

TITANIUM GRADE 9 / Ti 3AL/2.5V
(UNS R56320)

Ti Grade 9 is a near alpha, alpha-beta alloy, sometimes referred to as "half-6-4." It offers 20 to 50% higher tensile strength than the commercially pure titanium at room and elevated temperatures. It is much more amenable to cold working than Ti 6Al/4V alloy and can be cold worked 75 to 85% to result in moderately high strength and good ductility.

GENERAL INFORMATION

The alloy can be formed from the annealed temper. Severe forming may be aided by an intermediate stress relief. Stress relieving may be appropriate after severe cold forming to remove residual stresses. Weldability and corrosion resistance is very similar to commercially pure titanium. Welding should be performed with inert gas shielded arc or spot welding. Welding with active gases, coatings, or fluxes must be avoided to prevent embrittlement.

AVAILABLE PRODUCT FORMS
STRIP
FOIL

MATERIAL DESIGNATIONS
ASTM Ti GRADE 9
UNS R56320
EN Ti GRADE 9 (3AL/2.5V)
DIN 3.7195

TYPICAL MANUFACTURING SPECIFICATIONS
ASTM B265
AMS 4989
Also individual customer specifications.

TYPICAL APPLICATIONS
MEDICAL IMPLANTABLE NEUROSTIMULATORS
AEROSPACE HONEYCOMBS
INDUSTRIAL CORROSION RESISTANCE
CHEMICAL AND CONSUMER APPLICATIONS

TECHNICAL DATA

TYPICAL ANNEALED MINIMUM MECHANICAL PROPERTIES [1]	
Temper	GRADE 9 ANNEALED KSI (MPa)
Ultimate Tensile Strength	90 (620)
Yield Strength (0.2% Offset)	70 (483)
Elongation A50 *	12%

*The measured elongation will be less as thickness decreases to 0.002" and less. For thicknesses below .012", mechanical properties are to be negotiated.

[1] These values may be adjusted by control of process variables – consult HPM for desired values.

NOMINAL COMPOSITION (% by weight)		
Grade 9	Minimum	Maximum
Titanium	Balance	
Aluminum	2.5	3.5
Vanadium	2.0	3.0
Carbon	-	0.08
Oxygen	-	0.15
Nitrogen	-	0.03
Hydrogen	-	0.015
Iron	-	0.25
Others each		0.1
Others total		0.4

PHYSICAL PROPERTIES [2] (At 20°C)		
Density	4.48	g/cm³
Electrical Resistivity	12.6	μohm/cm
Coef. of Thermal Expansion	7.9	mm/m/°C
Thermal Conductivity	7.6	W/(m*K)
Specific Heat (0-100°C)	427	J/(kg*K)

[2] Typical values to guide alloy selection but are not a guarantee of minimum or maximum.

HPM HAMILTON PRECISION METALS | AMETEK SPECIALTY METAL PRODUCTS

THICKNESS CAPABILITY AND TOLERANCE CHARTS

Hamilton Precision Metals rolls metal strip and foil in nearly any alloy and specialty metal to the tightest tolerances and thinnest gauges in the industry – from 1.5mm (0.060") down to 1.5 microns (0.000060") in thickness.

THICKNESS (INCHES)	4" WIDE	8" WIDE	12" WIDE
0.00006 to 0.00045"	±5%	-	-
0.00045 to 0.001"	±5%	±0.000040"	±0.000050"
0.001 to 0.004"	±0.000050"	±0.000060"	±0.000075"
0.004 to 0.010"	±0.00010"	±0.00010"	±0.00012"
0.010 to 0.020"	±0.00015"	±0.00020"	±0.00025"
0.020 to 0.040"	±0.00020"	±0.00035"	±0.00050"
0.040 to 0.075"	±0.00035"	±0.00060"	±0.0010"

Tolerances in percent or inches. Tolerances may vary depending on alloy being rolled.

THICKNESS (MILLIMETERS)	100 mm WIDE	200 mm WIDE	300 mm WIDE
0.0015 to 0.012	±5%	-	-
0.012 to 0.025	±5%	±0.0010	±0.0013
0.025 to 0.10	±0.0013	±0.0015	±0.0019
0.10 to 0.25	±0.0025	±0.0025	±0.0030
0.25 to 0.50	±0.0038	±0.0051	±0.0064
0.50 to 1.0	±0.0051	±0.0089	±0.0127
1.0 to 1.9	±0.0089	±0.0152	±0.0254

Tolerances in percent or mm. Tolerances may vary depending on alloy being rolled.

The tables above outline typical thickness tolerances available from HPM, which are tighter than industry standards.

80 YEARS EXPERTISE IN ROLLING PRECISION TITANIUM STRIP

We supply the metal forming companies that make hermetic shields for the largest medical device manufacturers.

CUSTOM SURFACE FINISHES FROM ULTRA-SMOOTH TO MATTE

Our metallurgists work with you to develop special, customized, application and process specific surface finishes - to maximise the performance of your product.

EXCEPTIONALLY FAST LEAD TIMES AND SMALL LOT SIZES

We offer exceptionally short lead times and small batch sizes while maintaining product consistency from lot to lot.

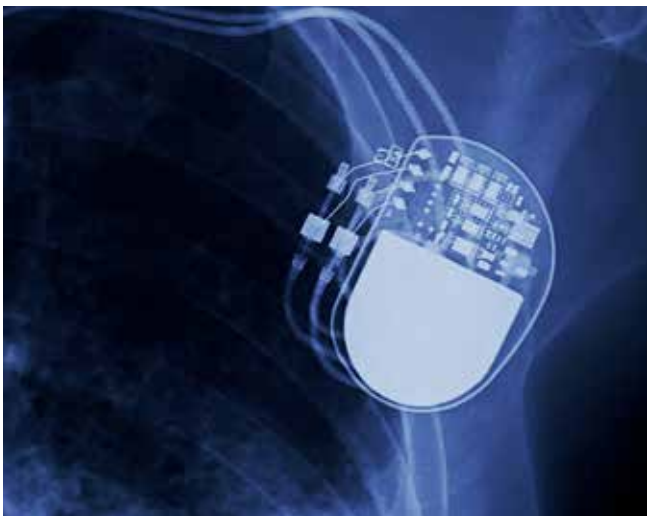
MECHANICAL PROPERTIES TO MATCH YOUR SPECIFICATIONS

Our team has the engineering expertise to precisely control mechanical properties to your exacting requirements.

IMPLANTABLE SHIELDS

We have more than 80 years expertise in rolling high quality precision titanium strip for the metal forming companies that make the hermetic shields and cans for the largest pacemaker, drug-infusion pump and electronic implant manufacturers around the world.

CP Grade 1 Titanium is the preferred material due to its light weight, biocompatibility and ability to be deep-drawn into the desired shape and EB-welded to provide a hermetic seal.



ADVANTAGES FOR IMPLANTABLE SHIELDS

Our biocompatible titanium strip and foil materials are custom-engineered to deliver outstanding properties for medical device manufacturers:

- **Fine Grain Size** - Improves drawability
- **Highly Ductile** - Reduces processing steps
- **Surface Finish** - Eliminates splitting, mitigates cosmetic issues improving yields
- **Gauge Control** - Repeatability in the stamp / draw process
- **Corrosion resistant**

This surface finish and gauge control translates to improvements in finished product quality as well as process controls during drawing, stamping, etching, or laser cutting.

IMPLANTABLE SHIELD APPLICATIONS

Our titanium strip is stamped and formed into enclosures (also referred to as shields, cases, or cans) used for implantable medical devices including:

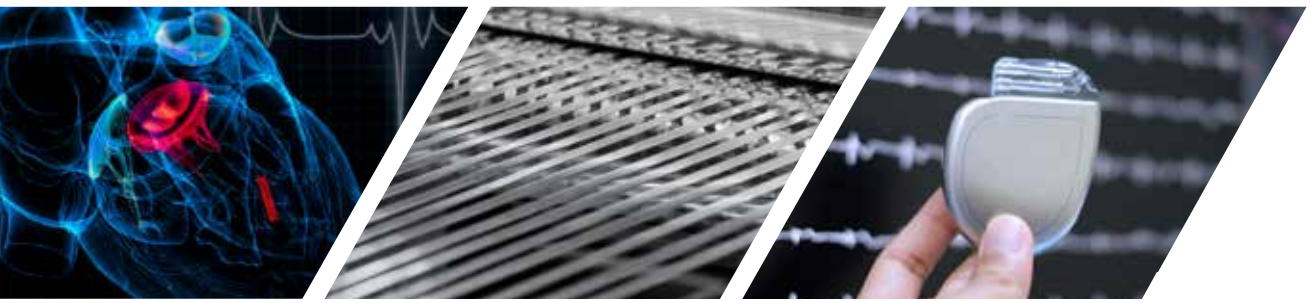
- Cardiac & Pacemaker
- Drug-infusion pump and delivery systems
- Cardiac Monitors
- Neurostimulator Implants
- Defibrillators (Cardiac Rhythm Management (CRM)

SAFE EXTERNAL CHARGING OF NEUROSTIMULATOR IMPLANTS

We have the expertise to produce thin strip in titanium grades 9 (and other titanium grades) for production of neurostimulator cases that allows for the external charging after being implanted in the patient.

Our materials allow for the manufacturing of smaller devices that enable safe, external re-charging for a range of transformative neuromodulation and neurostimulation therapy applications.

TITANIUM STRIP AND FOIL



ABOUT AMETEK SPECIALTY METAL PRODUCTS

AMETEK Specialty Metal Products (SMP) is a business unit of AMETEK, Inc. a leading global manufacturer of electronic instruments and electromechanical devices with annualized sales of approximately $5.5 billion.

The Specialty Metals business unit consists of five brands and operating facilities in the United States and the United Kingdom. All are proven experts in the manufacture of advanced metallurgical products including precision metal strip, ultra-thin foil, specialty shaped wire, engineered components, thermal management materials, water atomized powders, precision tube and roll-bonded clad plate.

These high performance metal products are used around the world for critical applications in a range of industries including aerospace, automotive, defense, electronics, industrial, medical, nuclear, and oil and gas.

HPM | HAMILTON PRECISION METALS

AMETEK SPECIALTY METAL PRODUCTS

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