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Superseding AMS4949	

Titanium, Sheet, Laminated, Surface Bonded

#### RATIONALE

AMS4949A results from a Five Year Review and update of this specification.

#### 1. SCOPE

##### 1.1 Form

This specification covers titanium in the form of laminated sheet.

##### 1.2 Application

This material has been used typically for shims in which thickness is adjusted by removal of laminations as required, but usage is not limited to such applications.

##### 1.3 Classification

Materials are classified as follows:

##### 1.3.1 Type

Type I - All laminations

Type II - One half laminations

Type III - Three quarters laminations

##### 1.3.2 Class

Class 1 - 0.002 inch (0.05 mm) thick laminations

Class 2 - 0.003 inch (0.075 mm) thick laminations

#### 2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The supplier may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been canceled and no superseding document has been specified, the last published issue of that document shall apply.

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## 2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), [www.sae.org](http://www.sae.org).

AMS4901 Titanium, Sheet, Strip, and Plate, Commercially Pure, 70ksi (485 Mpa) Yield Strength

AMS4907 Titanium Alloy, Sheet, Strip, and Plate, 6.0Al-4.0V, Extra Low Interstitial, Annealed

AMS4911 Titanium Alloy, Sheet, Strip, and Plate, 6.0Al-4.0V, Annealed

## 2.2 American Society for Quality Publications

Available from American Society for Quality, 600 North Plankinton Avenue, Milwaukee, WI 53203, Tel: 800-248-1946 (United States or Canada) or +1-414-272-8575 (International), [www.asq.org](http://www.asq.org).

ANSI/ASQC Z1.4 Sampling Procedures and Tables for Inspection by Attributes

## 3. TECHNICAL REQUIREMENTS

### 3.1 Composition

#### 3.1.1 Laminations

Shall conform to AMS4901 or harder condition.

#### 3.1.2 Solid Stock

When required, shall conform to AMS4907 or AMS4911.

#### 3.1.3 Adhesive

Shall be of a composition which will meet the fabrication and quality requirements of this specification.

### 3.2 Fabrication

The laminated shim stock shall consist completely of laminations each 0.002 inch  $\pm$  0.0002 (0.05 mm  $\pm$  0.005) thick or 0.003 inch  $\pm$  0.0003 (0.08 mm  $\pm$  0.008) thick, or partly of such laminations combined with a single thicker lamination, as ordered, bonded together by an adhesive such that individual laminations may be peeled for adjustment of shim thickness. The thickness of each layer of adhesive shall not exceed 0.0003 inch (0.008 mm).

3.2.1 Sheet shall be of the thicknesses and combinations of laminations and solid base shown in Table 1. The existence of the applicable type, class and nominal thickness shown in Table 1 is not intended to imply that all products described are commercially available.

TABLE 1 - THICKNESS COMBINATIONS OF SHIM STOCK

Inch	mm	Type I Class 1 All Laminated, 0.002 in. (0.05 mm) Laminations	Type I Class 2 All Laminated, 0.003 in. (0.08 mm) Laminations	Type II Class 1 Half Solid, Half Laminated 0.002 in. (0.05 mm) Laminations	Type II Class 2 Half Solid, Half Laminated 0.003 in. (0.08 mm) Laminations	Type III Class 1 Three Quarters Solid, One Quarter Laminated 0.002 in. (0.05 mm) Laminations	Type III Class 2 Three Quarters Solid, One Quarter Laminated 0.003 in. (0.08 mm) Laminations
0.006	0.15	X					
0.008	0.20	X					
0.010	0.25	X					
0.012	0.31	X					
0.015	0.38	X	X				
0.016	0.41	X	X				
0.020	0.51	X	X				
0.021	0.53	X	X				
0.032	0.81	X	X				
0.033	0.84	X	X				
0.047	1.19	X	X				
0.048	1.22	X	X				
0.062	1.58	X	X	X	X		
0.063	1.60	X	X	X	X		
0.078	1.98	X	X	X	X		
0.080	2.03	X	X	X	X		
0.093	2.37	X	X	X	X		
0.094	2.39	X	X	X	X		
0.109	2.77	X	X	X	X		
0.121	3.07	X	X	X	X	X	X
0.125	3.18	X	X	X	X	X	X

### 3.3 Construction

#### 3.3.1 General Requirements

Laminations and solid stock, when applicable, shall be bonded together throughout the whole surface area in a manner which will permit peeling of the laminations without the aid of mechanical devices, for adjustment of shim thickness, without separation of the remaining laminations and solid part. Laminations shall be bonded together in such a manner that any shape can be cut from the material using suitable tools, without separation. Laminations shall remain intact without separation during normal handling. Requirements shall be applicable to laminations not less than eight hours after completion of bonding.

#### 3.3.2 Surface Roughness

Flat surfaces of laminations, and solid stock when applicable, shall have a maximum roughness of 63 RA (microinches) on original surfaces and on metallic surfaces after peeling.

#### 3.3.3 Water Resistance

Sheet shall withstand total immersion in water at 120 °F ± 3 (49 °C ± 2) for at least three hours without separation of laminations or any evidence of corrosion.

### 3.3.4 Peel Strength

Each individual lamination shall have a peel strength no less than 1 pound per inch of width (180 gm/cm of width) and no more than 5 pounds per inch of width (900 gm/cm of width), except at the solid/laminate bond line which may be higher.

### 3.4 Quality

Sheet, as received by purchaser, shall be uniform in quality and condition, sound, and free from foreign materials and from dents, creases, and other imperfections detrimental to usage of the sheet.

### 3.5 Thickness Tolerances

Shall be as specified in Table 2.

TABLE 2A - TOTAL THICKNESS TOLERANCES, INCH-POUND UNITS

Nominal Total Thickness Inches	Tolerance, Inch Plus	Tolerance, Inch Minus
Up to 0.008, incl	0.001	0.0005
Over 0.008 to 0.010, incl	0.0015	0.0005
Over 0.010 to 0.016, incl	0.0015	0.001
Over 0.016 to 0.021, incl	0.002	0.001
Over 0.021 to 0.033, incl	0.003	0.002
Over 0.033 to 0.048, incl	0.005	0.002
Over 0.048 to 0.063, incl	0.006	0.002
Over 0.063 to 0.080, incl	0.007	0.002
Over 0.080 to 0.094, incl	0.009	0.003
Over 0.094 to 0.109, incl	0.010	0.003
Over 0.109 to 0.125, incl	0.012	0.003
Over 0.125 to 0.156, incl	0.015	0.003
Over 0.156 to 0.187, incl	0.018	0.003
Over 0.187 to 0.190, incl	0.018	0.005

TABLE 2B - TOTAL THICKNESS TOLERANCES, SI UNITS

Nominal Total Thickness Millimeters	Tolerance, Millimeter Plus	Tolerance, Millimeter Minus
Up to 0.20, incl	0.025	0.013
Over 0.20 to 0.25, incl	0.038	0.013
Over 0.25 to 0.41, incl	0.038	0.025
Over 0.41 to 0.53, incl	0.05	0.025
Over 0.53 to 0.84, incl	0.08	0.05
Over 0.84 to 1.22, incl	0.13	0.05
Over 1.22 to 1.60, incl	0.15	0.05
Over 1.60 to 2.03, incl	0.18	0.05
Over 2.03 to 2.39, incl	0.23	0.08
Over 2.39 to 2.77, incl	0.25	0.08
Over 2.77 to 3.18, incl	0.30	0.08
Over 3.18 to 3.96, incl	0.38	0.08
Over 3.96 to 4.75, incl	0.46	0.08
Over 4.75 to 4.83, incl	0.46	0.13