SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS2437 | REV. C

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Reaffirmed 2012-08

Superseding AMS2437B

Coating, Plasma Spray Deposition

RATIONALE

AMS2437C has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE:

1.1 Process:

This specification covers the engineering requirements for applying coatings to parts by the plasma spray process and the properties of such coatings.

1.2 Application:

This coating has been used typically to provide protection from wear, heat, corrosion (with sealer), and abrasion. The coating can also be used to restore dimensionally discrepant parts, but usage is not limited to such applications.

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 cancelled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001 or www.sae.org.

AMS 4027	Aluminum Alloy Sheet and Plate, 1.0Mg - 0.60Si - 0.28Cu - 0.20Cr (6061; -T6 Sheet, -T651 Plate), Solution and Precipitation Heat Treated
AMS 4117	Aluminum Alloy, Rolled or Cold Finished, Bars, Rods and Wire, and Flash Welded Rings, 1.0Mg - 0.60Si - 0.28Cu - 0.20Cr (6061, -T6, -T651), Solution and Precipitation Heat Treated
AMS 4911	Titanium Alloy Sheet, Strip, and Plate, 6Al - 4V, Annealed

TO PLACE A DOCUMENT ORDER: **Tel: 877-606-7323 (inside USA and Canada)**
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: **http://www.sae.org**

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS2437C

2.1 (Continued):

AMS 4928	Titanium Alloy Bars, Wire, Forgings, and Rings, and Drawn Shapes, 6Al - 4V, Annealed, 120,000 psi (825 MPa) Yield Strength
AMS 5510	Steel, Corrosion and Heat Resistant, Sheet, Strip, and Plate, 18Cr - 10.5Ni - 0.40Ti (SAE 30321), Solution Heat Treated
AMS 5645	Steel, Corrosion and Heat Resistant, Bars, Forgings, Tubing, and Rings, 18Cr - 10Ni - 0.40Ti (SAE 30321), Solution Heat Treated
AMS 5791	Cobalt Alloy, Powder, Plasma Spray, 56.5Co - 25.5Cr - 10.5Ni - 7.5W
AMS 5792	Powder, Plasma Spray, 50 (88W - 12Co) + 35 (70Ni - 16.5Cr - 4Fe - 4Si - 3.8B) + 15 (80Ni - 20Al), Three Component Mixture
AMS 5793	Powder, Plasma Spray, (95Ni - 5Al)
AMS 6350	Steel Sheet, Strip, and Plate, 0.95Cr - 0.20Mo (0.28 - 0.33C) (SAE 4130)
AMS 6370	Steel Bars, Forgings, and Rings, 0.95Cr - 0.20Mo (0.28 - 0.33C) (SAE 4130)
AMS 7875	Powder, Chromium Carbide Plus Nickel-Chromium Alloy, 75Cr_2C_3 + 25 (80Ni - 20Cr Alloy)
AMS 7878	Tungsten Carbide Powder, Cobalt Coated
AMS 7879	Tungsten Carbide-Cobalt Powder, Cast and Crushed
AMS 7880	Tungsten Carbide-Cobalt Powder, Sintered and Crushed

2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or www.astm.org.

ASTM C 633	Adhesion or Cohesive Strength of Flame-Sprayed Coatings
ASTM E 384	Microhardness of Materials

3. TECHNICAL REQUIREMENTS:

3.1 Equipment:

3.1.1 Torch: A specially constructed torch that dissociates and ionizes a suitable plasma-forming gas when an electric arc is struck between an anode and cathode. Coating particles, which are injected into the resultant high-velocity, high-temperature flame, are heated to plasticity and propelled toward the workpiece to be coated.

3.1.2 Gas: A suitable plasma-forming gas, as used in 3.1.1, may be any of the following, but the gas used shall be acceptable to the purchaser:

3.1.2.1 Nitrogen.

3.1.2.2 Mixtures of nitrogen and hydrogen.

3.1.2.3 Argon.

3.1.2.4 Mixtures of argon and hydrogen.

3.1.2.5 Mixtures of argon and helium.

3.1.2.6 For substrates of titanium, titanium alloys, and steels heat treated above 180 ksi (1241 MPa) tensile strength, the plasma-forming gases shall be argon or a mixture of argon and helium.

3.1.3 Coating Material: Shall be a powder conforming to the specification required by the coating designation (See 3.5.1) specified on the drawing. All powder shall be dry, free-flowing, and uniformly blended.

3.2 Personnel:

Operators or other personnel performing manual plasma spray operations shall be trained to spray using each material and gas system designated. Competence of the manual spray operator or of fully mechanized equipment shall be demonstrated by spraying a set of test specimens as in 4.5.1 which shall meet the requirements of 3.6.

3.3 Operation Sheets:

For each different part number to be sprayed, a process procedure shall be established covering preparation, preheating, and spraying parameters. Figure 1 shows a typical process control sheet; use of the format shown is not mandatory provided all applicable information thereon is shown. A single operation sheet may cover more than one part number if all parameters for coating the parts are the same. This process procedure shall be available for review by the purchaser upon request.

3.4 Preparation:

3.4.1 Surfaces to be coated shall be machined to allow for the finished thickness of the coating.

3.4.2 Surfaces to be coated shall be cleaned to remove water, oil, grease, dirt, scale, paint, and other foreign matter detrimental to adherence of the sprayed coating. Special cleaning procedures shall be employed in treating titanium parts to avoid hydrogen embrittlement and halide contamination. Cleaned surfaces shall be handled only with clean cloth or gloves before coating.

3.4.3 Parts shall be suitably masked to protect surfaces not required to be coated.

3.4.4 Surfaces to be coated shall be grit blasted to produce a uniform matte finish sufficient to produce good adhesion of the coating. The grit type and size shall be reported in the approved process procedure for each part. Surfaces shall not be blasted with grit previously used on dissimilar materials.

3.5 Procedure:

3.5.1 Coating Designation: The required coating material may be indicated on the drawing by this specification number and a suffix number designating the powder to be used, in accordance with Table 2; e.g., AMS 2437-1 indicates that parts are to be coated with AMS 7880 powder. Coating materials other than those shown in Table 2 may be used when specified by purchaser.

3.5.2 Surfaces to be coated shall be preheated, as required, to remove moisture and to control expansion of the part with respect to the coating. Preheating may be accomplished by use of the plasma torch or by other suitable means. Temperature of the part during preheating and spraying shall be controlled to prevent discoloration, oxidation, distortion, and other conditions detrimental to the coating or substrate. Special precautions shall be taken in coating high-thermal-conductivity materials, such as aluminum and magnesium, to avoid overheating.

3.5.3 Areas on which coating is optional shall, if coated, be prepared, handled, and coated in the same manner as the areas on which coating is required.

3.5.4 Coating material shall be deposited onto the designated surfaces to the thickness specified in the approved process procedure for each part. Finished coating thickness shall be as specified on the drawing. Minimum coating thickness requirements do not apply to areas designated as optional coating areas.

3.5.5 Surface Finishing: Procedures for grinding and lapping shall be acceptable to purchaser.

3.6 Properties:

The coating on parts and representative test specimens shall conform to the following requirements:

3.6.1 Cup Test: Shall not show separation of the coating from the substrate when tested in accordance with 4.5.2 and examined without magnification. Standards for acceptance shall be as specified by purchaser. Test is not applicable to ceramic coatings.

3.6.2 Bend Test (May be substituted for cup test of 3.6.1 when permitted by purchaser): Shall not show separation of the coating from the substrate when tested in accordance with 4.5.3 and examined without magnification. Standards for acceptance shall be as specified by purchaser. Test is not applicable to ceramic coatings.

3.6.3 Bond Strength: Shall be as specified in Table 2, determined in accordance with ASTM C 633.

3.6.4 Hardness: Average hardnesses as calculated from a minimum of ten representative readings of coatings, determined in accordance with ASTM E 384 on cross-sections of those coatings, shall be as specified in Table 2.

3.6.5 Microexamination: Examination of the deposited coatings shall show the coatings to be free from cracks, excessive and massive oxides, and excessive porosity. Coatings shall be essentially free from grit particles and contamination at the interface between the coating and substrate. Metallographic standards for acceptance shall be as specified by purchaser.

3.6.6 Hardness of Finished Parts: Shall be as specified in Table 2, determined in accordance with ASTM E 384 as the average of not less than ten microhardness readings of coatings taken on a cross-section of the part.

3.7 Quality:

The coating, as received by purchaser, shall be adherent to the basis metal and shall have a uniform, continuous surface free from spalling, chipping, flaking, and other imperfections detrimental to usage of the coating.

3.8 Tolerances:

A tolerance of -0 and +0.125 inch (+3.12 mm) is permissible on the boundaries of areas designated to be coated.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection:

The processor of coated parts shall supply all samples for processor's tests and shall be responsible for performance of all required tests. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the coating conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Thickness (3.5.4), properties of test specimens (3.6.1 or 3.6.2 and 3.6.4, and 3.6.5), quality (3.7), and tolerances (3.8) of coated parts are acceptance tests and shall be performed to represent each lot.

4.2.2 Periodic Tests: Bond strength of test specimens (3.6.3), and hardness of coated parts (3.6.6) are periodic tests and shall be performed at a frequency selected by the processor unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests: All technical requirements of this specification are classified as preproduction tests and shall be performed prior to or on the initial shipment of coated parts to a purchaser, when a change in processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.3 Sampling:

Shall be not less than the following; a lot shall be all parts of essentially the same configuration coated in a continuous operation to the same range of thickness with powder from the same batch and presented for processor's inspection at one time:

4.3.1 For Acceptance Tests:

4.3.1.1 Thickness and Properties of Test Specimens: Two sets of specimens, one coated at the beginning and one coated at the end of each lot.

4.3.1.2 Quality and Tolerances of Coated Parts: As acceptable to purchaser.

4.3.2 For Periodic Tests and Preproduction Tests: As determined by processor unless otherwise specified by purchaser.

4.4 Approval:

4.4.1 The process and control factors and/or a preproduction part, whichever is specified, shall be approved by the cognizant engineering organization before production parts are supplied.

4.4.2 The processor shall make no significant change to materials, processes, or control factors (See Figure 1) from those on which the approval was based, unless the change is approved by the cognizant engineering organization. A significant change is one which in the judgement of the cognizant engineering organization could affect the properties or performance of the parts.

4.5 Test Methods:

4.5.1 Test Specimens: Cup, bend, bond, and microexamination test specimens shall be made from the materials as shown in Table 1, unless otherwise permitted by purchaser:

TABLE 1 – Test Specimens

Material of Part to be Coated	Bond Strength Specimen	Cup and Bend Specimens
All Steels	AMS 6370	AMS 6350
Nickel Alloy or Cobalt Alloy	AMS 5645	AMS 5510
Aluminum Alloy or Magnesium Alloy	AMS 4117	AMS 4027
Titanium or Titanium Alloy	AMS 4928	AMS 4911, MAM 4911

4.5.2 Cup Test: Test panels, approximately 3 x 1.75 x 0.05 inch (76 x 44 x 1.3 mm), shall be coated on one side with the same material as the parts to the applicable thickness shown in Table 3, using as far as practicable the same preparation, equipment, and machine settings as for the parts they represent. Panel shall be cup tested on a Detroit or equivalent testing machine, using a 0.875-inch (22-mm) diameter ball and die with a 1.375 inch (35 mm) diameter opening to form a depression in the panel to a depth of 0.300 inch (7.6 mm) except 0.200 inch (5.1 mm) for fine powders up to 20 microns (20 µm). Cup shall be drawn at a slow, uniform deformation rate with the coated side of the panel on the outside of the cup.

4.5.3 Bend Test: Test panels, approximately 3 x 1 x 0.05 inch (76 x 25 x 1.3 mm), shall be coated on one side with the same material as the parts to a thickness as shown in Table 3, using as far as practicable the same preparation, equipment, and machine settings as for the parts they represent. Panels shall be tested by bending the panel 90 degrees around a 1/2-inch (12.7-mm) diameter bar in a direction away from the coating (coating on OD of bend) at a rate of approximately 4 degrees per second.

4.6 Reports:

The processor of coated parts shall furnish with each shipment a report stating that the parts have been processed and tested in accordance with specified requirements and that they conform to the acceptance test requirements. This report shall include the purchase order number, lot number, AMS 2437C, part number, and quantity.

4.7 Resampling and Retesting:

If any specimen used in the above tests fails to meet the specified requirements, disposition of the coated parts may be based on the results of testing three additional specimens, except as specified in 4.7.1, for each original nonconforming specimen. Except as specified in 4.7.2, failure of any retest specimen to meet the specified requirements shall be cause for rejection of the parts represented.

4.7.1 If a bond strength specimen fails at the adhesive-bonded joint, the test may be repeated on another specimen; such retest shall not be considered one of the retests specified in 4.7.

4.7.2 If any part fails to meet the specified requirements, either on the original sampling as in 4.3 or upon resampling as in 4.7 and 4.7.1, the parts in that lot may be stripped by a method approved by purchaser which does not roughen, pit, or embrittle the basis metal, recoated, and retested.

5. PREPARATION FOR DELIVERY:

5.1 Parts shall be handled and packaged in a manner that will ensure that the required physical characteristics and properties of the coated parts are preserved.

5.2 Packages of coated parts shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the parts to ensure carrier acceptance and safe delivery.

6. ACKNOWLEDGMENT:

Processor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders,

7. REJECTIONS:

Parts on which coating does not conform to this specification or to modifications authorized by purchaser will be subject to rejection.

8. NOTES:

8.1 A change bar (|) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of a specification. An (R) symbol to the left of the document title indicates a complete revision of the specification, including technical revision. Change bars and (R) are not used in original publications, nor in specifications that contain editorial changes only.

8.2 Parts manufacturing operations, such as heat treatment, plating, acid or alkaline cleaning, forming, joining, and media finishing, can affect the condition of the substrate for coating, or, if performed after coating, could adversely affect the coating. The sequencing of these types of operations should be specified by the cognizant engineering organization and is not controlled by this specification.

8.3 The parts manufacturer should ensure that surfaces of metal parts supplied to the processor are free from blemishes, pits, tool marks, and other irregularities that will affect the quality of the finished parts. Defects and variations in appearance that arise from surface conditions of the substrate, such as porosity, scratches, or inclusions, that persist in the finished coating despite observation of industry accepted coating practices should not be considered as cause for rejection.

8.4 Dimensions and properties in inch/pound units are primary; dimensions and properties in SI units are shown as the approximate equivalents of the primary units and are presented only for information.

8.5 Purchase documents should specify not less than the following:

AMS 2437C
Coating thickness desired
Quantity of pieces to be coated
Standards for acceptance of cup test or bend test, and microexamination (See 3.6.1 and 3.6.2).

8.6 Coatings meeting the requirements of this specification have been classified under Federal Standardization Area Symbol "MFFP".