Society of Automotive Engineers, Inc.
400 COMMONWEALTH DRIVE, WARRENDALE, PA. 15096

AEROSPACE MATERIAL SPECIFICATION

AMS 3138

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Revised

COATING MATERIALS, FLUOROCARBON ELASTOMERIC

1. SCOPE:

1.1 Form: This specification covers fluorocarbon elastomeric coating materials for fiber-reinforced-resin composite structures in the form of two-component brushable or sprayable liquids.

1.2 Application: Primarily for protection of aircraft and missile radomes and other components from rain erosion, aerodynamic heating, precipitation static build-up, thermal flash exposure, and weathering.

1.3 Classification: The requirements specified herein and in the applicable detail specification define each coating material on the basis of its primary usage and color which are shown in the title of each detail specification.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications (AMS) shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 2825 - Material Safety Data Sheets
AMS 3609 - Plastic Sheet, Methyl Methacrylate, Heat Resistant
AMS 3821 - Cloth, Type "E" Glass, "B" Stage Epoxy-Resin-Impregnated, 181 Style Fabric, Self-Extinguishing
AMS 3822 - Cloth, Type "E" Glass, "B" Stage Epoxy-Resin-Impregnated, Style 181-75DE
AMS 3844 - Cloth, Type E-Glass, Style 7781 Fabric, Hot-Melt, Addition-Type Polyimide Resin Impregnated
AMS 3849 - Cloth, Quartz, Style 581 Fabric, Hot-Melt, Addition-Type, Polyimide Resin Impregnated

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM D471 - Rubber Property - Effect of Liquids
ASTM D1475 - Density of Paint, Varnish, Lacquer, and Related Products
ASTM D1644 - Nonvolatile Content of Varnishes
ASTM D1824 - Apparent Viscosity of Plastisols and Organosols at Low Shear Rates by Brookfield Viscometer
ASTM D2267 - Aromatics in Light Naphthas, Reformates, and Gasolines by Gas Chromatography

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Federal Specifications:

PPP-P-1892 - Paint, Varnish, Lacquer, and Related Materials, Packaging, Packing, and Marking of

Printed in U.S.A.

2.3.2 Federal Standards:

FED-STD-595 - Color

2.3.3 Military Specifications:

MIL-R-7705 - Radomes, General Specification for
MIL-P-25421 - Plastic Material, Glass Fiber Base-Epoxy Resin, Low Pressure Laminated

3. TECHNICAL REQUIREMENTS:

3.1 Detail Specifications: The requirements for a specific coating material shall consist of all the requirements specified herein in addition to the requirements specified in the applicable detail specification. In the case of any conflict between the requirements of this basic specification and an applicable detail specification, the requirements of the detail specification shall govern.

3.2 Material: The coating materials shall be pigmented, chemically room-temperature-curing fluoroelastomeric compositions with appropriate curing agents, in kit form, formulated to meet the requirements of 3.3.

3.2.1 Solvents: Unless otherwise specified, all solvents used in the elastomeric compositions, curing agents, and primer when used, shall be non-photochemically reactive with an aggregate of less than 20% of its total volume composed of the chemical compounds classified below and shall not exceed any one of the following composition limitations with reference to the total volume of the solvent, determined in accordance with ASTM D2267:

3.2.1.1 A combination of hydrocarbons, alcohols, aldehydes, esters, ethers, or ketones having an olefinic or cycloolefinic type unsaturation: 5%.

3.2.1.2 A combination of aromatic compounds with 8 or more carbon atoms to the molecule, except ethylbenzene: 8%.

3.2.1.3 A combination of ethylbenzene, ketones having branched hydrocarbon structures, trichloroethylene, or toluene: 20%.

3.2.2 Accelerated Storage Stability: Coating material components, stored uncatalyzed for 4 days ± 0.1 at 120°F ± 2 (50°C ± 1), shall be free from lumps, skins, and gels and shall disperse readily to smooth, homogeneous mixtures.

3.2.3 Long-Time Storage Stability: Coating material components, including the primer and primer accelerator if applicable, shall meet the requirements of this specification and the applicable detail specification after being stored for one year at 70° - 100°F (21° - 38°C).

3.3 Properties: The product shall conform to the following requirements:

3.3.1 Mixed, Uncured Coating Materials: Shall meet the following requirements after mixing as in 4.5.1:

3.3.1.1 Nonvolatile Content: Shall be not lower than 10% by weight, determined in accordance with ASTM D1644, Method A.

3.3.1.2 Weight Per Unit Volume: Shall be not lower than 7.6 lb per gal (0.91 kg/L), determined in accordance with ASTM D1475.

3.3.1.3 Viscosity: Shall be 50 - 1000 cps (0.05 - 1.00 Pa·s) at 73°F ± 1 (23°C ± 0.5) but shall not vary from the qualification value by more than 150 cps (0.15 Pa·s), determined in accordance with ASTM D1824, using a Model LVF Viscometer and No. 2 spindle.

3.3.1.4 Odor: Shall not be obnoxious.

3.3.1.5 Pot Life: Coating materials, stored at 68° - 86°F (20° - 30°C) in closed containers for not less than 4 hr, shall show no evidence of lumping, seeding, or separation, shall meet the viscosity requirements of the applicable detail specification, and shall dilute readily to a viscosity suitable for application by spraying.

3.3.2 Application Properties: Coating materials, mixed as in 4.5.1 and applied in accordance with manufacturer's instructions, shall meet the following requirements:

3.3.2.1 Recoat Time: Shall be not more than 30 minutes.

3.3.2.2 Tack-Free Time: Shall be not more than 4 hr, as shown by no evidence of removal of the film, determined in accordance with 4.5.3.

3.3.3 Cured Coating Properties: Coating materials, mixed as in 4.5.1, applied in accordance with manufacturer's instructions, and cured for 7-10 days at 70°F ± 5 (24°C ± 2), shall meet the following requirements and those of the applicable detail specification. Application of antistatic topcoating material over not-fully-cured base material shall not retard or inhibit curing of either the base compound or the antistatic topcoating.

3.3.3.1 Peel Strength: Shall be not lower than 5 lb per in. (876 N/m), determined in accordance with 4.5.4.

3.3.3.2 Fluid Resistance: Coatings shall show no leaching of pigment, loss of adhesion, blistering, or discoloration and shall meet the peel strength requirements of 3.3.3.1 after being immersed as in 3.3.3.2.1 and 3.3.3.2.2, in accordance with 4.5.5. Peel testing shall be performed within 1 hr after removal from fluid and in accordance with 4.5.4.

3.3.3.2.1 Immerse in distilled water at 100°F ± 2 (38°C ± 1) for 4 days ± 0.1.

3.3.3.2.2 Immerse in ASTM Reference Fuel B (ASTM D471) at 70°F ± 5 (24°C ± 2) for 24 hr ± 1.

3.3.3.3 Heat Resistance: Coatings shall show no evidence of melting, erosion, cracking, crazing, or other film deterioration, determined in accordance with 4.5.9.

3.4 Quality:

3.4.1 The coating components shall be uniform in quality and condition, homogeneous, and free from foreign material that would alter their use or function.

3.4.2 The applied coatings shall be smooth, continuous, uniform in thickness, and free from pinholes, cracks, bubbles, and other film imperfections.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the product shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.6. Purchaser reserves the right to sample and to perform such confirmatory testing as he deems necessary to ensure that the product conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to the following requirements are classified as acceptance tests and shall be performed on each lot:

Requirement	Paragraph Reference
Accelerated Storage Stability	3.2.2
Nonvolatile Content	3.3.1.1
Weight per Unit Volume	3.3.1.2
Viscosity	3.3.1.3
Odor	3.3.1.4
Pot Life	3.3.1.5
Peel Strength	3.3.3.1
Surface Resistivity, Topcoated systems only	Detail specification

4.2.2 Preproduction Tests: Tests to determine conformance to all technical requirements of this specification are classified as preproduction tests and shall be performed on the initial shipment of a product to a purchaser, when a change in material or processing requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing to be required.

4.2.2.1 For direct U.S. Military procurement, substantiating test data and, when requested, preproduction test material shall be submitted to the cognizant agency as directed by the procuring activity, the contracting officer, or the request for procurement.

4.3 Sampling: Shall be as follows:

4.3.1 For Acceptance Tests: A sufficient quantity of each coating material component shall be selected at random from each lot to perform all required tests. The number of samples or specimens for each test shall be as specified in the applicable test procedure or, if not specified therein, not less than three.

4.3.1.1 A lot shall be all coating material produced in a single production run from the same batches of raw materials under the same fixed conditions, or all material subjected to the same unit chemical and physical process intended to make the final product homogeneous, and submitted for vendor's inspection at one time. A lot shall not exceed 500 gal (1900 L) and may be packaged in small containers as noted in 5.1 under the basic lot approval as long as the lot identification is maintained.

4.3.1.2 When a statistical sampling plan and acceptance quality level (AQL) have been agreed upon by purchaser and vendor, sampling shall be in accordance with such plan in lieu of sampling as in 4.3.1 and the report of 4.6.1 shall state that such plan was used.

4.3.2 For Preproduction Tests: As agreed upon by purchaser and vendor.

4.4 Approval:

4.4.1 Sample coating material shall be approved by purchaser before coating material for production use is supplied, unless such approval be waived. Results of tests on production coating material shall be essentially equivalent to those on the approved sample.

4.4.2 Vendor shall use ingredients, manufacturing procedures, processes, and methods of inspection on production coating material which are essentially the same as those used on the approved sample coating material. If any change is necessary in ingredients, in type of equipment for processing, or in manufacturing procedures, vendor shall submit for reapproval a statement of the proposed changes in material and processing and, when requested, sample coating material. Production coating material made by the revised procedures shall not be shipped prior to receipt of reapproval.

4.5 Test Methods:

4.5.1 Coating Material Preparation: Each container of coating material components to be used for tests of the uncured coating material or for preparation of coated specimens for testing of the cured coating shall be conditioned for not less than 24 hr at 75°F ± 5 (24°C ± 2). Components of product supplied in kit form shall be mixed in the proportions recommended by the manufacturer, and the components well mixed before sampling.

4.5.2 Specimen Preparation:

4.5.2.1 Specimen Material: Shall, unless otherwise specified, be laminates of epoxy-resin-impregnated glass cloth, any fabric type, conforming to any high-quality laminate material specification, such as AMS 3821, AMS 3822, or MIL-P-25421, except that specimens for heat resistance (4.5.9) and thermal flash resistance (4.5.10) shall be laminates of AMS 3844 polyimide-resin-impregnated glass cloth or AMS 3849 polyimide-resin-impregnated quartz cloth of the size specified in the applicable test procedure. Specimens shall be of low void content and representative of high quality laminates. Specimens, except those for peel strength, shall be sanded with 180 grit (80 µm) abrasive paper to remove the gloss from the surfaces to be coated, detergent washed, and dried before being coated; specimens for peel strength tests shall be sanded on only one half of the surface to be coated. When use of a primer is recommended by the coating material manufacturer, specimens shall be primed after washing and drying; peel strength specimens shall be primed on the sanded half.

4.5.2.2 Coating of Specimens: Specimens shall be coated with rain-erosion-resistant base compound to a cured film thickness of 12 - 14 mils (0.30 - 0.36 mm) or, when top coating with anti-static compound is specified, to a base compound thickness of not less than 10 mils (0.25 mm) and topcoated to a total cured film thickness of 12 - 14 mils (0.30 - 0.36 mm). Coatings shall be cured for not less than 10 days at 75°F ± 5 (24°C ± 2).

4.5.3 Tack-Free Time: Shall be determined on flat panels 1/8 x 3 x 8 in. (3 x 75 x 200 mm) prepared as in 4.5.2. A strip of polyethylene film 0.004 in. ± 0.002 (0.10 mm ± 0.05) thick by 1 x 6 in. (25 x 150 mm) shall be pressed on the surface of the coating with a 1-oz (28-g) weight (approximately 2 sq in. (13 cm^2)) in area. The film shall be withdrawn at right angles to the surface of the coating. Tack-free time may be determined on the panels on which peel strength is to be determined, the film being applied to the sanded, or sanded and primed, end of the panel.

4.5.4 Peel Strength: Shall be determined on flat panels 1/8 x 3 x 8 in. (3 x 75 x 200 mm) prepared as in 4.5.2. Two parallel cuts, 1 in. (25 mm) apart, shall be made through the coating to the substrate the full length of the panel. The 1-in. (25-mm) wide coating strip shall be peeled from the unsanded, or unprimed, end, dusted on both faces with talc, and heated in a circulating-air oven for not less than 3 hr. at 300°F ± 5 (150°C ± 2). After cooling to room temperature, the specimens shall be clamped in a tensile testing machine arranged to provide a 180 deg pull at a jaw separation rate of 2 in. (50 mm) per minute. Peel strength shall be reported as the average of the peak loads for all specimens. If the coating fails cohesively and does not separate from the panel surface, peel strength shall be reported as greater than the observed peak load.

4.5.5 Fluid Resistance: Shall be determined on flat panels 1/8 x 3 x 8 in. (3 x 75 x 200 mm) prepared as in 4.5.2, three panels being immersed in each test fluid. After exposure, the panels shall be removed from the test fluid, wiped clean with lint-free paper towels or lint-free cloth, examinated visually for deterioration of the coating, and the peel strength determined as in 4.5.4.

4.5.6 Rain-Erosion Resistance: Shall be determined as in 4.5.6.4 on airfoil-shaped specimens conforming to Fig. 1 prepared as in 4.5.2; six specimens shall be tested after exposure under each of the following conditions:

4.5.6.1 As cured.

4.5.6.2 Aged in a circulating-air oven for 24 hr ± 0.25 at 400°F ± 5 (205°C ± 2).

4.5.6.3 After weathering as in 4.5.11.

4.5.6.4 Procedure: One specimen shall be mounted near the tip of each 0 deg pitch blade of a suitable diameter 2-blade propeller, driven horizontally by a variable speed motor designed to permit testing the specimens at a speed of 500 mph ± 5 (805 km/h ± 8) at the test area of each panel. A suitable water ring, mounted above the rotating blade, shall be used to simulate a natural rainfall of 1.00 in. ± 0.01 (25.0 mm ± 0.2) per hr and an approximately 2-mm droplet size impinging on the center section of the panel. The propeller shall be rotated and the time for each specimen to be eroded through the coating shall be recorded. Report the average of the six erode-through times for each test condition.

4.5.7 Electrical Transmission: Shall be determined on flat panels 0.050 - 0.055 in. (1.27 - 1.40 mm) thick by 24 in. (610 mm) square, prepared as in 4.5.2, on equipment meeting the transmission efficiency test of MIL-R-7705, and in accordance with MIL-R-7705 and as follows; uncoated panels shall be used as controls:

4.5.7.1 Panels shall be subjected to one-way microwave power measurements at incidence angles of -30 to +30 deg, using parallel and perpendicular polarization of the incident energy, at a frequency of 9.375 Gigahertz, after exposure to each of the following conditions:

4.5.7.1.1 One panel as cured and one uncoated panel.

4.5.7.1.2 The panels of 4.5.7.1.1 after exposure for 7 days at 100°F ± 5 (38°C ± 2) and relative humidity of 95% ± 5.

4.5.7.1.3 One panel as cured and one control panel after weathering as in 4.5.11.

4.5.7.1.4 One panel after heating for 24 hr ± 0.5 at 400°F ± 5 (205°C ± 2).

4.5.7.2 The specimen shall be clamped perpendicular to, and at the approximate midpoint between, the horns with the center of the specimen coincident with the centerline of the horns. The clamp shall be of wood, shall extend the full length of the bottom edge of the specimen, and shall cover not more than 1 in. (25 mm) of the edge. If the clamp causes interference, it shall be covered with absorbing material.

4.5.7.3 The specimen, in the clamp, shall be mounted on a turntable with provisions for moving the panel through 0 deg to 70 deg and for lateral movement of not less than 1 in. (25 mm). Readings shall be taken in maximum increments of 10 deg and each 0.1-in. (2.5-mm) setting for angles up to 30 degrees. Test data shall be converted to, and reported as, percent transmission by the equation:

$$\% \text{ Transmission} = \frac{T_s}{T_b} \times 100$$

where,

T_s = Power transmission of coated panel at 20 deg parallel polarization

T_b = Power transmission of uncoated panel at 20 deg parallel polarization.

4.5.8 Surface Resistivity: Shall be determined on the applicable coated panels of 4.5.7 after each conditioning of 4.5.7.1, as follows:

4.5.8.1 Equipment shall be a 500-VDC megohmmeter having a range of 1 - 1000 MΩ, suitable brass or steel wool faced, spring loaded electrodes, and an AMS 3609 acrylic plastic sheet 1/4 x 24 x 24 in. (6.5 x 610 x 610 mm) as shown in Fig. 2.

4.5.8.2 Procedure: The template shall be placed over the panel to be tested. The two electrodes, with their leads connected to the megohmmeter, shall be placed to coincide, in turn, with each pair of holes in the template. A total of 17 readings, taken with uniform pressure of 3 - 5 lb (14 - 22 N) on the electrodes, shall be taken on each panel and the average of the readings reported.

4.5.9 Heat Resistance: Shall be determined on flat panels 1/8 x 3 x 8 in. (3 x 75 x 200 mm) prepared as in 4.5.2. Panels shall be heated in a circulating-air oven for 24 hr ± 0.25 at 500°F ± 10 (260°C ± 5), cooled to room temperature, and examined.

4.5.10 Thermal Flash Resistance: Shall be determined on flat panels 1/8 x 4 x 4-1/2 in. (3 x 100 x 115 mm) prepared as in 4.5.2. The coating shall be exposed to a quartz lamp radiation source with spectral quality representative of 2200°K (3500°F) black body radiation with one thermal flash pulse of 80 fluence at 55 cal/cm^2. sec, and with multiple thermal flash pulses (not less than 3) of 120 fluence at 32 cal/cm^2. second. Operational characteristics of the apparatus shall include a pre-set irradiance level and precise regulation of overheating and of contamination by pyrolysis gases.

4.5.11 Weather Resistance: Shall be determined on the airfoil-shaped specimens of 4.5.6 and on flat panels as in 4.5.7. The specimens shall be exposed for six months in southern Florida with the specimens mounted facing due south at an angle of 45 deg and so positioned as to provide unobstructed exposure to sunlight throughout the day. Airfoil-shaped specimens shall have the leading edge of the specimens positioned as specified herein.

4.6 Reports:

4.6.1 The vendor of the product shall furnish with each shipment three copies of a report showing the results of tests to determine conformance to the acceptance test requirements and stating that the product conforms to the other technical requirements of this specification and the applicable detail specification. This report shall include the purchase order number, AMS 3138 and its applicable detail specification number, vendor's product designation, lot number, and quantity of base compound and component materials.

4.6.1.1 A material safety data sheet conforming to AMS 2825 shall be supplied to each purchaser prior to, or concurrent with, the report of preproduction test results or, if preproduction testing be waived by purchaser, concurrent with the first shipment of coating material for production use. Each request for modification of formulation shall be accompanied by a revised data sheet for the proposed formulation.

4.6.2 The vendor of finished or semi-finished coated parts shall furnish with each shipment three copies of a report showing the purchase order number, AMS 3138 and its applicable detail specification number, contractor or other direct supplier of coating material, supplier's material designation, part number, and quantity. When coating material for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of coating material to determine conformance to the requirements of this specification and the applicable detail specification, and shall include in the report a statement that the coating material conforms, or shall include copies of laboratory reports showing the results of tests to determine conformance.

4.7 Resampling and Retesting: If any sample or specimen used in the above tests fails to meet the specified requirements, disposition of the product may be based on the results of testing three additional samples or specimens from the same lot for each original nonconforming sample or specimen. Failure of any retest sample or specimen to meet the specified requirements shall be cause for rejection of the product represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Packaging and Identification:

5.1.1 The base coating material and the anti-static coating material shall be packaged in suitable airtight 1 gal (4 L) or 5 gal (20 L) containers, as ordered. Unless otherwise specified, each container of base coating material and each container of anti-static coating material shall be packaged as a kit with the appropriate amount of catalyst for each container of coating material packaged in a suitable container and attached to the coating container. When the manufacturer requires a primer to be applied prior to coating application, a suitable quantity of primer and primer catalyst shall be furnished with each container of base coating material to prime coat an area equivalent to the area coverage of the base coating material.

5.1.2 Containers of base coating material, of primer when required, and of anti-static coating material shall be packaged in individual kit-type containers with the respective required catalyst. When specified, if thinner is required to prepare the coating materials for spraying, sufficient thinner shall be included in a suitable container with each kit-type package. Mixing and application instructions shall be included in each package along with appropriate warnings, precautionary notices, and antidote or emergency medical procedures. See 4.6.1.1 also.

5.1.3 Identification: Each container shall be identified with not less than the following information applied to durable labels, using characters of such size as to be clearly legible and which will not be obliterated by normal handling:

* COATING, FLUOROCARBON ELASTOMERIC
AMS 3138/ **
MANUFACTURER'S PRODUCT DESIGNATION _____
DATE OF MANUFACTURE _____
LOT NUMBER _____
QUANTITY _____
PERISHABLE - STORE BELOW 38°C (100°F)
APPROPRIATE WARNINGS OR PRECAUTIONARY NOTICES

* Add appropriate word(s) or code from applicable detail specification, such as BASE, BASE CATALYST, ANTI-STATIC, ANTI-STATIC CATALYST, PRIMER, or PRIMER CATALYST.
** Add applicable detail specification number.

5.1.4 The individual kit-type containers shall be packed in an exterior shipping container to protect the product during shipment and storage.

5.1.5 Each exterior shipping container shall be legibly marked with not less than the information specified in 5.1.3 and, in addition, the purchase order number, in such a manner that the markings will not smear or be obliterated during normal handling or use.

5.1.6 Containers 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 product to ensure carrier acceptance and safe delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

5.1.7 For direct U.S. Military procurement, packaging shall be in accordance with PPP-P-1892, Level A or Level C, as specified in the request for procurement. Commercial packaging as in 5.1.1, 5.1.2, 5.1.4, and 5.1.6 will be acceptable if it meets the requirements of Level C.

6. ACKNOWLEDGMENT: A vendor shall mention this specification number and the applicable detail specification number in all quotations and when acknowledging purchase orders.

7. REJECTIONS: Coating material not conforming to this specification and the applicable detail specification or to modifications authorized by purchaser will be subject to rejection.

8. NOTES:

8.1 For direct U.S. Military procurement, purchase documents should specify not less than the following:

Title, number, and date of the applicable detail specification
Coating system components desired (See 3.1)
Size of coating material containers desired
Quantity of coating material desired
Applicable level of packaging (See 5.1.7)

8.2 Products meeting the requirements of this specification have been classified under Federal Stock Class FSCN 8030.