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400 Commonwealth Dr., Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 2521B

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Superseding AMS 2521A

REFLECTION-REDUCING COATINGS For Instrument Glasses

1. SCOPE:

1.1 Form: This specification covers optical-qualtiy coatings applied to instrument glasses.

1.2 Application: Primarily to reduce the intensity of reflection from the surfaces of instrument glasses and to increase light transmission through the glasses.

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

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods

2.1.2 Aerospace Recommended Practices:

ARP924 - Specification and Inspection of Glass for Integrally Lighted Aerospace Instruments

2.2 ASTM Publications: Available from ASTM, 1916 Race Street, Philadelphia, PA 19103.

ASTM B117 - Salt Spray (Fog) Testing
ASTM D1003 - Haze and Luminous Transmittance of Transparent Plastics
ASTM E11 - Wire-Cloth Sieves for Testing Purposes
ASTM G21 - Determining Resistance of Synthetic Polymeric Materials to Fungi

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120, except as specified in 2.3.3.

2.3.1 Military Specifications:

MIL-E-12397 - Eraser, Rubber-Pumice (for Testing Coated Optical Elements)

2.3.2 Military Standards:

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes
MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of
MIL-STD-1241 - Optical Terms and Definitions

2.3.3 U.S. Army Drawings: Available from Quality Assurance Directorate, DRDAR-TST-S, U.S. Army Armament Research and Development Command, Dover, NJ 07801.

D7680606 - Coating, Eraser Abrasion Tester

3. TECHNICAL REQUIREMENTS:

3.1 Material: The composition of the coating material shall be optional with the coating vendor.

3.2 Properties of the Applied Coating: The coating, applied to substrate materials having indicies of refraction within the range 1.47 - 1.55, shall conform to the following requirements. Tests shall be performed on the coated parts or on coated glass witness specimens of the same index of refraction and surface finish as the substrate for the coated parts, coated in the same evaporation run as the parts, and positioned in the chamber so as to represent the optical and durability characteristics of the parts.

3.2.1 Spectral Properties:

3.2.1.1 Specular Reflectance: The specular reflectance from each coated surface, measured with a calibrated spectrophotometer as defined in ASTM D1003, shall not exceed the following limits for energy incident on the surface at the angles specified below:

Wavelength Range Millimicrons (nm)	Reflectance, %, maximum For Angle of Incidence Shown	
	0 to 15 degrees, incl	30 degrees ± 0.5
450 to 675, incl	0.6 absolute	---
450 to 650, incl	---	1.0 absolute
500 to 620, incl	0.35 average	0.50 average
425 to 700, incl	0.35 average	0.50 average

3.2.1.2 Light Absorption: Within the wavelength range 425 – 700 millimicrons (nm), light loss shall not exceed the following limits per surface, determined with a calibrated spectrophotometer as defined in ASTM D1003:

Maximum average absorption	0.5%
Maximum absolute absorption	2.0%

3.2.2 Durability: The coating, subjected to the adhesion test of 4.5.1 followed by the abrasion resistance test of 4.5.2, shall show no evidence of peeling, flaking, cracking, crazing, or delamination and shall have no change in spectral characteristics resulting in nonconformance to the requirements of 3.2.1.

3.2.3 Environmental Resistance: The coating shall show no change in spectral characteristics resulting in nonconformance to the requirements of 3.2.1 after exposure to any of the following:

3.2.3.1 Elevated temperature in accordance with 4.5.3.

3.2.3.2 Sand and dust in accordance with 4.5.4.

3.2.3.3 Fungus in accordance with 4.5.5.

3.2.3.4 Thermal shock in accordance with 4.5.6.

3.2.3.5 Continuous exposure to salt spray in accordance with ASTM B117 for not less than 50 hours.

3.2.3.6 Humidity in accordance with 4.5.7. After exposure, the coating, lighted and inspected in accordance with ARP924, shall show no evidence of a cloudy or hazy appearance.

3.3 Quality: The coating, as received by purchaser, shall be uniform in quality and condition, smooth, and free from foreign materials and from physical and optical imperfections detrimental to performance of parts, determined in accordance with ARP924.

3.3.1 Surface Imperfections: Imperfections in the clear aperture area of the coating, as defined in MIL-STD-1241, shall not exceed the following limits, evaluated in accordance with ARP924:

Article	Scratch	Spatter	Pinhole, Void, or Lint
Window	#80	#50	#50
Cover glass or cover wedge	#60	#20	#40
Lighting wedge	#40	#20	#40

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the coating 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 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: Tests to determine conformance to requirements for specular reflectance (3.2.1.1), light absorption (3.2.1.2), durability (3.2.2), salt spray resistance (3.2.3.5), humidity resistance (3.2.3.6), and quality (3.3) are classified as acceptance tests and shall be performed on each lot.

4.2.2 Preproduction Tests: Tests to determine conformance to all technical Ø 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 material and/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, contracting officer, or request for procurement.

4.3 Sampling: Shall be not less than the following; a lot shall be all parts Ø made of the basis material, coated in the same equipment in a single pump-down cycle, and presented for vendor's inspection at one time.

4.3.1 For Acceptance Tests: One part or one witness specimen for each requirement except as specified in 4.3.1.1.

4.3.1.1 Sampling for inspection to quality requirements shall be in accordance with MIL-STD-105, Normal Inspection Level II, with an acceptance quality level (AQL) of 2.5. Samples shall be coated parts.

4.3.2 For Preproduction Tests: Thirty parts or witness specimens, five for each requirement except that the durability and humidity resistance tests shall be performed on the same five specimens and all 30 specimens shall be inspected for conformance to quality requirements.

4.4 Approval:

4.4.1 Sample coated parts shall be approved by purchaser before coated parts for production use are supplied, unless such approval be waived by purchaser. Results of tests on production coated parts shall be essentially equivalent to those on the approved samples.

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

4.5 Test Methods:

4.5.1 Adhesion: Test specimens shall be clean and free from contaminants, Ø including finger prints, that would affect the adhesion of the testing tape. A strip of pressure-sensitive tape, 1 inch (25 mm) in nominal width or approximately 2/3 of the least dimension of the test specimen if less than 1 inch (25 mm), shall be pressed firmly in contact across the entire coated surface. After 30 - 60 seconds the tape shall be removed quickly with a snap action which exerts the greatest possible stripping effect on the surface.

4.5.2 Abrasion Resistance:

4.5.2.1 Test Procedure: The coating shall be tested by holding a standard Ø abrasion testing device in the hand and rubbing the coated surface with a standard eraser conforming to MIL-E-12397 mounted in the holding device. A pressure of approximately 2.0 - 2.5 pounds force (8.9 - 11.1 N) shall be applied. Strokes of approximately 1 inch (25 mm) shall be made if the size of the element or specimen will permit it; smaller strokes for smaller specimens. All strokes shall be made on one path for 20 complete strokes.

4.5.2.2 Test Equipment: Assembly details of the Abrasion Tester may be obtained on written request from U.S. Army Armament Research and Development Command as indicated in 2.3.4. The only rubber eraser plug which is acceptable for this test is also available from the same source. All requests should make reference to Drawing D7680606.

4.5.3 Elevated Temperature: Specimens shall be heated to 315°C ± 8 (599°F ± 14), held at temperature for not less than 15 minutes, and cooled to room temperature. Heating and cooling rates shall be not greater than 8 C (14 F) degrees per minute.

4.5.4 Sand and Dust Resistance:

4.5.4.1 Test Chamber: The chamber shall consist of a dust-tight cabinet with the floor designed to permit the dust to fall into hoppers for recirculation. The facility shall be time-cycle-controlled to accomplish the exposure and shutdown required. A blower and duster shall be provided to circulate the dust throughout the test chamber with the velocity and concentration outlined.

4.5.4.2 Test Procedure: The test samples shall be placed in the test chamber and the sand and dust density raised to, and maintained at, 0.1 - 0.5 gram/cubic foot (3.5 - 17.7 g/m^3) and velocity between 100 and 500 feet/minute (508 and 2540 mm/s) within the test space. The internal temperature of the test chamber shall be maintained at 25°C ± 5 (77°F ± 9) for not less than 6 hours then raised to and maintained at 70°C ± 3 (158°F ± 5) for not less than 6 hours additional. The relative humidity shall not exceed 30% at any time during the test. At the end of the exposure period, the sample shall be removed from the test chamber and allowed to cool to room temperature. Accumulated dust shall be removed by brushing, wiping, shaking, or blowing with clean, dry air.

4.5.4.3 Sand and Dust: Sand and dust used in the test shall be of angular structure and shall have characteristics as follows:

4.5.4.3.1 Particle Size: Shall be as follows, determined using U.S. Standard Sieve Series or equivalent as defined in ASTM E11:

100% shall pass through a 100 mesh (150-µm) sieve.
98% ± 2 shall pass through a 140 mesh (106-µm) sieve.
98% ± 2 shall pass through a 200 mesh (75-µm) sieve.
75% ± 2 shall pass through a 325 mesh (44-µm) sieve.

4.5.4.3.2 Chemical Composition: Shall be as follows, determined by wet chemical methods or as agreed upon by purchaser and vendor:

Substance	% by Weight minimum	maximum
SiO_2	97	99
Fe_2O_3	--	2
Al_2O_3	--	1
TiO_2	--	2
MgO	--	1
Ignition	--	2