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400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 3829A

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Superseding AMS 3829

CLOTH, TYPE "E"-GLASS, STYLE 7781 FABRIC
Solution-Addition-Type PMR-15 Polyimide Resin Impregnated

THIS REVISION CONTAINS ONLY EDITORIAL CHANGES.

1. SCOPE:

1.1 Form: This specification covers one type of glass cloth impregnated with a heat-reactive, thermosetting, solution-addition-type PMR-15 polyimide resin system, supplied in the form of continuous rolls of full width cloth or slit tape.

1.2 Applications: Primarily for structural laminates requiring high strength and heat resistance for long-term service up to 290°C (550°F) and short-time service up to 315°C (600°F).

1.3 Safety - Hazardous Materials: While the materials, methods, applications and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards which may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications 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
AMS 2825 - Material Safety Data Sheets
AMS 3824 - Cloth, Type "E" Glass, Finished for Resin Laminates

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

ASTM D638 - Tensile Properties of Plastics
ASTM D790 - Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
ASTM D792 - Specific Gravity and Density of Plastics by Displacement
ASTM D2344 - Apparent Interlaminar Shear Strength of Parallel Fiber Composites by Short Beam Method
ASTM D2584 - Ignition Loss of Cured Reinforced Resins
ASTM D2734 - Void Content of Reinforced Plastics

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

2.3.1 Military Standards:

MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of

3. TECHNICAL REQUIREMENTS:

3.1 Material: Shall be the reinforcement specified in 3.1.1, impregnated with the resin system specified in 3.1.2, supplied as rolls of full width impregnated cloth or as slit tape, as ordered, and in a condition suitable for in situ polymerization by vacuum/autoclave processing at 290°C (550°F) under 100 psi (790 kPa) pressure.

3.1.1 Reinforcement: Shall be AMS 3824 Type "E" Glass cloth, Style 7781, treated with a suitable finish to produce the required performance characteristics with the resin system specified in 3.1.2.

3.1.2 Resin: Shall be a heat-reactive, thermosetting monomeric reactants solution-addition-type PMR-15 polyimide resin system resulting in a pre-polymer polyimide resin system with a 1500 formula molecular weight.

3.2 Storage Life: Cloth shall have a storage life of not less than three months from the date of impregnation when stored or shipped in a barrier container and maintained at not warmer than 7°C (45°F).

3.3 Working Life: Cloth shall meet the requirements of 3.4 and 3.5 when tested, after warming to room temperature, at any time up to five days after removal from storage at not warmer than 7°C (45°F).

3.4 Properties: Cloth shall conform to the following requirements:

3.4.1 Uncured Impregnated Cloth: Shall have the following properties, determined on the product supplied, sampled in accordance with 4.3.1 after warming to above the dew point, and tested in accordance with 4.5.2:

3.4.1.1 Volatile Content 9% ± 2

3.4.1.2 Resin Content by weight 38% ± 3

3.4.2 Cured Laminates: Shall have the following properties, determined on specimens cut from a test laminate prepared as in 4.5.1. Specimens for elevated temperature tests shall be tested after exposure for 30 min. ± 1 at the test temperature. Property values specified in 3.4.2.1 through 3.4.2.4 are the minimum averages for five determinations for each test; no individual value shall be less than 90% of the minimum average value specified.

3.4.2.1 Tensile Strength, min avg		ASTM D638, Type I Specimen
At 25°C ± 5 (77°F ± 10)	55,000 psi (380 MPa)	
At 288°C ± 5 (550°F ± 10)	50,000 psi (345 MPa)	
3.4.2.2 Flexural Strength, min avg		ASTM D790
At 25°C ± 5 (77°F ± 10)	65,000 psi (450 MPa)	
At 288°C ± 5 (550°F ± 10)	50,000 psi (345 MPa)	
3.4.2.3 Flexural Modulus, min avg		ASTM D790
At 25°C ± 5 (77°F ± 10)	3,300,000 psi (22.8 GPa)	
At 288°C ± 5 (550°F ± 10)	3,000,000 psi (20.7 GPa)	
3.4.2.4 Short-Beam Shear Strength, min avg		ASTM D2344
At 25°C ± 5 (77°F ± 10)	6,000 psi (41.5 MPa)	
At 288°C ± 5 (550°F ± 10)	3,300 psi (23.0 MPa)	
3.4.2.5 Specific Gravity		ASTM D792
At 23°/23°C (73°/73°F)	Preproduction Value ±0.10	
3.4.2.6 Void Content, Max	3.0%	ASTM D2734, Method A

3.5 Quality: Cloth, as received by purchaser, shall be uniform in quality and condition, clean, and free from foreign materials and from imperfections detrimental to usage of the cloth.

3.6 Tolerances: Width shall not vary more than +1/2 in. (+13 mm), -0 from the width ordered.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the impregnated cloth 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 cloth 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 to represent each lot:

Requirement	Paragraph Reference
Volatile Content, uncured	3.4.1.1
Resin Content, uncured	3.4.1.2
Flexural Strength	3.4.2.2
Flexural Modulus	3.4.2.3
Short-Beam Shear Strength	3.4.2.4
Specific Gravity, cured	3.4.2.5
Void Content, cured	3.4.2.6

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 prior to or on the initial shipment of impregnated cloth to a purchaser, when a change in material, processing, or both 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 as follows:

4.3.1 For Acceptance Tests: Each lot of impregnated cloth shall be sampled at random on the following sampling basis, using the number of specimens specified therein for each requirement. Samples for the panels required for testing the cured product shall be taken in approximately equal amounts from three locations in the lot, selected randomly. There shall be not more than 500 yd (450 m) of cloth, full width, represented in any one test panel; lots of greater quantity shall require one panel for each 500 yd (450 m) or portion thereof.

Requirement	Sampling	Minimum Number of Specimens
Volatile Content, uncured	Every Roll	2
Resin Content, uncured	Lot Basis	2
Flexural Strength	Lot Basis	5
Flexural Modulus	Lot Basis	5
Short-Beam Shear Strength	Lot Basis	5
Specific Gravity, cured	Lot Basis	2 from each test laminate
Void Content, cured	Lot Basis	2 from each test laminate

4.3.1.1 A lot shall be all cloth treated at one time without significant changes in treater setting using a single batch of resin and reinforcement and presented for vendor's inspection at one time. An inspection lot shall not exceed 2000 yd (1825 m) of full width product.

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. A lot may be packaged in smaller quantities and delivered under the basic lot approval provided lot identification is maintained.

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

4.4 Approval:

4.4.1 Sample cloth shall be approved by purchaser before cloth for production use is supplied, unless such approval be waived by purchaser. Results of tests on production cloth 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 cloth which are essentially the same as those used on the approved sample cloth. 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 material, processing, or both and, when requested, sample cloth. Production cloth made by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 Test Methods:

4.5.1 Specimen Preparation: Each roll to be sampled shall be allowed to warm above the dew point before opening the sealed package for sampling. Immediately after sampling, the roll shall be resealed and returned to storage at not higher than 7°C (45°F).

4.5.1.1 Tests of Uncured Product: Specimens shall be cut from test cloth and tested immediately as specified in the applicable test procedure.

4.5.1.2 Preparation of Test Laminate Panels:

4.5.1.2.1 Laminate panels from which all specimens are cut shall be composed of 14 plies, all face up, in makeup with ply orientation at 0 - 90 degrees. Laminate panel dimensions shall be sufficient to yield all specimens required for tests.

4.5.1.2.2 All test laminate panels shall be fabricated by vacuum bag/autoclave method under process parameters of 100 psi and 288°C (790 kPa and 550°F). Each test laminate shall be subjected to a postcure of 12 hr ± 0.25 at 315°C ± 3 (600°F ± 5) in an air environment prior to any specimen preparation or test.

4.5.2 Volatile and Uncured Resin Contents: Shall be determined as follows:

4.5.2.1 Cut a single-ply specimen of impregnated cloth nominally 4 in. (100 mm) square and weigh. Record weight as W_1. Place the specimen in an oven preset to, and maintained at, 165°C (325°F) and heat at 165°C ± 3 (325°F ± 5) for 5 - 7 minutes. Remove specimen from oven, cool, and reweigh. Record weight as W_2.

4.5.2.2 Place the specimen on which volatile content was determined in a muffle furnace preset to, and maintained at, 565°C (1050°F) and heat at 565°C ± 5 (1050°F ± 10) for not less than 30 minutes. Remove specimen from furnace, cool, and reweigh. Record weight as W_3.

4.5.2.3 Calculate volatile content and resin content from the following equations:

$$\text{Volatile Content, \%} = \frac{W_1 - W_2}{W_1} \times 100$$

$$\text{Resin Solids Content, \%} = \frac{W_2 - W_3}{W_2} \times 100$$

4.6 Reports:

4.6.1 The vendor of impregnated cloth shall furnish with each shipment a report showing the results of tests to determine conformance to the acceptance test requirements and stating that the cloth conforms to the other technical requirements of this specification. This report shall include the purchase order number, AMS 3829A, vendor's material designation, cure cycle for each test panel and panel parameters, lot number, roll numbers, and quantity.

4.6.1.1 The vendor of impregnated cloth product shall furnish with each lot a statement that the product provided is "E" glass cloth impregnated with the PMR-15 resin binder system.

4.6.1.2 The vendor of impregnated cloth shall furnish with each lot a statement that purity of monomers and solvent used conformed to the following requirements:

4,4' - Methylenedianiline (MDA) - % MDA - 95% min
Melting Point - 90°C (190°F) min
Aniline Impurity - 0.1% max

Dimethyl Ester of 3,3' - Benzophenonetetracarboxylic Acid (BTDE) - % Dimethyl ester of BTDE as measured

Monomethyl Ester of 5 - Norbornene - 2,3 - Dicarboxylic Acid (N,E)
Melting Point - 100°C (212°F) min

Anhydrous Methyl Alcohol - % Methyl Alcohol - 99.8% min
Acidity (Acetic Acid) - 0.003 % by weight, max

Alkalinity (Ammonium Hydroxide) - 0.0003 % by weight, max

Acetone - 0.003 % by weight, max

4.6.1.3 A material safety data sheet conforming to AMS 2825, or equivalent, 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 cloth 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 parts shall furnish with each shipment a report showing the purchase order number, AMS 3829A, contractor or other direct supplier of impregnated cloth, part number, and quantity. When impregnated cloth for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of cloth to determine conformance to the requirements of this specification and shall include in the report either a statement that the cloth conforms or copies of laboratory reports showing the results of tests to determine conformance.

4.7 Resampling and Retesting: If any specimen used in the above tests fails to meet the specified requirements, disposition of the cloth may be based on the results of testing three additional specimens for each original nonconforming specimen. These specimens shall be cut from additional or newly-prepared panels using the same procedures and curing cycles as used on the original panels. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the cloth represented and no additional testing shall be permitted. Results of all tests shall be reported.