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400 Commonwealth Dr., Warrendale, PA 15096

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

SAE AMS 3906A

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AEROSPACE MATERIAL SPECIFICATION
GLASS TAPE AND FLAT SHEET, NON-WOVEN CLOTH
Epoxy Resin Impregnated, For Hand and Machine Layup

1. SCOPE:

1.1 Form: This specification and its supplementary detail specifications cover various types of non-woven glass cloth in the form of tape and flat sheet impregnated with epoxy resin, the resin to be supplied in a "B" staged condition.

1.2 Application: Primarily for fabricating high strength composite parts, using autoclave, press, vacuum bag, or filament winding techniques for fabrication.

1.3 Classification: The tapes and flat sheets shall be as specified in the applicable detail specification wherein each product is defined by basic fiber, property characteristics, and maximum continuous service temperature. An example is shown in 8.2. The product covered by each detail specification appears in the title.

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 3898 - Interleaf Carrier Material, Composite Tape

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

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 D2734 - Void Content of Reinforced Plastics
ASTM D3039 - Tensile Properties of Fiber-Resin Composites
ASTM D3529 - Resin Solids Content of Carbon Fiber-Epoxy Prepreg
ASTM D3530 - Volatiles Content of Carbon Fiber-Epoxy Prepreg
ASTM D3531 - Resin Flow of Carbon Fiber-Epoxy Prepreg
ASTM D3532 - Gel Time of Carbon Fiber-Epoxy Prepreg

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 Specifications:

MIL-R-60346 - Roving, Glass, Fibrous

2.3.2 Military Standards:

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

2.4 AIA Publications: Available from National Standards Association, Inc., 1321 Fourteenth Street, N. W., Washington, DC 20005.

NAS 992 - Reel Composite Filament Tape - Automated Machine Lay-up

3. TECHNICAL REQUIREMENTS:

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

3.2 Material:

3.2.1 Construction: The product shall consist of parallel, non-woven, unidirectional glass fibers meeting the requirements of MIL-R-60346, impregnated with an epoxy resin meeting the requirements of the applicable detail specification, and arranged in a single in-plane layer.

3.2.2 Storage Life: The product, when packaged in waterproof, heat-sealed bags, shall meet the requirements of the applicable detail specification after storage as specified therein.

3.2.3 Working Life: The product shall meet the requirements of the applicable detail specification after exposure for a continuous period at the relative humidity and temperature specified therein.

3.3 Properties:

3.3.1 Uncured Impregnated Material: The product as received shall conform to the requirements of this specification and the applicable detail specification. Tests shall be performed on the product supplied and in accordance with applicable test procedures specified in 4.5.

3.3.2 Cured Laminate: Test laminates shall conform to the requirements of this specification and the applicable detail specification. Tests shall be performed in accordance with applicable test procedures specified in 4.5 on specimens cut from laminates produced as in 4.5.1.

3.4 Quality: The product, 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 product.

3.5 Sizes and Tolerances. Tape and sheet shall be supplied to the dimensions specified in the purchase order. The width shall not vary more than +0.04 in. (+1.0 mm) for each 3 in. (75 mm) of width specified, and the length shall be not less than the net length ordered.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of the product shall supply all Ø 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 product conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to requirements for Ø construction (3.2.1); properties of uncured impregnated material (3.3.1); longitudinal flexural strength, modulus of elasticity in flexure, short beam shear strength at room temperature, density, void content, and fiber volume of cured laminate (3.3.2),; and sizes and tolerances (3.5) 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 and the applicable detail specification are classified as preproduction tests and shall be performed prior to or on the initial shipment of the product 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 Ø 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: Sufficient product shall be taken at random from Ø each lot and each inspection unit to perform all required tests. The number of determinations for each requirement shall be as stated in 4.5, or if not specified therein, not less than three.

4.3.1.1 A lot shall be all product produced at one time without significant Ø changes in treater settings using a single batch of resin and reinforcement and presented for vendor's inspection at one time. An inspection unit shall not exceed 1000 sq yd (835 m^2). A lot may be packaged and delivered in smaller quantities under the basic lot approval provided lot identification number 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 material shall be approved by purchaser before material for production use is supplied, unless such approval be waived by purchaser. Results of tests on production 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 material which are essentially the same as those used on the approved sample material. 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 material. Production material made by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 Test Methods: Shall be as follows, properties of cured product shall be Ø determined on test laminates prepared as in 4.5.1:

Property	Minimum Number of Specimens per Test	Test Procedure	Test Frequency
Volatile Content	3	ASTM D3530	Lot Basis
Total Non-fiber Content	3	ASTM D3529	Lot Basis
Resin Flow	3	ASTM D3531	Lot Basis
Gel Time	3	ASTM D3532	Lot Basis
Tack	1	4.5.2	Lot Basis
Total Weight per Unit Area	3	4.5.3	Lot Basis
Uncured Ply Thickness	1	4.5.4	Lot Basis
Tensile Strength and Modulus of Elasticity	4	ASTM D3039	Preproduction
Compressive Strength and Modulus of Elasticity	4	4.5.5	Preproduction
Flexural Strength and Modulus of Elasticity	4	ASTM D790, Span/Thickness Ratio 24:1	Unit Basis
Interlaminar Shear Strength	4	ASTM D2344	Unit Basis
Density	3	ASTM D792	Unit Basis
Void Content	3	ASTM D2734	Unit Basis
Fiber Volume	3	4.5.6	Unit Basis
Cured Thickness per Ply	1	4.5.7	Unit Basis

4.5.1 Preparation of Test Laminates: Test laminates of suitable area shall be prepared from sufficient plies of impregnated cloth oriented unidirectionally to produce cured thicknesses as close as possible to 0.030 in. (0.75 mm) for tensile strength and modulus of elasticity and as close as possible to 0.125 in. (3.00 mm) for all other tests of cured product. Laminates shall be cured at a temperature and pressure which will provide optimum properties; the temperature and pressure used shall be noted in the report. The resulting laminates shall each be uniform in thickness within 0.003 in. (0.08 mm).

4.5.2 Tack:

4.5.2.1 Cut two pieces of impregnated glass cloth approximately 1 x 3 in. (25 x 75 mm), retaining the protective film until immediately before using the specimens. Fiber direction shall be parallel to the 1-in. (25-mm) dimension. For cloth less than 3 in. (75 mm) wide, butt sufficient pieces on the panel to produce a 3-in. (75-mm) wide specimen.

4.5.2.2 Remove the protective film from one side of one specimen and apply the cloth to the center of a clean piece of austenitic corrosion resistant steel sheet with a commercial 2D finish, any thickness by approximately 4 x 8 in. (100 x 200 mm). Apply light pressure with a squeegee or roller over the backing film. Remove the backing film and apply the second specimen to the first, in exactly the same manner, making sure

4.5.2.2 (Cont'd.)

the opposing faces of the cloth are not covered with protective backing film. The second layer of narrow cloth shall be so positioned that the butt joints do not coincide with those of the first layer. Remove the protective film from the exposed surface of the cloth and maintain the test plate and the long dimension of the test specimen in a vertical position for not less than 30 min. at 20° - 30°C (68° - 86°F) and 50 - 70% relative humidity.

4.5.2.3 Report results as pass or fail. If a specimen fails to adhere for the test period, record the elapsed time at failure.

4.5.3 Total Weight Per Unit Area:

4.5.3.1 Cut sufficient cloth for each of three specimens 24 sq in. (155 cm^2) in area and weigh to the nearest mg (W_9).

4.5.3.2 Remove the interleaf carrier from the specimen and weigh to the nearest mg (W_{10}).

4.5.3.3 Calculate total weight per unit area as follows:

$$\text{Total Weight per sq yd} = 54(W_9 - W_{10})$$

$$\text{Total weight per } m^2 = 45.1(W_9 - W_{10})$$

where, W_9 = Weight of specimen and interleaf carrier, g/24 sq in. (g/155 cm^2)

W_{10} = Weight of interleaf carrier, g/24 sq in. (g/155 cm^2)

4.5.3.4 Calculate the arithmetic mean of the three determinations of total weight per area of the sample. Report both the individual results and the arithmetic mean.

4.5.4 Ply Thickness:

4.5.4.1 Cut a piece of impregnated glass cloth approximately 3 in. (75 mm) square.

4.5.4.2 Measure the thickness in five locations to the nearest 0.001 in. (.02 mm).

4.5.4.3 Calculate the arithmetic mean of the five determinations of ply thickness. Report the individual results and the arithmetic mean.

4.5.5 Compressive Strength and Modulus of Elasticity: Shall be determined in accordance with the method identified as the "Celanese Compression Test".

4.5.6 Laminate Fiber Volume:

4.5.6.1 Preparation of Specimens: Three pieces, each not less than 1 in. (25 mm) square, shall be cut from the laminate prepared as in 4.5.1, and weighed in separate cleaned and tared (W_{11}) constant-weight crucibles to the nearest mg (W_{12}).

4.5.6.2 Ignition: The specimens shall be placed in a furnace at not higher than 345°C (650°F). The temperature of the furnace shall be raised to 565°C ± 30 (1050°F ± 50) at a rate that will not cause blowing or loss of inorganic material. The specimen and crucible shall be ignited at this maximum temperature to constant weight and allowed to cool in a desiccator. The weight of the remaining material shall be determined to the nearest mg (W_{13}).

4.5.6.3 Calculation: The laminate fiber volume shall be calculated as follows:

$$\text{Fiber Volume, \%} = \frac{(W_{13} - W_{11})\, D_2 \times 100}{(W_{12} - W_{11})\, D_1}$$

where, W_{11} = Weight of crucible, mg

W_{12} = Weight of crucible plus specimen, mg

W_{13} = Weight of crucible plus specimen after ignition, mg

D_1 = Density of glass fiber as specified in applicable detail specification

D_2 = Density of laminate determined in accordance with ASTM D792

4.5.6.4 Calculate the arithmetic mean of three determinations as the fiber volume of the test laminate. Report the individual test results and the arithmetic mean.

4.5.7 Cured Thickness Per Ply: Shall be determined on each laminate prepared as in 4.5.1.

4.5.7.1 Measure the thickness in five locations to the nearest 0.001 in. (0.02 mm).

4.5.7.2 Divide the thickness values by the number of plies in the laminate.

4.5.7.3 Calculate the arithmetic mean of the five thicknesses-per-ply determinations. Report the individual results and the arithmetic mean.

4.6 Reports:

4.6.1 The vendor of the product shall furnish with each shipment a report showing the results of tests to determine comformance to the acceptance tests requirements of this specification and the applicable detail specification, including identification of the resin system used and the cure cycle and fiber volume of the test laminate, and stating that the product conforms to the other technical requirements. This report shall include the purchase order number, AMS 3906A and its applicable detail specification number and revision letter, if any, vendor's material designation, lot number, spool or sheet numbers, date of manufacture, quantity (width and length), and location of test samples within the lot and roll.

4.6.1.1 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 resin 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 3906A and its applicable detail specification number and its revision letter, if any, contractor or other direct supplier of cloth, vendor's material designation, part number, and quantity. When 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 the applicable detail 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 prepared from the original panel or a newly prepared panel, for each original nonconforming specimen. 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.

5. PREPARATION FOR DELIVERY:

5.1 Packaging and Identification:

5.1.1 Tape: Shall be wound on spools. For hand layup material, the spools shall be not less than 3 in. (75 mm) in diameter. For machine laying, the spools shall conform to NAS 992. The tape shall be interleaved with a nonadherent carrier conforming to AMS 3898 and its applicable detail specification. Winding shall be uniform and shall provide for proper unreeling. Tape ends shall be secured.