

# AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard



AMS 3906B

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Superseding AMS 3906A

## 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 specification 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:

These products have been used typically for fabricating high strength composite parts, using autoclave, press, vacuum bag, or filament winding techniques for fabrication, but usage is not limited to such applications.

#### 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.

#### 1.4 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.

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## 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 publications shall be the issue in effect on the date of the purchase order.

### 2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2825 Material Safety Data Sheets  
AMS 3898 Interleaf Carrier Material, Composite Tape

### 2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 695 Compressive Properties of Rigid Plastics  
ASTM D 695M Compressive Properties of Rigid Plastics (Metric)  
ASTM D 790 Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials  
ASTM D 790M Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials (Metric)  
ASTM D 792 Specific Gravity (Relative Density) and Density of Plastics by Displacement  
ASTM D 2344 Apparent Interlaminar Shear Strength of Parallel Fiber Composites by Short Beam Method  
ASTM D 2734 Void Content of Reinforced Plastics  
ASTM D 3039 Tensile Properties of Fiber-Resin Composites  
ASTM D 3529 Resin Solids Content of Carbon Fiber-Epoxy Prepreg  
ASTM D 3530 Volatiles Content of Carbon Fiber-Epoxy Prepreg  
ASTM D 3531 Resin Flow of Carbon Fiber-Epoxy Prepreg  
ASTM D 3532 Gel Time of Carbon Fiber-Epoxy Prepreg

### 2.3 U.S. Government Publications:

Available from DODSSP, Subscription Services Desk, Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094.

MIL-R-60346 Roving, Glass, Fibrous  
MIL-STD-2073-1 DOD Materiel, Procedures for Development and Application of Packaging Requirements

## 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 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 shall meet the requirements of the applicable detail specification when tested at any time up to 12 months from date of receipt of the product by purchaser provided the product has been stored in the original waterproof, heat-sealed container at a temperature not higher than 4 °C (39 °F).

3.2.3 Working Life: The product shall meet the requirements of the applicable detail specification when tested after continuous exposure to a relative humidity not higher than 70% and a temperature not higher than 27 °C (81 °F) for not less than three months.

### 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 and in the detail specifications.

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 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, 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 vary not more than  $\pm 0.04$  inch ( $\pm 1.0$  mm) for each 3 inches (76 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 samples for vendor's tests and shall be responsible for performing all required tests. 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 for 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 acceptance tests and shall be performed on each lot.

4.2.2 Preproduction Tests: Tests for all technical requirements of this specification and the applicable detail specification are preproduction tests and shall be performed prior to or on the initial shipment of the product to a purchaser, when a change in ingredients 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 and Testing:

Shall be as follows:

4.3.1 For Acceptance Tests: Sufficient product shall be taken at random from each lot and each inspection unit to perform all required tests. The number of determinations for each requirement shall be as stated in 4.3.3, or if not specified herein, not less than three.

4.3.1.1 A lot shall be all product produced at one time without significant change 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 square yards (836 m<sup>2</sup>).

4.3.1.2 When a statistical sampling plan has 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 shall state that such plan was used.

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

4.3.3 The minimum number of specimens per test requirement and test frequency are shown in Table 1.

TABLE 1 - Minimum Number of Specimens and Test Frequency

Requirement	Number of Specimens per Requirement, minimum	Test Frequency
Volatile Content	3	Each lot
Total Non-Fiber Content	3	Each lot
Resin Flow	3	Each lot
Gel Time	3	Each lot
Tack	1	Each lot
Total Weight per Unit Area	3	Each lot
Uncured Ply Thickness	1	
Tensile Strength and Modulus of Elasticity	4	Preproduction
Compression Strength and Modulus of Elasticity	4	Preproduction
Flexural Strength and Modulus of Elasticity	4	Each Inspection Unit
Interlaminar Shear Strength	4	Each Inspection Unit
Density	3	Each Inspection Unit
Void Content	3	Each Inspection Unit
Fiber Volume	3	Each Inspection Unit

4.4 Approval:

4.4.1 Sample product shall be approved by purchaser before product for production use is supplied, unless such approval be waived by purchaser. Results of tests on production product 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 product which are essentially the same as those used on the approved sample product. 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 product. Production product 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 determined on test laminates prepared as in 4.5.1:

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 inch (0.76 mm) for tensile strength and modulus of elasticity and as close as possible to 0.125 inch (3.18 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 inch (0.08 mm).

#### 4.5.2 Tack:

4.5.2.1 Cut two pieces of impregnated glass cloth approximately 1 x 3 inches (25 x 76 mm), retaining the protective film until immediately before using the specimens. Fiber direction shall be parallel to the 1-inch (25-mm) dimension. For cloth under 3 inches (76 mm) wide, butt sufficient pieces on the panel to produce a 3-inch (76-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 inches (102 x 203 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 certain that 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 minutes at 20 to 30 °C (68 to 86 °F) and 50 to 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 square inches (155 cm<sup>2</sup>) in area and weigh to the nearest mg ( $W_9$ ).

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

4.5.3.3 Calculate total weight per unit area as shown in Equation 1 and Equation 2.

$$\text{Total Weight per square yard} = 54(W_9 - W_{10}) \quad (\text{Eq.1})$$

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

where,  $W_9$  = Weight of specimen and interleaf carrier, grams/24 square inches (g/155 cm<sup>2</sup>)  
 $W_{10}$  = Weight of interleaf carrier, grams/24 square inches (g/155 cm<sup>2</sup>)

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 inches (76 mm) square.

4.5.4.2 Measure the thickness in five locations to the nearest 0.001 inch (0.025 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 Laminate Fiber Volume:

4.5.5.1 Preparation of Specimens: Three pieces, each not less than 1 inch (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 ( $W_{12}$ ).

4.5.5.2 Ignition: The specimens shall be placed in a furnace at a temperature not higher than 345 °C (653 °F). The temperature of the furnace shall be raised to 565 °C ± 30 (1049 °F ± 54) 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 ( $W_{13}$ ).

4.5.5.3 Calculation: The laminate fiber volume shall be calculated as shown in Equation 3.

$$\text{Fiber Volume, \%} = \frac{(W_{13} - W_{11}) D_2 \times 100}{(W_{12} - W_{11}) D_1} \quad (\text{Eq.3})$$

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 D 792

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

- 4.5.6 Cured Thickness Per Ply: Shall be determined on each laminate prepared as in 4.5.1.
- 4.5.6.1 Measure the thickness in five locations to the nearest 0.001 inch (0.025 mm).
- 4.5.6.2 Divide the thickness values by the number of plies in the laminate.
- 4.5.6.3 Calculate the arithmetic mean of the five thickness-per-ply determinations. Report the individual results and the arithmetic mean.

#### 4.6 Reports:

The vendor of product shall furnish with each shipment a report showing the results of tests to determine conformance to the acceptance test requirements, including identification of 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, lot number, AMS 3906B and its applicable detail specification number and revision letter, if any, vendor's material designation, values to be reported, spool or sheet numbers, date of manufacture, quantity (width and length), and location of test samples within the lot and roll.

- 4.6.1 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.

#### 4.7 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. Results of all tests shall be reported.

### 5. PREPARATION FOR DELIVERY:

#### 5.1 Packaging and Identification:

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

- 5.1.1 Tape: Shall be wound on spools. For hand layup, the spools shall be not less than 3 inches (76 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.