



AEROSPACE MATERIAL SPECIFICATION

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

AMS 3903

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Revised

CLOTH, ORGANIC FIBER, HIGH MODULUS Epoxy Resin Impregnated

1. SCOPE:

- 1.1 Form: This specification and its supplementary detail specifications cover organic fibers in the form of cloth impregnated with epoxy resin, the resin to be supplied in a "B" stage condition.
- 1.2 Application: Primarily for fabricating high-strength, high-modulus composite parts.
- 1.3 Classification: The preimpregnated cloth shall be as specified in the applicable detail specifications, wherein each material is defined by fabric characteristic and continuous service temperature. An example is shown in 8.1. The material covered by each detail specification appears as part of 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 (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, Pennsylvania 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods
AMS 3902 - Cloth, Organic Fiber, High Modulus, for Structural Composites

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

ASTM D638 - Tensile Properties of Plastics
ASTM D695 - Compressive Properties of Rigid Plastics
ASTM D790 - Flexural Properties of Plastics
ASTM D792 - Specific Gravity and Density of Plastics by Displacement
ASTM D1505 - Density of Plastics by the Density-Gradient Technique
ASTM D2344 - Apparent Horizontal Shear Strength of Reinforced Plastics by Short Beam Method
ASTM D2734 - Void Content of Reinforced Plastics
ASTM D3171 - Fiber Content of Reinforced Resin Composites

- 2.3 Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, Pennsylvania 19120.

2.3.1 Federal Standards:

FED-STD-406 - Plastics, Methods of Testing

2.3.2 Military Standards:

MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes

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3. TECHNICAL REQUIREMENTS:

- 3.1 Detail Specifications: The requirements for a specific 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:
- 3.2.1 Construction: The product shall consist of woven cloth meeting the requirements of AMS 3902, impregnated with an epoxy resin meeting the requirements of the applicable detail specification.
- 3.2.2 Ends: The product shall contain no unspliced yarn or tow ends, unless otherwise specified.
- 3.3 Properties of Uncured Impregnated Material: The product, as-received, shall conform to the requirements of 3.3.1 and those of the applicable detail specification. Tests shall be performed on the product supplied and in accordance with test procedures specified herein.
- 3.3.1 Bending: The product shall withstand, without visible damage, when examined under 10X magnification, bending through an angle of 180 deg (3.14 rad) around a 1.0 in. (25 mm) diameter with the fabric warp direction parallel to the axis of the bend.
- 3.4 Properties of Cured Laminate: Test laminates shall conform to the requirements of this specification and the applicable detail specification. Tests shall be performed on specimens cut from laminates produced as in 4.5.1 and tested in accordance with the test procedures specified herein.
- 3.5 Quality: The product shall be uniform in quality and condition and free from foreign materials and from internal and external imperfections detrimental to fabrication, appearance, or performance of parts.
- 3.6 Sizes and Tolerances: Preimpregnated cloth shall be supplied to the dimensions specified in the purchase order. The width shall not vary more than ± 0.50 in. (12.7 mm) and the length shall be not less than the net length specified on the purchase order.

4. QUALITY ASSURANCE PROVISIONS:

- 4.1 Responsibility for Inspection: The vendor of the product shall supply all samples 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 perform such confirmatory testing as he deems necessary to assure 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 construction (3.2.1) and bending (3.3.1); longitudinal flexural strength, flexural modulus and short beam shear strength of cured laminate at room temperature (3.4); and tolerance (3.6) requirements are classified as acceptance or routine control tests.
- 4.2.2 Qualification Tests: Tests to determine conformance to all technical requirements of this specification and the applicable detail specification are classified as qualification or periodic control tests and may be the basis for approval of the product (See 4.4.1).

4.3 Sampling:

4.3.1 Sampling Schedule: Shall be in accordance with Single Sampling for Normal Inspection, General Inspection Level II, with an Acceptable Quality Level (AQL) of 1.5 specified in MIL-STD-105 as shown in Table I. Test specimens shall be taken from randomly chosen inspection units in the lot.

TABLE I

SAMPLING SCHEDULE

Number of Inspection Units in the Lot	Number of Inspection Units from Which Samples are to be Taken	Number of Nonconforming Specimens to	
		Accept	Reject
1 - 90	8 (See 4.3.1.1)	0	1
91 - 280	32	1	2
281 - 500	50	2	3

4.3.1.1 If number of inspection units to be sampled equals or exceeds lot size, inspect each unit.

4.3.2 Lot: A lot shall be all product produced in a single production run from the same batch of raw materials under the same fixed conditions and submitted for vendor's inspection at one time.

4.3.3 Inspection Unit: Unless otherwise specified, an inspection unit is defined as each 100 yd (91.4 m) of impregnated product or fraction thereof.

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. 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 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 revised material. No production material made by the revised procedure shall be shipped prior to receipt of reapproval.

4.5 Test Methods: Shall be as follows; tension, compression, flexural, and shear test specimens shall be oriented so that the direction of stress is parallel to the warp direction of the impregnated fabric.

Volatile Content	4.5.2
Total Nonfiber Content	4.5.3
Resin Flow	4.5.4
Gel Time	4.5.5
Tack	4.5.6
Tensile Strength and Modulus of Elasticity	4.5.7
Compressive Strength and Modulus of Elasticity	4.5.8
Flexural Strength and Modulus of Elasticity	ASTM D790
Short Beam Shear Strength	ASTM D2344
Density	4.5.9
Fiber Volume	ASTM D3171
Void Content	ASTM D2734

4.5.1 Preparation of Test Laminates: All test laminates shall be layed up with the warp parallel and unnested so that the satin shafts of the warp always face the top of the layup and shall be molded under appropriate pressure and cured in accordance with the resin manufacturer's recommendation. Laminates from which tensile test specimens are cut shall be not less than 14 in. (357 mm) in the warp direction. Laminates from which test specimens for all other tests are cut shall be not less than 12 in. (305 mm) square.

4.5.2 Volatile Content:

- 4.5.2.1 Cut sufficient material to obtain a specimen weighing approximately 1 g and weigh to the nearest mg (W_1).
- 4.5.2.2 Suspend the specimen on a removable tray (areas of the tray in contact with the specimen shall be covered with a suitable parting agent film) in a circulating-air oven preheated to the temperature and for the time specified in the applicable detail specification for the resin being tested.
- 4.5.2.3 Remove specimen from the tray and place in a desiccator.
- 4.5.2.4 Cool specimen to room temperature but for not less than 30 min. in the desiccator and weigh to the nearest mg (W_2).
- 4.5.2.5 Calculate volatile content as follows:

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

where, W_1 = Original weight of specimen

W_2 = Final weight of specimen

4.5.3 Total Nonfiber Content:

- 4.5.3.1 Cut sufficient material to obtain two specimens, each weighing approximately 1 g, and weigh to the nearest mg (W_3).
- 4.5.3.2 Place the specimens in separate containers and extract the resin with a suitable boiling solvent for not less than 2 minutes. Time starts when the solvent starts to boil. The solvent used shall be selected on the basis of being able to completely dissolve the resin under the conditions of this test. Decant the solvent. Repeat the extraction for 3 complete cycles. Report the solvent and temperature used.
- 4.5.3.3 Dry the specimens by placing them in a circulating-air oven maintained at $325^\circ\text{F} \pm 10$ ($162.8^\circ\text{C} \pm 5.6$) for not less than 1 hr or until weight is constant. Remove and place in desiccator.
- 4.5.3.4 After 10 min., remove specimens from desiccator and weigh to the nearest mg (W_4).
- 4.5.3.5 Calculate nonfiber content in percent by weight as follows:

$$\text{Total Nonfiber Content, \% by Weight} = \frac{W_3 - W_4}{W_3} \times 100$$

where, W_3 = Original weight of specimen

W_4 = Final weight of specimen

- 4.5.3.6 Calculate the arithmetic mean of the two determinations as total nonfiber content of the sample. Report both the individual results and the arithmetic mean.

4.5.4 Resin Flow:

- 4.5.4.1 Cut two pieces of the product, each piece approximately 4 in. or 100 mm square and weigh to the nearest mg (W_5). Cut four pieces of a suitable release bleeder cloth and two pieces of porous polytetrafluoroethylene/glass cloth, each piece approximately 6 in. or 150 mm square.
- 4.5.4.2 Layup a flow specimen assembly of two layers of bleeder cloth, one layer of polytetrafluoroethylene/glass cloth, the two pieces of the product, crossplied at approximately 90 deg (1.57 rad) centered in the middle, one layer of polytetrafluoroethylene/glass cloth, and two layers of bleeder cloth. Weigh the assembly to the nearest mg (W_6). Product less than 2 in. or 50 mm in width shall be cut and positioned to form an approximately 2 in. or 50 mm square.
- 4.5.4.3 Place the flow specimen assembly in a heated platen press between nonporous polytetrafluoroethylene sheets and cover with a heat resistant elastomeric sheet approximately 0.06 in. or 1.5 mm thick. Heat the assembly at a temperature and pressure recommended by the resin manufacturer for 15 min. ± 0.25 , cool to room temperature, and weigh to the nearest mg (W_7).
- 4.5.4.4 Remove the cured product from the bleeder cloth and porous polytetrafluoroethylene layers and trim the specimen free from resin flash, taking care not to remove any organic fibers. Weigh the cured product to the nearest mg (W_8).

- 4.5.4.5 Calculate the volatile free resin flow as follows:

$$\text{Resin Flow, \% by Weight} = \frac{W_5 - (W_6 - W_7) - W_8}{W_5 - (W_6 - W_7)} \times 100$$

where, W_5 = Original weight of organic material

W_6 = Original weight of specimen assembly

W_7 = Weight of specimen assembly after press heating

W_8 = Weight of organic material after trimming

- 4.5.4.6 Report the test results and the temperature and pressure used in press heating of the specimen assembly.

4.5.5 Gel Time:

- 4.5.5.1 Cut a piece of the product approximately 0.25 in. or 6.5 mm square.
- 4.5.5.2 Preheat a hot plate to the same temperature used for resin flow $\pm 2^\circ\text{F}$ ($\pm 1.1^\circ\text{C}$).
- 4.5.5.3 Place a micro cover glass on the hot plate, allowing 20 sec for it to reach temperature equilibrium. Position the specimen at the center of the micro cover glass and simultaneously commence timing. Within 5 sec, place a second micro cover glass over the specimen. After the resin softens and during the first 30 sec, probe the top micro cover glass and isolate a drop of resin. Observe the fluidity and color of the isolated resin drop periodically (continuously as the end point approaches). The lateral (spreading) movement of the resin upon probing will decrease or regress and the color shade will change as the gel point approaches. Stop the timer at the first indication of resin immobility and record the lapsed time to the nearest second.

4.5.6 Tack:

- 4.5.6.1 Cut two pieces of product approximately 1 x 3 in. or 25 x 75 mm. Fabric warp direction shall be parallel to the 1 in. or 25 mm dimension. For material less than 3 in. or 75 mm wide, butt sufficient pieces on the panel to produce a 3-in. or 75-mm wide specimen.
- 4.5.6.2 Apply one specimen 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. or 100 x 200 millimetres. 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 the mating faces of the material are not covered with backing film. The second layer of narrow material shall be so positioned that the butt joints do not coincide with those of the first layer. Maintain the test plate and the long dimension of the test specimen in a vertical position for not less than 30 min. at 70° - 80° F (21.1° - 26.7° C) and 50 - 70% relative humidity.
- 4.5.6.3 Report results as pass or fail. If a specimen fails to adhere for the test period, record the elapsed time at failure.
- 4.5.7 Tensile Strength and Modulus of Elasticity: Shall be determined in accordance with ASTM D638, except that the specimen in Fig. 1 shall be used, at the test temperature specified in the applicable detail specification.
- 4.5.8 Compressive Strength and Modulus of Elasticity: Shall be determined in accordance with ASTM D695 or the method identified as the "Celanese Compression Test" using a sample thickness of 0.160 in. or 4 mm without tabs. The method of test used shall be reported.
- 4.5.9 Density: Shall be determined in accordance with ASTM D792, ASTM D1505, or FED-STD-406, Method 5011 or 5012. The method of test used shall be reported.

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 made on the product to determine conformance to the acceptance test requirements of this specification and the applicable detail specification, including the identification of the resin system used and the cure cycle and fiber volume of the test laminate, and a statement that the product conforms to the other technical requirements. This report shall include the purchase order number, material specification number including the applicable detail specification number, 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.
- 4.6.2 The vendor of finished or semi-finished parts shall furnish with each shipment three copies of a report showing the purchase order number, material specification number including the applicable detail specification number, contractor or other direct supplier of material, supplier's material designation, part number, and quantity. When material for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of 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 material conforms, or shall include 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 product may be based on the results of testing three additional specimens for each original nonconforming specimen, cut from the same panel or a newly prepared panel. Failure of any retest 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 product shall be wound on spools not less than 3 in. or 75 mm in hub diameter and interleaved with nonadherent film. Winding shall be uniform and shall provide for proper unreeling. Fabric ends shall be secured.

5.1.2 Each roll of impregnated cloth shall be identified by attached removable tags using characters of such size as to be clearly legible and which will not be obliterated by normal handling. Each tag shall show the following information:

ORGANIC FIBER CLOTH (FABRIC), EPOXY RESIN IMPREGNATED
 AMS 3903/* _____
 MANUFACTURER'S MATERIAL DESIGNATION _____
 PURCHASE ORDER NUMBER _____
 DATE OF MANUFACTURE _____
 LOT AND ROLL NUMBERS _____
 QUANTITY _____

* Enter applicable detail specification number

5.1.3 Each roll of product shall be sealed in a bag of suitable nonadherent material to prevent penetration of moisture or loss of impregnating resin solvent.

5.1.4 The protected product shall be packed in an exterior shipping container identified with a package number and capable of protecting the product adequately during shipment and storage below the temperature specified in the applicable detail specification.

5.1.5 Each exterior shipping container shall be legibly marked with the following information in such a manner that the markings shall not smear or be obliterated during normal handling or use.

ORGANIC FIBER CLOTH (FABRIC), EPOXY RESIN IMPREGNATED
 AMS 3903/* _____
 PURCHASE ORDER NUMBER _____
 MANUFACTURER'S MATERIAL DESIGNATION _____
 LOT AND PACKAGE NUMBERS _____
 QUANTITY _____
 PERISHABLE - STORE BELOW _____ (See applicable detail specification)

* Enter applicable detail specification number.

5.1.6 Containers shall be prepared for shipment in accordance with commercial practice to assure carrier acceptance and safe transportation to the point of delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

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

7. REJECTIONS: Material not conforming to this specification or to authorized modifications will be subject to rejection.

8. NOTES: