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400 Commonwealth Dr., Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard

AMS 3832B

Issued 11-1-70
Revised 10-1-89

Superseding AMS 3832A

ROVING, TYPE "S" GLASS
Epoxy Resin Impregnated

1. SCOPE:

1.1 Form: This specification covers continuous, multiple-strand, roving of Type "S" glass impregnated with a heat-curable epoxy resin matrix and processed to a "B" stage condition.

1.2 Application: Primarily for filament winding of rocket motor cases, pressure vessels, aircraft, and related structures.

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 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

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

ASTM D2290 - Apparent Tensile Strength of Ring or Tubular Plastics and Reinforced Plastics by Split Disk Method
ASTM D2291 - Fabrication of Ring Test Specimens for Glass-Resin Composites
ASTM D2343 - Tensile Properties of Glass Fiber Strands, Yarns, and Rovings Used in Reinforced Plastics
ASTM D2344 - Apparent Interlaminar Shear Strength of Parallel Fiber Composites by Short Beam Method
ASTM D2410 - Finish Content of Woven Glass Fabric, Cleaned and After-Finished with Chrome Complexes, for Plastic Laminates

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:

3.1.1 Roving: Shall be "20 End" Type "S" Glass, treated immediately after forming with a suitable high-strength finish.

3.1.2 Splices: No splices or knots shall be introduced during the resin impregnation process.

3.1.3 Resin: Shall be a low-pressure, epoxy laminating resin modified as necessary to meet the requirements of 3.2.

3.1.4 Shelf Life: The impregnated roving shall have a shelf life of not less than three months from date of impregnation when packaged in vapor-proof, heat-sealed bags and stored at not higher than -18°C (0°F).

3.1.5 Cure: Product shall become fully processed by filament winding under 12 - 15 pounds force (53.4 - 66.7N) tension and curing, using temperature ranges and times recommended by the manufacturer; however, curing time, exclusive of the post cure, shall not exceed five hours.

3.2 Properties: The product shall conform to the following requirements; tests shall be performed on the product supplied and in accordance with specified test methods, insofar as practicable:

3.2.1 As Received (Uncured):

3.2.1.1	Resin Solids (Volatile Free)	17 - 23% by weight	4.5.1
3.2.1.2	Volatiles, maximum	3% by weight	4.5.1
3.2.1.3	Gel Time	1 - 4 minutes	4.5.2
3.2.1.4	Resin Flow	8 - 17% by weight	4.5.3
3.2.1.5	Filament Diameter	0.00035 - 0.00040 inch (8.9 - 10.2 µm)	-
3.2.1.6	Weight	0.560 - 0.640 gram per yard (0.61 - 0.70 g/m)	-
3.2.1.7	Tensile Strength, minimum	525,000 psi (3620 MPa)	ASTM D2343

3.2.2 As Cured: Specimens fabricated in accordance with ASTM D2291 from the "B" stage impregnated roving and cured as in 3.1.5 shall have the following properties, determined at 23°C ± 1 (73° ± 2).

3.2.2.1	Tensile Strength, minimum (Determined on specimens conforming to ASTM D2343)	380,000 psi (2620 MPa)	ASTM D2290
3.2.2.2	Horizontal Shear Strength, minimum (Determined on specimens conforming to ASTM D2291, Type C)	8,000 psi (55.2 MPa)	ASTM D2344

3.3 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.

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. 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 the following requirements are classified as acceptance tests and shall be performed on each lot:

Requirement	Paragraph
Resin Solids	3.2.1.1
Resin Flow	3.2.1.4
Tensile Strength, as cured	3.2.2.1

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 the product 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 Ø 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: Sufficient product shall be taken at random from each lot to perform all required tests. Except as specified in 4.3.2, the number of determinations for each requirement shall be as specified in the applicable test procedure or, if not specified therein, not less than three. A lot shall be all product from the same batches of roving and resin produced in one continuous run and presented for vendor's inspection at one time.

4.3.1 A batch of resin shall be that quantity of resin formulated and mixed at the same time.

4.3.2 When a statistical sampling plan and acceptance quality level (AQL) for the product has been agreed upon by purchaser and vendor, sampling shall be in accordance with such plan in lieu of sampling as in 4.3 and the report of 4.6.1 shall state that such plan was used.

4.4 Approval:

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

4.5 Test Methods:

4.5.1 Volatile and Resin Content:

4.5.1.1 Specimen Preparation: Cut three specimens, each 72 inches ± 0.1 (1829 mm ± 3) long. Fold each specimen three times to a length of approximately 9 inches (229 mm) and tie loosely into an overhand bow knot.

4.5.1.2 Volatile Content: Weigh each specimen to the nearest 0.001 gram (W_1). Hang pieces separately on a rack and place in a circulating-air oven at 135°C ± 3°C (275°F ± 5) for 15 minutes ± 1, cool to room temperature in a desiccator, and reweigh each specimen (W_2). Calculate volatiles as follows:

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

where, W_1 = original weight

W_2 = final weight

4.5.1.3 Resin Content: Place the volatile-free specimens of 4.5.1.2 in porcelain crucibles brought to constant weight by heating at 845°C ± 25 (1553°F ± 45) for not less than 3 hours. Burn out the resin by heating the specimens at 565°C ± 25 (1049°F ± 45) for 3 hours ± 0.25 in a muffle furnace. Cool in a desiccator and reweigh (W_3). Calculate resin solids as follows:

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

where, W_2 = weight of sample after removing volatiles

W_3 = final weight of the ash

Report the average of the three specimens.

4.5.2 Gel Time: Precondition a suitable melting point apparatus to 165°C ± 1 (329°F ± 2). Place a microscope slide on the heated block, allowing 20 - 30 seconds for it to reach temperature equilibrium. Cut a piece of roving 1/4 inch ± 1/16 (6.4 mm ± 1.6) long. Place a sample on the heated microscope slide and commence timing. Within 5 seconds, place a second microscope slide over the sample. As the resin softens and during the first 30 seconds, isolate a drop of resin by gently pressing on the upper slide. Observe lateral movement of the resin drop while periodically pressing on the upper slide. As the resin thickens, the lateral movement will be retarded. A sharp color change and the formation of small droplets when the cover slide is pressed indicate the gel point. Stop the timer and record the elapsed time as gel time. Report the average of three results.

4.5.3 Resin Flow: Cut six lengths of roving, each 3 inches ± 0.010 (76 mm ± 0.25) long. Weigh each specimen, consisting of two 3 inch (76 mm) lengths to the nearest 0.001 gram (W_1). With the lengths spaced 1/2 inch (12.7 mm) apart, sandwich the specimens between four layers (two on each side of the specimen) of glass cloth conforming to ASTM D2410, type 181 - 150 or type 181 - 75G. Preheat a hot plate and a 1500-g metal weight to 150°C ± 5 (302°F ± 9). Place the sandwiched material on the hot plate, cover with the metal weight, and maintain at temperature for 2 minutes ± 0.2 using a surface thermocouple to ensure maintenance of the required temperature. While still hot, remove the specimens from the sandwich, remove any excess resin, and cool in desiccator to room temperature. Reweigh each specimen to the nearest 0.001 gram (W_1). Calculate resin flow as follows:

$$\text{Resin Flow, wt\%} = \frac{W_1 - W_2}{W_1} \times 100$$

where, W_1 = weight of specimen before heating

W_2 = weight of specimen after removal of excess resin

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 conformance to the acceptance test requirements and stating that the product conforms to the other technical requirements of this specification. This report shall include the purchase order number, AMS 3832B, lot number, vendor's material designation, form and size or part number, and quantity.

4.6.2 The vendor of finished or semi-finished parts shall furnish with each shipment a report showing the purchase order number, AMS 3832B, contractor or other direct supplier of roving, supplier's material designation, part number, and quantity. When roving for making parts is produced or purchased by the parts vendor, that vendor shall inspect each lot of roving to determine conformance to the requirements of this specification and shall include in the report either a statement that the roving conforms or copies of laboratory reports showing the results of tests to determine conformance.