



AEROSPACE MATERIAL SPECIFICATION

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

AMS 3832A

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GLASS ROVING, TYPE "S" GLASS Epoxy Resin Impregnated

1. SCOPE:

- 1.1 Form: This specification covers continuous, multiple-strand, glass 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.

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, PA 15096.

2.1.1 Aerospace Material Specifications:

AMS 2350 - Standards and Test Methods

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

ASTM D2290 - Apparent Tensile Strength of Ring or Tubular Plastics by Split Disk Method

ASTM D2291 - Fabrication of Ring Test Specimens for Reinforced Plastics

ASTM D2343 - Tensile Properties of Glass Fiber Strands, Yarns, and Roving Used in Reinforced Plastics

ASTM D2344 - Apparent Horizontal Shear Strength of Reinforced Plastics by Short Beam Method

ASTM D2410 - Woven Glass Fabric, Cleaned and After-Finished with Chrome Complexes, for Plastic Laminates

- 2.3 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 vaporproof, 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 lb (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 wt	4.5.1
3.2.1.2	Volatile, max	3% by wt	4.5.1
3.2.1.3	Gel Time	1 - 4 min.	4.5.2
3.2.1.4	Resin Flow	8 - 17% by wt	4.5.3
Ø 3.2.1.5	Filament Diameter	0.00035 - 0.00040 in. (8.9 - 10.2 µm)	-
Ø 3.2.1.6	Weight	0.560 - 0.640 gr per yd (0.619 - 0.700 g/m)	-
Ø 3.2.1.7	Tensile Strength, min	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	<u>Tensile Strength, min</u> (Determined on specimens conforming to ASTM D2343)	380,000 psi (2620 MPa)	ASTM D2290
3.2.2.2	<u>Horizontal Shear Strength, min</u> (Determined on specimens conforming to ASTM D2291, Type C)	8,000 (55.5 MPa)	ASTM D2344

3.3 Quality: The product shall be uniform in quality and condition and free from foreign materials and from imperfections detrimental to fabrication, appearance, or performance of parts.

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 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
(Cured) Tensile Strength	3.2.2.1

- 4.2.2 Qualification Tests: Tests to determine conformance to all technical requirements of this specification are classified as qualification tests and shall be performed on the initial shipment of the product to a purchaser, when a change in material or processing requires reapproval, or when purchaser deems confirmatory testing is required.

- 4.2.2.1 For direct U.S. Military procurement, substantiating test data and, when requested, qualification test material shall be submitted to the cognizant qualification agency as directed by the procuring activity, the contracting officer, or the request for procurement.

- 4.3 Sampling: Sufficient product shall be taken at random from each lot to perform all required tests. Except as noted in 4.3.2, the number of specimens to be tested 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 or lots of roving and resin produced in one continuous run and submitted 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 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 material. Production material made by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 Test Method:

4.5.1 Volatile and Resin Content:

- 4.5.1.1 Specimen Preparation: Cut three specimens, each 72 in. ± 0.1 (1830 mm ± 3) long. Fold each specimen three times to a length of approximately 9 in. (230 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 $135^\circ\text{C} \pm 3^\circ\text{C}$ ($275^\circ\text{F} \pm 5$) for 15 min. ± 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 $845^\circ\text{C} \pm 25$ ($1530^\circ\text{F} \pm 50$) for not less than 3 hours. Burn out the resin by heating the specimens at $565^\circ\text{C} \pm 25$ ($1045^\circ\text{F} \pm 50$) for 3 hr ± 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 Fisher-Johns Melting Point Apparatus to $165^\circ\text{C} \pm 1$ ($330^\circ\text{F} \pm 2$). Place a microscope slide on the heated block, allowing 20 - 30 sec for it to reach temperature equilibrium. Cut a piece of roving $1/4$ in. $\pm 1/16$ (6.5 mm ± 1.5) long. Place a sample on heated microscope slide and commence timing. Within 5 sec, place a second microscope slide over the sample. As the resin softens and during the first 30 sec, 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 thickness, 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 in. ± 0.010 (75 mm ± 0.25) long. Weigh each specimen, consisting of two 3-in. (75-mm) lengths to the nearest 0.001 gram (W_1). With the lengths spaced $1/2$ in. (13 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 $150^\circ\text{C} \pm 5$ ($300^\circ\text{F} \pm 10$). Place the sandwiched material on the hot plate, cover with the metal weight, and maintain at temperature for 2 min. ± 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_2). 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