

# AEROSPACE MATERIAL SPECIFICATION

Submitted for recognition as an American National Standard



**AMS 3828C**

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Superseding AMS 3828B

## Glass Roving, Epoxy Resin Preimpregnated Type E Glass

### 1. SCOPE:

#### 1.1 Form:

This specification covers glass roving impregnated with epoxy resin, the resin being partially processed to a "B" stage condition.

#### 1.2 Application:

This roving has been used typically in high strength filament-wound structures for aircraft, missiles, and related structures, but usage is not limited to such applications.

#### 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 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

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## 2.2 ASTM Publications:

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

- ASTM D 2290 Apparent Tensile Strength of Ring or Tubular Plastics and Reinforced Plastics by Split Disk Method
- ASTM D 2343 Tensile Properties of Glass Fiber Strands, Yarns, and Rovings Used in Reinforced Plastics
- ASTM D 2344 Apparent Interlaminar Shear Strength of Parallel Fiber Composites by Short Beam Method
- ASTM D 2584 Ignition Loss of Cured Reinforced Resins

## 2.3 U.S. Government Publications:

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

- MIL-C-9084 Cloth, Glass, Finished for Resin Laminates
- MIL-R-9300 Resin, Epoxy, Low Pressure Laminating
- MIL-R-60346 Roving, Glass, Fibrous (For Prepreg Tape and Roving, Filament Winding, and Pultrusion Applications)
- MIL-STD-2073-1 DoD Materiel, Procedures for Development and Application of Packaging Requirements

## 3. TECHNICAL REQUIREMENTS:

### 3.1 Material:

Shall be glass roving conforming to MIL-R-60346, Type II, Class ECG 135-140, impregnated with epoxy resin formulated to meet MIL-R-9300, Type I, Class 1, the resin being processed to "B" stage condition.

- 3.1.1 Splices: No splices or knots shall be introduced during the impregnation process except as shall have been previously agreed upon by purchaser and vendor.
- 3.1.2 Shelf Life: When packaged in vapor-proof, heat-sealed bags, the preimpregnated roving shall have a shelf life of not less than three weeks when stored at not higher than 4 °C (39 °F), and not less than three months when stored at not higher than -18 °C (0 °F).
- 3.1.3 Cure: Roving shall be fully cured by filament winding under 12 to 15 psi (83 to 103 kPa) tension and curing for one hour at 95 °C ± 15 (203 °F ± 27) plus two hours at 175 °C ± 15 (347 °F ± 27), or as recommended by the manufacturer.

### 3.2 Properties:

Roving shall conform to requirements shown in Table 1; tests shall be performed on the product supplied and in accordance with specified test methods, insofar as practicable.

TABLE 1 - Properties

Paragraph	Property	Requirement	Test Method
3.2.1	As Received (Uncured):		
3.2.1.1	Volatile Content, by weight	0.5 to 2.5%	4.5.1
3.2.1.2	Ignition Loss, by weight	17 to 23%	ASTM D 2584
3.2.1.3	Gel Time	1.0 to 3.5 minutes	4.5.2
3.2.1.4	Resin Flow, by weight	8 to 17%	4.5.3
3.2.1.5	Tensile Strength, Impregnated Strand, min	300 ksi (2068 MPa)	ASTM D 2343
3.2.2	As Cured: Specimens, cured as in 3.1.3, shall have the following properties, determined at 23 °C ± 1 (73 °F ± 2):		
3.2.2.1	Hoop Tensile Strength (NOL Ring), min	190 ksi (1310 MPa)	ASTM D 2290
3.2.2.2	Interlaminar Shear Strength, min	6000 psi (41.4 MPa)	ASTM D 2344

### 3.3 Quality:

Roving, as received by purchaser, shall be uniform in quality and condition and free from foreign materials and from imperfections detrimental to usage of the roving.

## 4. QUALITY ASSURANCE PROVISIONS:

### 4.1 Responsibility for Inspection:

The manufacturer of roving shall supply all samples for required 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 roving conforms to the requirements of this specification.

### 4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests for volatile matter (3.2.1.1), resin flow (3.2.1.4), and cured hoop tensile strength (3.2.2.1) are acceptance tests and shall be performed on each lot.

4.2.2 Preproduction Tests: Tests for all technical requirements are preproduction tests and shall be performed prior to or on the first shipment of roving by the manufacturer, 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 roving shall be taken at random from each lot to perform all required tests. 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.

4.3.1.1 A lot shall be all product from the same batches or lots of roving and resin produced in one continuous run and presented for manufacturer's inspection at one time. A lot shall not exceed 500 pounds (227 kg).

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

4.3.1.2 When a statistical sampling plan has been agreed upon by purchaser and supplier, 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 supplier.

4.4 Approval:

4.4.1 Sample impregnated 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 Manufacturer 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, manufacturer 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 Content: Cut three specimens each 72 inches  $\pm$  0.1 (1829 mm  $\pm$  2.5) long. Fold each specimen three times to a length of approximately 9 inches (229 mm) and tie loosely into an overhand bow knot. Weigh each specimen to the nearest 0.001 gram. Hang each specimen separately on a rack and place in an oven at 135 °C  $\pm$  3 (275 °F  $\pm$  5) for 15 minutes  $\pm$  1. Cool to room temperature in a desiccator and weigh each specimen. Calculate volatile using Equation 1.

$$\text{Volatile content, \%} = \frac{W_o - W_1}{W_o} \times 100 \quad (\text{Eq. 1})$$

where:

$W_o$  = original weight

$W_1$  = final weight

Average the results from the three specimens.

- 4.5.2 Gel Time: Precondition a suitable melting point apparatus to 165 °C  $\pm$  1 (329 °F  $\pm$  2). Place a microscope slide on the heated block, allowing 20 to 30 seconds for it to reach temperature equilibrium. Cut a piece of roving 1/4 inch  $\pm$  1/16 (6.4 mm  $\pm$  1.6) long. Place sample on a heated microscope slide and commence timing. Within five 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 in minutes as gel time. Report the average of three results.
- 4.5.3 Resin Flow: Cut six lengths of roving, each 3 inches (76 mm) long. Weigh each specimen, consisting of two 3-inch (76-mm) lengths, to the nearest 0.001 gram. With the lengths spaced 1/2 inch (12.7 mm) apart, sandwich the specimen between four layers (two on each side of specimen) of MIL-C-9084, Type I, Volan A finish glass cloth. Preheat a 1500-gram metal weight to 150 °C  $\pm$  5 (302 °F  $\pm$  9). Press the sandwiched material on a preheated hot plate and maintain at 150 °C  $\pm$  5 (302 °F  $\pm$  9) for two minutes, using a surface pyrometer to ensure maintenance of the required temperature. While still hot, remove the glass cloth and reweigh each roving specimen to the nearest 0.001 gram. Calculate resin flow using Equation 2.

$$\text{Resin flow, wt \%} = \frac{W_o - W_1}{W_o} \times 100 \quad (\text{Eq. 2})$$

where:

$W_o$  = Weight of roving before cure

$W_1$  = Weight of roving with excess resin removed (after cure)

Report the average value of the tests on the three specimens.