Society of Automotive Engineers, Inc.
TWO PENNSYLVANIA PLAZA, NEW YORK, N.Y. 10001

AEROSPACE MATERIAL SPECIFICATION

AMS 3901

Issued 6-1-74
Revised

ORGANIC FIBER, YARN AND ROVING, HIGH MODULUS
For Structural Composites

1. SCOPE:

1.1 Form: This specification and its supplementary detail specifications cover organic fibers in the form of continuous, multifilament yarn and roving.

1.2 Application: Primarily for use as reinforcements in composites for structural applications.

1.3 Classification: The fibers shall be as specified in the applicable detail specification, wherein each material is defined by form and property characteristics. 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., Two Pennsylvania Plaza, New York, New York 10001.

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, Pennsylvania 19103.

ASTM D1505 - Density of Plastics by the Density-Gradient Technique
ASTM D2343 - Tensile Properties of Glass Fiber Strands, Yarns, and Rovings Used in Reinforced Plastics

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

2.3.1 Military Standards:

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

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 parallel, unidirectional, continuous, organic filaments characterized by flexibility and fineness.

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3.2.2 Finish: A finish or treatment may be applied if required to promote compatibility of the fiber with the resin system with which it is to be used. Unless otherwise specified, the fiber shall be supplied without finish or treatment.

3.2.3 Color: The material shall be essentially yellow in color.

3.3 Properties: 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 of this specification.

3.4 Quality: The product shall be uniform in quality and condition, clean, and free from foreign materials and from internal and external 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 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), property testing in accordance with 3.3 or as specified in the applicable detail specification, quality (3.4), and splicing requirements of the detail specification, 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 spools selected at random throughout the lot.

TABLE I

SAMPLING SCHEDULES

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 (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 is defined as all material produced in a single production run from the same batch of raw materials under the same fixed conditions and submitted for inspection at one time.

4.3.3 Inspection Unit: An inspection unit is defined as each 6.0 lb (2.72 kg) spool of yarn or 5.0 lb (2.27 kg) spool of roving.

4.3.4 Tensile Strength and Modulus of Elasticity: Four specimens from each inspection unit.

4.3.5 Denier: Two specimens from each inspection unit.

4.3.6 Fiber Finish: One specimen from each inspection unit.

4.3.7 Density: One specimen from each 10 inspection units.

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 which could affect quality or properties of the material, vendor shall submit samples for reapproval unless purchaser grants written approval after review of a detailed statement of materials and processing used on the approved sample and those proposed. No production material made by the revised procedure shall be shipped prior to receipt of approval of such procedure.

4.5 Test Methods: Tensile strength and modulus of elasticity shall be determined in accordance with ASTM D2343, Procedure A. Density shall be determined in accordance with ASTM D1505. Denier and fiber finish content shall be determined as follows:

4.5.1 Denier:

4.5.1.1 Measure a 900-mm length of yarn or roving to the nearest millimeter.

4.5.1.2 Weigh the yarn or roving sample in grams to the nearest 10 milligrams.

4.5.1.3 Calculate the denier (weight per length) as follows:

Denier = wt in g of 9000 m = wt of 900-mm sample x 10,000

4.5.2 Fiber Finish Content: Shall be determined as follows:

4.5.2.1 Weigh, to the nearest mg, a 1.0-2.0 g sample of finished yarn or roving (W_1). Place sample in a Whatman paper thimble previously extracted with acetone.

4.5.2.2 Pour approximately 200 cm^3 of freshly distilled acetone into a 300 cm^3 boiling flask previously cleaned, dried, and weighed to the nearest mg (W_2).

4.5.2.3 Place the thimble containing the sample in a Soxhlet extraction apparatus with condenser and attach the boiling flask containing the acetone.

4.5.2.4 Adjust the rate of condensation dripping into the thimble to not less than 1 cm^3 per minute.

4.5.2.5 Extract for not less than 4 hr at this rate.

4.5.2.6 Remove flask and distill off all but approximately 5 - 10 cm^3 of acetone. Place flask in oven at 210° F ± 10 (98.9° C ± 5.6) and allow to remain until completely dry.

4.5.2.7 Reweigh the flask to the nearest mg (W_3). Determine weight of resin extracted from the sample and calculate percent by weight of finish as follows:

$$\text{Fiber Finish Content, \% by weight} = \frac{(W_3 - W_2)}{W_1} \times 100$$

where, W_1 = Weight of original fiber sample

W_2 = Weight of clean, dry flask

W_3 = Weight of flask plus extracted resin

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 tensile strength, modulus of elasticity, finish weight (if used), and fiber density and a statement that the product conforms to all other technical requirements of this specification and the applicable detail specification. This report shall include the purchase order number, material specification number including applicable detail specification number, vendor's material designation, treatment finish (if used), date of manufacture, lot number, spool number, and net weight.

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 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. 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 Yarn and roving shall be supplied in continuous lengths wound on spools with cores having an outside diameter of not less than 1 in. (25 mm). Winding shall be uniform and provide for proper unreeling. Ends shall be secured.

5.1.2 Each spool of yarn or roving shall be identified with a label attached to the inside surface of the core showing the following information; characters on the label shall be of such size as to be clearly legible and shall not be obliterated by normal handling:

ORGANIC FIBER, YARN (ROVING) FOR STRUCTURAL COMPOSITES
AMS 3901 *
MANUFACTURER'S NAME_____
MANUFACTURER'S MATERIAL DESIGNATION_____
DESCRIPTION_____
SPOOL NUMBER_____
TYPE OF FINISH OR TREATMENT (IF USED)_____
DENIER_____

*Insert applicable detail specification number