



# AEROSPACE MATERIAL SPECIFICATION

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

AMS 3709A  
Superseding AMS 3709

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## SYNTACTIC FOAM TILES

### 1. SCOPE:

- 1.1 Form: This specification covers dielectrically-loaded syntactic foam tiles having a polyimide resin matrix.
- 1.2 Application: Primarily as a controlled-dielectric core material for applications requiring long-term heat resistance up to 315° C (600° F).
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  
AMS 3619 - Resin, Polyimide, Laminating, High Temperature Resistant, 315° C (600° F).  
AMS 3751 - Microspheres, Hollow Glass

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19108

ASTM C271 - Density of Core Materials for Structural Sandwich Constructions  
ASTM D2520 - Complex Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials at Microwave Frequencies and Temperatures to 1650 C  
ASTM D2841 - Sampling Hollow Microspheres

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

2.3.1 Federal Specifications:

OA-51 - Acetone, Technical

2.3.2 Military Standards:

MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of

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3. TECHNICAL REQUIREMENTS:

3.1 Material: Tiles shall be composed of the following materials in the proportions specified:

Component	Parts by Weight
Hollow Glass Microspheres, AMS 3751, Class 15	100
Polyimide Resin Solution, AMS 3619	140
Glass Fibers, 0.25 in. (6.4 mm) (See 8.3)	7.2
Aluminum Powder (See 8.3)	15 - 16
Acetone, Technical, 0-A-51	85

3.2 Fabrication: Tiles shall be fabricated as follows; drying, curing, and post-curing temperatures and vacuum readings shall be continuously monitored and recorded. All equipment and thermocouples used shall be calibrated at regular intervals.

3.2.1 Mold Preparation: The foam tile mold surfaces shall be coated with a fluorocarbon mold-release material.

3.2.2 Foam Mixing: Each component of the foam formulation in 3.1 shall be weighed to the nearest gram. The resin and acetone shall be combined in a slow-speed, low-shear mixer and mixed thoroughly. While mixing, the other components shall be sprinkled slowly into the resin-acetone solution in the following order: the glass fibers, the aluminum powder, and the microspheres (taken in accordance with ASTM D2841), with thorough mixing after each addition. Mixing shall be continued for not less than 5 min. after adding the final component.

3.2.3 Mold Packing: The foam mixture shall be evenly packed into the release-coated molds to the specified depth for the applicable tile design.

3.2.4 Material Drying: A thermocouple shall be located at the mold surface at least 1 in. (25 mm) from the mold edge, in the thickest available mold area. The packed mold shall be placed, uncovered, into a preheated 80° C (176° F), forced draft, explosion-proof oven, set for high air-flow. The mold shall be held in the 80° C  $\pm$  3 (176° F  $\pm$  5) oven for 30 min.  $\pm$  1 after the mold-surface thermocouple has reached 70° C  $\pm$  3 (158° F  $\pm$  5) or for 150 min.  $\pm$  5, whichever occurs first. The mold shall then be removed from the oven and cooled to ambient temperature.

3.2.5 Tile Bagging: The surface of the dried foam in the mold shall be covered, in order, with one ply of silicone release fabric, one ply of glass cloth (181-type fabric), and one ply of glass cloth (184-type fabric). The mold assembly shall then be vacuum-bagged and a vacuum of not less than 22 in. (559 mm) of mercury applied.

3.2.6 Tile Curing: The bagged assembly shall be placed in an ambient temperature oven under full vacuum of not less than 22 in. (559 mm) Hg. The oven temperature shall be raised to 120° C  $\pm$  3 (248° F  $\pm$  5) at the rate of 1.0 C (1.8 F) deg per min., and held at 120° C  $\pm$  3 (248° F  $\pm$  5) for 45 min.  $\pm$  5. The oven temperature shall then be raised to 175° C  $\pm$  3 (347° F  $\pm$  5) at the rate of 1.0 C (1.8 F) deg per minute. After the mold-surface thermocouple reaches 175° C (347° F), the assembly shall be maintained at 175° C  $\pm$  5 (347° F  $\pm$  9) for 120 min.  $\pm$  10. The assembly shall then be cooled under vacuum to below 65° C (149° F) and removed from the bag.

3.2.7 Tile Post-Curing: The tile shall be placed in a suitable holding fixture designed to maintain the part contour throughout the post-curing cycle. The assembly shall be placed in an ambient temperature oven and the temperature raised to 315° C  $\pm$  5 (599° F  $\pm$  9) in not less than 4 hr with a rate of rise not greater than 1 C (1.8 F) deg per minute. The assembly shall be held at 315° C  $\pm$  5 (599° F  $\pm$  9) for 120 min.  $\pm$  10. The assembly shall then be cooled to below 65° C (149° F) under restraint before removal from the post-curing fixture.

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

3.3.1 Density: Shall be 19.0 lb per cu ft  $\pm$  1.5 (304 kg/m<sup>3</sup>  $\pm$  24), determined in accordance with ASTM C271.

3.3.2 Dielectric Constant: Shall be 3.1  $\pm$  0.1 at 9.375 GHz (X-band), determined in accordance with ASTM D2520.

3.3.3 Cracks: Hairline cracks shall not exceed 0.005 in. (0.13 mm) in width, measured with a dimensionally-indexed magnifying glass or microscope.

3.4 Quality: Tiles shall be uniform in quality and condition, clean, smooth, 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 tiles 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 4.5. Purchaser reserves the right to perform such confirmatory testing as he deems necessary to ensure that the tiles conform to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to all technical requirements of this specification are classified as acceptance tests and shall be performed on each lot.

4.2.2 Preproduction Tests: Tests to determine conformance to all technical requirements of this specification are classified as preproduction tests and shall be performed on the initial shipment of tiles to a purchaser, when a change in material 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, the contracting officer, or the request for procurement.

4.3 Sampling: Shall be as follows:

4.3.1 For Acceptance Tests: Sufficient product shall be taken at random from each lot to perform all required tests. The minimum sample size shall be 0.7 in. (18 mm) thick x 8 in. (203 mm) square. The number of specimens for each test 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 tiles produced in a single production run from the same batches of raw materials under the same fixed conditions and submitted for vendor's inspection at one time. A lot shall not exceed 50 lb (25 kg) of tiles.

4.3.1.2 When a statistical sampling plan and acceptance quality level (AQL) for the tiles have been agreed upon by purchaser and vendor, sampling shall be in accordance with such plan in lieu of sampling as in 4.3.1 and the report of 4.6.1 shall state that such plan was used.

4.3.2 For Preproduction Tests: As agreed upon by purchaser and vendor.

4.4 Approval:

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

4.5 Reports:

4.5.1 The vendor of tiles shall furnish with each shipment three copies of a report showing the results of tests to determine conformance to the technical requirements of this specification. This report shall include the purchase order number, material specification number and its revision letter, vendor's product designation, lot number, date of manufacture, and quantity.

4.5.2 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 and its revision letter, contractor or other direct supplier of tiles, suppliers' product designation, part number, and quantity. When tiles for making parts are produced or purchased by the parts vendor, that vendor shall inspect each lot of tiles to determine conformance to the requirements of this specification, and shall include in the report a statement that the tiles conform, or shall include copies of laboratory reports showing the results of tests to determine conformance.

4.6 Resampling and Retesting: If any specimen used in the above tests fails to meet the specified requirements, disposition of the tiles 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 tiles 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 Packaging shall be accomplished in such a manner as to ensure that the tiles, during shipment and storage, will not be permanently distorted and will be protected against damage from exposure to weather or any other normal hazard.

5.1.2 Each package shall be identified using characters of such size as to be clearly legible and which will not be obliterated by normal handling. The markings shall show not less than the following information:

SYNTACTIC FOAM TILES

AMS 3709A

MANUFACTURER'S MATERIAL DESIGNATION \_\_\_\_\_

PURCHASE ORDER NUMBER \_\_\_\_\_

DATE OF MANUFACTURE \_\_\_\_\_

LOT NUMBER \_\_\_\_\_

QUANTITY \_\_\_\_\_

5.1.3 Packages shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging, and transportation of the tiles to ensure carrier acceptance and safe delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.

5.1.4 For direct U. S. Military procurement, packaging shall be in accordance with MIL-STD-794, Ø Level A or Level C, as specified in the request for procurement. Commercial packaging as in 5.1.1 and 5.1.3 will be acceptable if it meets the requirements of Level C.

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