

**AEROSPACE
MATERIAL
SPECIFICATION**

AMS 3871A
Superseding AMS 3871

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**GLAZED CERAMIC SHEET
95% Alumina**

1. SCOPE:

1.1 Form: This specification covers a 95% alumina ceramic in the form of sheet glazed on one face.

1.2 Application: Primarily for substrates for use in microelectronic circuit applications.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications 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 American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM D149 - Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies

ASTM D150 - A-C Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulating Materials

ASTM D257 - D-C Resistance or Conductance of Insulating Materials

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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

2.4 ANSI Publications: Available from American National Standards Institute, Inc., 1430 Broadway, New York, NY 10018.

ANSI B46.1 - Surface Texture

3. TECHNICAL REQUIREMENTS:

3.1 Composition: The product base shall contain not less than 95% aluminum oxide, determined by chemical or instrumental analysis. The product shall have one glazed surface.

3.2 Properties: Sheet shall conform to the following requirements; tests shall be performed on the sheet supplied whenever possible. Tests shall be performed at 23° - 29°C (73° - 84°F) unless otherwise specified.

3.2.1 Thermal Shock: Sheet shall show no evidence of pitting, cracking, checking, chipping, or haze when transferred from room temperature to liquid nitrogen to ice water to boiling water. Soak time at each temperature shall be not less than 5 min.; transfer time between media shall be not more than 5 seconds. Handling devices used for transfer shall be thermally insulated from the specimen insofar as practicable.

3.2.2 Flexural Strength: Shall be not lower than 30,000 psi (205 MPa), determined as follows:

3.2.2.1 Procedure: At least ten dry specimens at room temperature shall be tested. Examine the specimen under 10X magnification. Any parts with cracks or chips exceeding 0.005 in. (0.12 mm) shall be discarded. The specimen shall be oriented so that any edge chipped in sample preparation is placed in compression. The specimen shall be placed on two bearing edges rounded to a 0.0625 in. (1.562 mm) radius, spaced 0.375 in. $\pm$ 0.003 (9.50 mm $\pm$ 0.08) between centers, with the specimen overhanging at each end by at least 1/8 in. (3 mm). The load shall be applied uniformly by a third identical knife edge at a rate of 200,000 psi $\pm$ 30,000 (1,380 MPa $\pm$ 205) per min. at right angles to the upper surface of the specimen midway between the two lower bearing edges within 0.003 in. (0.08 mm) until fracture occurs. The load at fracture (P), the specimen thickness at the break (d), and the specimen width at the break (b) shall all be recorded. Specimen dimensions shall be taken with a micrometer calibrated within 0.0001 in. (0.002 mm); the load shall be noted within 0.10 lb (0.5 N).

- 3.2.2.2 Calculation: The flexural strength (MOR) for each specimen shall be calculated as follows:

$$\text{MOR} = \frac{3PL}{2bd^2}$$

where MOR = flexural strength, psi (MPa)

P = load at failure, lb (MN)

L = span of support edges, in. (m)

b = width of specimen, in. (m)

d = thickness of specimen, in. (m)

- 3.2.3 Surface Resistivity: The surface resistivity of the glaze shall be greater than 1×10^{14} ohms per square after 10 hr at $125^\circ\text{C} \pm 10$ ($255^\circ\text{F} \pm 20$) and not lower than 1×10^{10} ohms per square after 10 hr at $300^\circ\text{C} \pm 10$ ($570^\circ\text{F} \pm 20$), determined in accordance with ASTM D257 except that straight parallel electrodes may be used instead of the guarded ring configuration if a minimum of 100 squares are contained within this parallel electrode configuration. Measurements shall be made at room temperature after conditioning.
- 3.2.4 Dielectric Strength: The short time dielectric strength shall be not lower than 400 V per mil (15.5 KV/mm), determined in accordance with ASTM D149 with 60 Hz AC imposed on an 0.025 in. (0.62 mm) thick specimen using 1 in. (25 mm) diameter electrodes and a 1000 V/s rate of rise in air.
- 3.2.5 Dielectric Constant: Shall be not lower than 8.8, determined in accordance with ASTM D150 at 25°C (77°F) and 1 MHz.
- 3.2.6 Loss Index: Shall not be greater than 0.0008, determined in accordance with ASTM D150 at room temperature and 1 MHz.
- 3.2.7 Etch Resistance: Sheet shall show no evidence of glaze delamination, crazing, etching, or pitting after 16 sec ± 1 exposure in heated [$95^\circ\text{C} \pm 5$ ($205^\circ\text{F} \pm 10$)] reagent grade concentrated hydrochloric acid (36 - 38%). The product shall be rinsed in running water and dried before examination.
- 3.3 Quality: Sheet, as received by purchaser, shall be uniform in quality and free from foreign materials and visible pits and scratches and from imperfections detrimental to usage of the sheet.
- 3.4 Tolerances:
- 3.4.1 Finish: The glaze shall have a maximum surface roughness of 1 microin. (0.025 μm) centerline average, measured by a profilometer or equivalent in accordance with ANSI B46.1. Measurement shall be made more than 0.060 in. (1.50 mm) from edge of the sheet.

3.4.2 Waviness: The height variation of the glazed surface shall be not more than 0.0005 in. (0.012 mm) in any 0.5 in. (12 mm) square when supported on a microflat plate and measured with a dial indicator or equivalent. Measurements shall be made more than 0.060 in. (1.50 mm) from edge of the sheet. Camber may be compensated for in this measurement.

3.4.3 Camber: Sheet shall have a maximum camber of 0.004 in. per in. (0.004 mm/mm). Camber shall be computed by subtracting actual from effective thickness and dividing by the length. Effective thickness shall be the maximum height of the exposed specimen surface above a microflat surface (surface plate or equivalent) upon which the specimen has been placed. Thickness measurements shall be accurate to ± 0.0002 in. (± 0.005 mm) and the length measurement to ± 0.010 in. (± 0.25 mm). Thickness should be measured with a micrometer with anvils under 0.125 in. (3 mm) in diameter.

4. QUALITY ASSURANCE PROVISIONS:

4.1 Responsibility for Inspection: The vendor of sheet 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 4.4. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the sheet conforms to the requirements of this specification.

4.2 Classification of Tests:

4.2.1 Acceptance Tests: Tests to determine conformance to requirements for composition (3.1), flexural strength (3.2.2), etch resistance (3.2.7), quality (3.3), and tolerance (3.4) 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 prior to or on the initial shipment of sheet to a purchaser, when a change in material, processing, or both 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 sheet shall be selected 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 two.
- 4.3.1.1 A lot shall be all sheet produced in a single production run from the same batches of raw materials under the same fixed conditions and presented for vendor's inspection at one time. The lot shall not exceed 200 sq ft (19 m²).
- 4.3.1.2 When a statistical sampling plan and acceptance quality level (AQL) 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 4.5.1 shall state that such plan was used.
- 4.3.1.3 Specimens: Specimens for flexural strength shall be rectangular bars 0.025 in. $\pm$ 0.001 in. (0.62 mm $\pm$ 0.02) thick by 0.070 in. $\pm$ 0.001 (1.75 mm $\pm$ 0.02) wide by not less than 0.625 in. (15.75 mm) long to permit an overhang of at least 1/8 in. (3 mm) at each end when mounted on supports. All angles between test sample side surfaces shall be 90 deg $\pm$ 1. Camber shall not exceed 0.004 in. per in. (0.004 mm per mm).
- 4.3.1.3.1 The specimens shall be diced to 0.070 in. $\pm$ 0.001 (1.75 mm $\pm$ 0.02) width from a substrate blank which is 0.025 in. $\pm$ 0.001 (0.62 mm $\pm$ 0.02) thick and not less than 0.625 in. (15.25 mm) square. The substrate blank should be prepared by a process which represents the normal manufacturing procedure.
- 4.3.1.3.2 The specimens shall be cleaned in detergent and hot water followed by a hot water rinse. The specimens shall be oven dried at 175°C $\pm$ 25 (350°F $\pm$ 45) for not less than 1 hr and cooled in a desiccator to room temperature. The specimens shall be removed from the desiccator and immediately tested.
- 4.3.2 For Preproduction Tests: As agreed upon by purchaser and vendor.

4.4 Approval:

- 4.4.1 Sample sheet shall be approved by purchaser before sheet for production use is supplied, unless such approval be waived by purchaser. Results of tests on production sheet shall be essentially equivalent to those on the approved sample sheet.