



AEROSPACE MATERIAL

Society of Automotive Engineers, Inc. SPECIFICATION

TWO PENNSYLVANIA PLAZA, NEW YORK, N.Y. 10001

AMS 3689

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Revised

ADHESIVE, FOAMING, HONEYCOMB CORE SPLICE, STRUCTURAL
-67° to +350° F (-55° to +177° C)

1. SCOPE:

1.1 Form: This specification covers a foaming-type, heat-curing, resin-base adhesive in paste or sheet form.

1.2 Application: Primarily for use in splicing aluminum-base alloy or nonmetallic honeycomb core and for providing a shear tie between core edges and inserts or edge members in honeycomb assemblies for use over the temperature range from -67° to +350° F (-55° to +177° C). It is useful for filling gaps between core faces which are inserted into channels or similar areas where bonding pressure cannot be obtained.

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

AMS 4037 - Aluminum Alloy Sheet and Plate, 4.4Cu - 1.5Mg - 0.60Mn
(2024 - T3 Flat Sheet, -T351 Plate)

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

2.2.1 Military Specifications:

MIL-C-7438 - Core Material, Aluminum, for Sandwich Construction

MIL-A-25463 - Adhesive, Film Form, Metallic Structural Sandwich Assemblies

3. TECHNICAL REQUIREMENTS:

3.1 Material: The adhesive material shall be a heat-curing (nominally 350° F (177° C)) resin system containing fillers and foaming agents as necessary to meet the requirements specified herein. The material shall have low sagging properties to assure complete filling of core splice gaps when splices are cured in a vertical position. The material shall be suitable for splicing nonperforated honeycomb core without damage to core node bonds located adjacent to the splice.

3.1.1 Sheet Adhesive: Shall be supplied as an unsupported sheet with a suitable nonadhering separator film on both surfaces.

3.1.2 Paste Adhesive: Shall be supplied as a thixotropic paste, single-component or two-part system suitable for extrusion from a disposable cartridge or caulking gun.

3.2 Properties of Uncured Adhesive: The product, as-received, shall conform to the following requirements; tests shall be performed on the product supplied and in accordance with the test procedures specified herein:

SAE Technical Board rules provide that: "All technical reports, including standards, are advisory only. Their use by anyone engaged in industry or trade is entirely voluntary. There is no agreement to adhere to any SAE standard or recommended practice, and no commitment to conform to or be guided by any technical report. In formulating and approving technical reports, the Board and its Committees will not investigate or consider patents which may apply to the subject matter. Prospective users of the report are responsible for protecting themselves against liability for infringement of patents."

3.2.1 Storage Life:

3.2.1.1 Single-component products, when packaged as specified herein, shall meet the requirements of this specification after storage at a maximum temperature of 0° F (-18° C) for any time up to 3 months from the date of manufacture.

3.2.1.2 Two-part paste systems, when packaged as specified herein, shall meet the requirements of this specification after storage at a maximum temperature of 90° F (32° C) for any time up to one year from the date of manufacture.

3.2.2 Working Life: Single-component products, and two-part paste systems mixed in accordance with the manufacturer's instructions, shall meet the requirements of this specification for any time up to 48 hr after exposure at a relative humidity of 50 - 70% and a temperature of 70° - 80° F (21.1° - 26.7° C).

3.2.3 Sagging: Shall be not greater than specified in Table I, determined in accordance with 4.5.1.

3.3 Properties of Cured Adhesive: Shall be as specified below, determined on specimens prepared as specified herein and cured at 350° F $\pm$ 10 (176.7° C $\pm$ 5.6) for a period of 60 min. $\pm$ 5:

3.3.1 Curing Properties:

		Number of Specimens	Test Procedure
Sagging, max	0.05 in. (1.3 mm)	3	4.5.1
Expansion Ratio, min	1.7	3	4.5.2 or 4.5.3
Peak Exotherm, max	450° F (232.2° C)	1	4.5.4

3.3.2 Cured Properties:

Density, max	40 lb per cu ft (640 kg/m ³)	3	4.5.5
Beam Shear Strength, min			4.5.6
At -67° F (-55° C)	720 psi (4964 kPa)	3	
At 75° F (23.9° C)	720 psi (4964 kPa)	3	
At 350° F (176.7° C)	468 psi (3227 kPa)	3	

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

3.5 Tolerances of Sheet Adhesive: Thickness shall be as specified, $\pm$ 0.010 in. ($\pm$ 0.25 mm). Width and length shall be as specified, +0.125 in. (+3.18 mm), -0.0.

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 expansion ratio (3.3.1) and beam shear strength at room temperature (3.3.2) requirements are classified as acceptance or routine control tests.

- 4.2.2 Qualification Tests: Tests to determine conformance to all technical requirements of this specification are classified as qualification or periodic control tests and may be the basis for approval of the adhesive (See 4.4.1).
- 4.3 Sampling: Each lot of adhesive shall be sampled at random to provide sufficient material to perform acceptance testing on the number of specimens required herein.
- 4.3.1 A lot shall be all material produced in a single production run from the same batch of raw materials under the same fixed conditions, or all material subjected to the same unit chemical or physical process intended to make the final product homogeneous, and submitted for inspection at one time.
- 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 adversely 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:
- 4.5.1 Sagging: The sagging characteristics of an adhesive shall be determined by fabricating a beam shear specimen in accordance with 4.5.6.1, with no face bonding adhesive between the upper facing and the core, and using a 0.020 in. (0.51 mm) thick upper facing. After curing as specified in 3.3, remove the upper facing, observe the degree of fill of the splice and measure sag from the upper face of the core. Evidence of adherence of foam adhesive on the upper face over the entire splice area will also constitute evidence of acceptable sagging characteristics.
- 4.5.2 Expansion Ratio for Sheet Adhesives:
- 4.5.2.1 Cut three 2 x 2 in. (51 x 51 mm) pieces of sheet material and measure the thickness of each piece at each corner and at the center to the nearest 0.01 in. (0.3 mm).
- 4.5.2.2 Place the specimens separately on a caul plate which has been covered with a suitable parting agent to prevent adhesion of the test pieces to the plate.
- 4.5.2.3 Place the caul plate with the specimens in a circulating air oven which is at a temperature not higher than 80° F (27° C) and raise the temperature to 350° F $\pm$ 10 (176.7° C $\pm$ 5.6) at a rate of 3 - 5 F (1.7 - 2.8 C) deg per minute. Maintain the specimens at 350° F $\pm$ 10 (176.7° C $\pm$ 5.6) for 60 min. $\pm$ 5 and cool to room temperature.
- 4.5.2.4 Measure the thickness of each specimen at each quadrant to the nearest 0.01 in. (0.3 mm) and calculate the expansion ratio as follows:
- $$\text{Expansion Ratio} = \frac{\text{Average thickness of each specimen after cure}}{\text{Average original thickness of the specimen}}$$
- 4.5.3 Expansion Ratio for Paste Adhesives:
- 4.5.3.1 Clamp a sheet of 0.100 in. (2.54 mm) thick aluminum-base alloy having a 2.0 in. (51 mm) diameter hole in the center to a caul plate. All metal surfaces, including the inside edges of the hole, shall be covered with a suitable parting agent to prevent adhesion of the test specimen to the tool.

- 4.5.3.2 Extrude sufficient paste adhesive to fill the hole in the sheet. Using a knife blade or suitable scraper, wipe across the hole to fair the adhesive flush with the upper surface of the sheet.
- 4.5.3.3 Place the caul plate assembly in a circulating air oven which is at a temperature not higher than 80° F (27° C) and raise the temperature to 350° F $\pm$ 10 (176.7° C $\pm$ 5.6) at a rate of 3-5 F (1.7-2.8 C) deg per minute. Maintain the expansion specimens at 350° F $\pm$ 10 (176.7° C $\pm$ 5.6) for 60 min. $\pm$ 5 and cool to room temperature.
- 4.5.3.4 Measure the thickness of each specimen at each quadrant to the nearest 0.01 in. (0.3 mm) and calculate the expansion ratio as follows:

$$\text{Expansion Ratio} = \frac{\text{Average thickness in in. (mm) of each specimen after cure}}{0.10 \text{ in. (or 2.5 mm)}}$$

- 4.5.4 Peak Exotherm Temperature: Shall be determined on a test panel consisting of two 0.020 x 12.0 x 12.0 in. (0.51 x 305 x 305 mm) aluminum-base alloy faces and a 2.00 in. (50.8 mm) thick, 3/16 in. (4.8 mm) cell size nonmetallic core as shown in Fig. 1. The core shall be spliced in the center of the panel. A suitable thermocouple shall be inserted in the approximate geometric center of the splice. The panel shall be cured as specified in 3.3. The maximum temperature of the thermocouple during cure of the test panel shall be reported.

4.5.5 Density of Cured Adhesive:

- 4.5.5.1 Measure the width and length or the diameter of the cured specimens used in the expansion ratio determinations (4.5.3) to the nearest 0.01 in. (0.3 mm).
- 4.5.5.2 Weigh each specimen to the nearest mg.
- 4.5.5.3 Using the average thickness of each specimen obtained during the expansion ratio determination, calculate the density of the cured adhesive as follows:

$$\begin{aligned} \text{Density} &= \frac{\text{Weight, g}}{\text{Volume, cu in.}} \times 3.81 \\ &\text{or} \\ &= \frac{\text{Weight, g}}{\text{Volume, cm}^3} \times 1000 \end{aligned}$$

4.5.6 Beam Shear Strength:

- 4.5.6.1 Specimen Preparation: Beam shear test panels shall be prepared using 0.125 in. (3.18 mm) thick aluminum-base alloy sheet facings conforming to AMS 4037, or equivalent, and 0.625 in. (15.88 mm) thick 7.9-1/4-40 (5056)T aluminum-base alloy honeycomb core treated for corrosion resistance conforming to MIL-C-7438. Butting of core sections and splice locations shall be as shown in Fig. 2. Test panels shall be bonded using a face-to-core adhesive conforming to MIL-A-25463, Type 3, suitable for curing at 350° F (177° C). Test panels shall be cured as specified in 3.3.
- 4.5.6.2 Beam shear testing shall be conducted as specified in MIL-C-7438 for flexural shear. Tests shall be conducted at the temperature specified in 3.3.2 after not less than 10 min. at the test temperature as verified by a thermocouple attached to the specimen in the splice material.

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 acceptance test requirements and a statement that the product conforms to all other technical requirements of this specification. This report shall include the purchase order number, material specification number, vendor's material designation, lot number, date of manufacture, form, and quantity.

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, 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 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 Sheet Adhesive: Shall be supplied flat with each sheet protected on both sides by nonadherent separator film. Sheets shall be packaged individually, or as specified, in sealed bags of suitable nonadherent material to prevent penetration of moisture or loss of volatiles.

5.1.2 Paste Adhesive: Shall be packaged in suitable containers or in disposable polyethylene cartridges, as ordered, for use in extrusion equipment. Each container or cartridge shall be sealed to prevent penetration of moisture or loss of volatiles.

5.1.3 Packing: The protected sheets, containers, or cartridges shall be packed in an exterior container capable of protecting the materials adequately during transit and storage below the specified temperature.

5.1.4 Each unit shall be identified with the following information, using characters of such size as to be clearly legible and which will not be obliterated by normal handling:

ADHESIVE, FOAMING, HONEYCOMB CORE SPLICE, -67° to +350° F (-55° to +177° C)
AMS 3689
FORM (Sheet or Paste)
MANUFACTURER'S MATERIAL DESIGNATION _____
PURCHASE ORDER NUMBER _____
DATE OF MANUFACTURE _____
LOT NUMBER _____
QUANTITY OR THICKNESS _____
PERISHABLE - STORE BELOW 0° F (-18° C) (or, for two-part paste, 90° F (32° C))

5.1.4.1 Sheet Adhesive: Shall be identified by marking on at least one of the protective separator films on each sheet.

5.1.4.2 Paste Adhesive: Shall be identified by marking on each container or cartridge.

5.1.5 Marking of Exterior Package: Each exterior shipping container shall be legibly marked with the following information in such a manner that the markings shall not smear or be obliterated during normal handling or use:

ADHESIVE, FOAMING, HONEYCOMB CORE SPLICE, -67° to +350° F
(-55° to +177° C)

AMS 3689

FORM (Sheet or Paste)

PURCHASE ORDER NUMBER _____

MANUFACTURER'S MATERIAL DESIGNATION _____

DATE OF MANUFACTURE _____

LOT NUMBER _____

QUANTITY _____

PERISHABLE - STORE BELOW 0° F (-18° C) (or 90° F (32° C))

- 5.1.6 Containers shall be prepared for shipment in accordance with commercial practice to assure carrier acceptance and safe transportation to the point of delivery. Packaging shall conform to carrier rules and regulations applicable to the mode of transportation.
6. ACKNOWLEDGMENT: A vendor shall mention this specification number in all quotations and when acknowledging purchase orders.
7. REJECTIONS: Material not conforming to this specification or to authorized modifications will be subject to rejection.
8. NOTES: None.

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