3M

Scotch-Weld™

Structural Core Splice Adhesives

AF 3028 • AF 3028 FR

Technical Data **Issue No. 2**

Introduction

3M™ Scotch-Weld™ Structural Core Splice Adhesives AF 3028 and AF 3028 FR are 250°F to 350°F (121°C to 176°C) curing, low density, expandable core splice adhesive films. AF 3028 and AF 3028 FR were designed for filling mismatch areas or reinforcing and splicing honeycomb core.

Advantages

- Expands during cure for void filling and core splicing
- Low sag during cure
- Low volatile loss during cure
- High performance from -67°F to 350°F (-55°C to 176°C)
- AF 3028 FR has flame retardant properties
- Can be cured/expanded at slow heat up rates

Description

	AF 3028	AF 3028 FR
Color:	Off White	Off White
Base:	Epoxy	Epoxy
Form:	Unsupported Film	Unsupported Film
Thickness:	50 ± 5 mil	50 ± 5 mil
Weight (approx.):	0.26 lb/ft^2	0.27 lb/ft^2
Expansion Ratio (approx.):	1.9	2.1
Volatile Loss (250°F [121°C] cure):	Less than 1%	Less than 1%
Uncured Density (approx.):	63 lb/ft^3	64 lb/ft^3

Available as 10" x 24" flat sheets or as rolls in various length and widths.

Product Performance

1. Volatile Content:

The volatile content for AF 3028 and AF 3028 FR was determined by measuring the weight loss of a of 4" x 4" square sample of adhesive during cure (3M AdhD Test Method C-286). The polyethylene separating liner was removed prior to cure. Cure time was 1 hour.

	250°F (121°C) Cure	350°F (176°C) Cure
Volatile content for AF 3028:	Less than 1%	Less than 1%
Volatile content for AF 3028 FR:	Less than 1%	Less than 1%

2. Cured Density:

The free film cured density for AF 3028 and AF 3028 FR was determined by weighing 1" x 1" cured specimens and dividing by the volume of the specimens (3M AdhD Test Method C-2310). Specimens were cured for 1 hour at 250°F (121°C), 4-6°F rise rate/minute.

	AF 3028	AF 3028 FR
Cured Density (Typical)	34 lb/ft^3 (.54 g/cc)	29 lb/ft^3 (.46 g/cc)

3. Expansion During Cure:

The free film expansion ratio for AF 3028 and AF 3028 FR was determined by dividing the average cured thickness of the cured density specimens by the average original (uncured) thickness (3M AdhD Test Method C-286).

Cure Cycle:	250°F (121°C), 60 minutes 4-6°F/minute 0 PSIG		350°F (176°C), 60 minutes 4-6°F/minute 0 PSIG
	AF 3028	**AF 3028 FR**	**AF 3028**
Expansion Ratio (Typical):	1.8	2.1	1.9

4. Slump or Sag:

Sag during cure was measured by laminating a 4" x 4" piece of adhesive to an 8" x 8" x 0.020" clean aluminum panel. It was then placed in a vertical position with the bottom edge horizontal. A scribe line was made along the bottom 4" edge of the adhesive. This assembly was cured as given below and slump or sag is the distance the adhesive flowed beyond the scribe line (3M AdhD Test Method C-277).

Cure Cycle:	250°F (121°C), 90 minutes 4-6°F/minute 0 PSIG		350°F (176°C), 90 minutes 4-6°F/minute 0 PSIG
	AF 3028	**AF 3028 FR**	**AF 3028**
Sag or Slump (Typical):	0.03" (0.8 mm)	0.02" (0.5 mm)	0.03" (0.8 mm)

Product Performance ***(continued)***

5. Splice Delamination Strength:

Splice delamination has been determined in accordance with the procedure outlined in MIL-C-7438F, Paragraph 4.7.9.

Honeycomb Core Used: 5052 alloy-1/4" cell-4.0 mil foil – 1/2" thick non-perf.
Size: 5" x 10" (core ribbon perpendicular to ten inch dimension).
Splice Position: Centered and perpendicular to the 10" dimension running the full width of the specimen.
Number of Layers: One layer of adhesive.
Cure: 1 hour at 250°F (121°C).
Load Rate: 0.25" per minute.

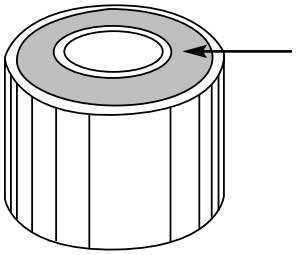
Test Temperature	AF 3028	AF 3028 FR
75°F (24°C)	110 lbs (490 N)	100 lbs (445 N)

6. Tube Shear Strength:

The tube shear strength has been determined on AF 3028 and AF 3028 FR using the procedure outlined in AdhD Test Method C-280. Tube shear specimens are prepared by placing 45 ± 0.2 grams of adhesive between the walls of two 9" long tubes and curing in an oven. After cure, the tubes were cut into 0.5" specimens as shown below and tested by pushing out the inside tube at a rate of 0.05"/minute.

Test Specimen

Tube Shear = $\frac{P \text{ (lbs)}}{0.784 \text{ (in}^2\text{)}}$



Core Splice Adhesive

Outer Tube – 1" OD, 0.049" thick 5052-0 bare aluminum

Innter Tube – 1/2" OD, 0.049" thick 5052-0 bare aluminum

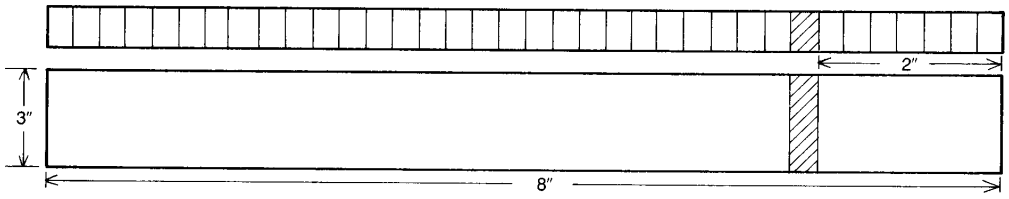
P = Force required to push out inner tube.
Cure Cycle A: 250°F (121°C) for 90 minutes, 4-6°F rise rate/minute.
Cure Cycle B: 350°F (176°C) for 60 minutes, 7.5°F rise rate/minute.
Test Results (Typical Averages)

Test Temperature		Cure Cycle A AF 3028		Cure Cycle A AF 3028FR		Cure Cycle B AF 3028	
°F	(°C)	psi	(MPa)	psi	(MPa)	psi	(MPa)
-67	(-55)	1100	(7.6)	—	—	—	—
75	(24)	950	(6.5)	1070	(7.4)	1036	(7.1)
180	(82)	950	(6.5)	—	—	—	—
250	(121)	900	(6.2)	—	—	—	—
350	(176)	492	(3.4)	—	—	565	(0.4)

Product Performance ***(continued)***

7. Flexural Shear Strength:

Flexural shear strength of AF 3028 was determined by using a 3" x 8" beam flexure specimen with a splice made with AF 3028 located 2" from one end of the flexure specimen as shown below:



Adherends: 2024T-3 alclad aluminum, .063" thick.

Surface Preparation: FPL etch.

Face Sheet Adhesive: 3M™ Scotch-Weld™ Adhesive Film 163-2K 0.6 lb/ft^2.

Honeycomb Core: 8.1, 1/8" cell-1/2" thick – 5052 alloy – 2 mil foil – nonperforated.

Core Splice: 2" in from one end of specimen. Spliced with one layer of AF 3028.

Cure Cycle: 250°F (121°C) for 60 minutes, 40 psi pressure (rise rate shown below).

Test: 3" x 8" specimens tested for flexural shear strength using double point loading at .02"/minute. (Reference ASTM C-393).

Test Procedure:
Core shear strength determined according to ASTM-C-393 using the following conditions:

Load Pad: Double point loading.

Load Rate: 0.02"/minute.

Span: 6 inches.

$$\text{Core Shear (psi)} = \frac{P}{b\,(t + t_c)}$$

Where: P = Load at failure; b = beam width; t = specimens thickness; t_c = core thickness

Test Results:

	Flexural Shear			
Test Temperature	**1-2°F rise rate/minute**		**7-8°F rise rate/minute**	
	psi	**MPa**	**psi**	**MPa**
75°F (24°C)	815	(5.6)	857	(5.9)
220°F (104°C)	580	(4.0)	536	(3.7)

8. Flammability

A 0.120" thick by 1" wide cured specimen of AF 3028 FR was held in a vertical position for 15 seconds, 3/4" above a burner which had a 1.5 inch high flame (3M AdhD Test Method C-519). The flame in the specimen extinguished in an average of 4 seconds upon removal of the burner.

Product Application

The product performance data were developed using the following suggested procedures.

1. **Surface Preparation:**
   A thoroughly cleaned, dry, grease-free surface is recommended for maximum performance. Cleaning methods which will produce a breakfree water film on metal surfaces generally satisfactory.

   A. Aluminum Skins and Tubes (3M Test Method C-2803 or ASTM D 2651)

   1. Alkaline Degrease – Immerse skins in Oakite 164 solution (9-11 oz./gallon water) at 190 ± 10°F (82 to 93°C) for 15 ± 5 minutes. Rinse in generous quantities of clear running distilled, deionized, or tap water.
   2. Optimized FPL Etch Solution (1 liter)

Material	**Amount**
Distilled Water	700 ml plus balance of liter (see below)
Sodium Dichromate	28 to 67.3 grams
Sulfuric Acid	287.9 to 310.0 grams
Aluminum Chips	1.5 grams/liter of mixed solution

      To prepare 1 liter of this solution, dissolve sodium dichromate in 700 ml of distilled water. Add sulfuric acid and mix well. Add additional distilled water to fill 1 liter. Heat mixed solution to 150 to 160°F (66 to 71°C). Dissolve 1.5 grams of 2024 bare aluminum chips per liter of mixed solution. Gentle agitation will help aluminum dissolve in about 24 hours.

      To FPL etch panels, place them in the above solution at 150 to 160°F (66 to 71°C) for 12 to 15 minutes.

      Note: Review and follow safety and precautionary information provided by chemical supplier prior to preparation of this etch solution.
   3. Rinse – Rinse face sheets in clear running tap water.
   4. Dry – Air dry 15 minutes; force dry 10 minutes minimum at 140°F (60°C) maximum.

   B. Aluminum Honeycomb Core

   1. Soak in clean aliphatic naptha* (to conform to TT-N-95A) for five minutes at room temperature. Dry 10 minutes at 140°F (60°C) maximum.
   2. Optional – Immerse in acid etching solution above in A. for (2) minutes at 155 ± 5°F (66 to 71°C). Rinse, air dry and force dry in similar manner to skin panels.

   *When using solvents, extinguish all ignition sources and follow manufacturer's precautions and directions for use.

2. **Film:**
   Care should be taken to avoid contaminating adhesive and cleaned or primed aluminum by any substance which will hinder wetting action of the adhesive.

   A. Film Application

   1. Cut portion of film to be used from roll with protective liners in place.
   2. Remove liner from one side of the film.
   3. Place film on metal or edge or honeycomb core using the remaining liner as a protective cover.
   4. On metal surfaces, roll film into position with a rubber roller to insure that no air is trapped between film and metal.
   5. Remove second protective liner.
   6. Assemble parts and cure.

Product Application ***(continued)***

3. Cure Cycle:

A. General

The tack, flow, expansion, and cure initiation temperature for AF 3028 and AF 3028 FR is a time-temperature relationship and depends upon the rate of heat input.

Normally, the adhesive will begin to cure when a temperature of 225°F (107°C) is reached. The rate of heat input affects the degree of expansion.

A minimum cure temperature for 230°F (110°C) is suggested to effect a useful cure in reasonable length of time (approximately 90 minutes).

Full or partial vacuum applied during cure will cause excessive expansion of AF 3028 and AF 3028 FR.

Storage and Handling

Storage at 0°F (-18°C) or below is suggested for AF 3028 and AF 3028 FR to obtain maximum shelf life.

Care must be taken when handling the adhesive at low temperatures because it can easily crack. Warm the adhesive to ambient conditions in the sealed package to prevent moisture condensation on the adhesive surface.

3M Standard shelf life of AF 3028 and AF 3028 FR is 6 months from date of shipment from 3M when stored at 0°F (-18°C) or lower.

Precautionary Information

Refer to Product Label and Material Safety Data Sheet for health and safety information before using this product. For additional health and safety information, call 1-800-364-3577 or (651) 737-6501.

For Additional Information

To request additional product information or to arrange for sales assistance, call toll free (800) 235-2376. Our fax number is (417) 869-5219. Address correspondence to: 3M Aerospace Central, 3211 E. Chestnut Expressway, Springfield, MO 65802.

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ISO 9002

This Adhesives Division product was manufactured under a 3M quality system registered to ISO 9002 standards.

3M

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