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3M

Bonding Film

AF111 for Electronics Applications

Technical Data

March, 2004

Product Description

3M™ Bonding Film AF111 is an epoxy, thermoset film adhesive developed for structural bonding of metals and high-strength plastic materials (epoxy and phenolic).

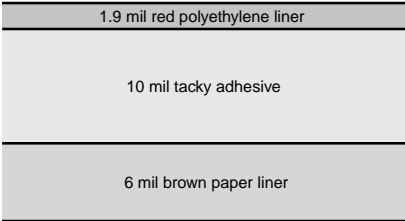
Bonding Film AF111 must be stored at or below 40°F (4°C) before use.

Key Features

- Moderate tack
- Thick 10 mil caliper
- 250°F (121°C) cure
- High metal OLS and peel adhesion
- High flow

Physical Properties Before Cure

Note: The following technical information and data should be considered representative or typical only and should not be used for specification purposes.

	Bonding Film AF111
Base Resin	Epoxy
Thickness	10 mil (0.25 mm)
Tack	Moderate
Color	Off-White
Construction	

Physical Properties After Cure

	Bonding Film AF111
Tensile (psi)	7200
Elongation (%)	10
Modulus (psi)	150,000

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Suggested Use Procedure

Room Temperature Work Life – 3M™ Bonding Film AF111 has a room temperature work life of 4 weeks. Work life is defined as the time at room temperature that the product will still yield the performance data summarized in this data sheet if bonds are made and tested per instructions.

Shelf Life – (usable life) of Bonding Film AF111 is:

- 4 weeks @ 70°F (21°C)
- 6 months @ 40°F (4°C)
- 12 months @ 0°F (-18°C)

Cure Conditions – The suggested curing condition for Bonding Film AF111 is 60 minutes at 250°F (121°C). The adhesive may be cured either under pressure or in a vacuum bag. Alternate suggested cure cycles are shown below.

Bondline Temperature	Time (in minutes)
235°F (113°C)	90
250°F (121°C)	60
275°F (135°C)	40
300°F (149°C)	35
325°F (163°C)	20
350°F (177°C)	10
400°F (204°C)	5

During cure, pressure is required to keep parts in alignment and in intimate contact. A minimum of 20 psi is suggested, but higher psi is acceptable if resultant flow during cure is not excessive.

Bondline Thickness – Unless otherwise specified, the bondline thickness used to generate the data in this data sheet was 10 mils. Since Bonding Film AF111 will flow when heated to its curing temperature (... and the higher the cure temperature, the more the flow...), it may be necessary to insert mechanical spacers (i.e., beads, wires, stops, etc.) in the bondline to maintain this thickness.

Cold Storage Removal – Important: During storage, Bonding Film AF111 should be wrapped/sealed in a polyethylene (or similar) wrap/bag. When removing the wrapped roll or sheets from cold storage, especially if stored below 32°F (0°C), ample time should be given before handling or overwrap removal to allow for the roll/sheets to acclimate to room temperature for two reasons:

- 1) to prevent moisture from condensing on the adhesive surface; and
- 2) to prevent cracking of the adhesive as it is brittle when cold.

Surface Preparation Prior to Bonding – A thoroughly cleaned, dry, grease-free surface is essential for maximum performance. Cleaning methods which will produce a break-free water film on metal surfaces are generally satisfactory.

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Suggested Use Procedure (continued)

Application of Film to Substrate:

- A. Cut a portion of film sufficient for the assembly from the stock roll with protective liner in place. Note earlier comment to bring adhesive to room temperature before use.
- B. Remove one liner and place the exposed adhesive against the substrate using the remaining liner as a protective cover.
- C. Position film and rub out all air between the adhesive and the substrate. Use of a rubber roller will facilitate this process.
- D. Remove second protective liner.
- E. Complete assembly and cure, being careful to avoid trapping air.

Typical Overlap Shear (OLS) Adhesions to Various Substrates

Note: The following technical information and data should be considered representative or typical only and should not be used for specification purposes.

Substrate	3M™ Bonding Film AF111 OLS
Al (etched)	5300 psi
Al (sanded, solvent wiped)	3500 psi
Al (scour pad abraded, solvent wiped)	3250 psi
Al (solvent wiped)	3100 psi
CRS (scour pad abraded, solvent wiped)	2450 psi
Stainless Steel (solvent wiped)	450 psi
FR-4 (solvent wiped)	1150 psi
LCP (solvent wiped)	300 psi
Polyimide Film	1750 psi
Polyester Film	1075 psi
Black E-coat	1150 psi
Phenolic Board	1100 psi
Ultem® 1000	650 psi
PEN Plastic	450 psi

- OLS values given in psi (pounds per square inch). ASTM D1002.
- Al (aluminum), CRS (cold rolled steel), FR-4 (printed circuit board substrate), LCP (liquid crystal polymer), and PEN (polyethylene naphthalate).
- Solvent wiped (MEK, alcohol)*; 3M™ Scotch-Brite™ Scour Pad (green) abraded; sanded (600 grit sandpaper).
- OLS bonds were 1" x 0.5" and tested at 0.2"/minute.
- Bonds were cured 60 minutes (+ 7 minutes ramp time) at 250°F (121°C).
- The polyimide and polyester films were overbonded to CRS using 3M™ Scotch-Weld™ Epoxy Adhesive DP-190.

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

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Typical Peel Adhesion to Various Substrates

Note: The following technical information and data should be considered representative or typical only and should not be used for specification purposes.

Substrate	3M™ Bonding Film AF111 Peel
Al (etched)	38 piw
Al (sanded, solvent wiped)	36 piw
Al (scour pad abraded, solvent wiped)	36 piw
Al (solvent wiped)	36 piw
CRS (scour pad abraded, solvent wiped)	35 piw
Stainless Steel (solvent wiped)	3 piw
FR-4 (solvent wiped)	33 piw
LCP (solvent wiped)	3.5 piw
Polyimide Film	20 piw
Polyester Film	3 piw
Black E-coat	34 piw
Phenolic Board	19 piw
Ultem® 1000	26 piw
PEN Plastic	14 piw
Borosilicate Glass	1 piw

- 90° peel test of 1/2" wide, 4 mil thick etched aluminum foil bonded to each test substrate.
- Peel rate 2"/minute.
- Peel values given in piw (pounds per inch width). ASTM D1876.
- Al (aluminum), CRS (cold rolled steel), FR-4 (printed circuit board substrate), LCP (liquid crystal polymer), and PEN (polyethylene naphthalate).
- Solvent wiped (MEK, alcohol)*; 3M™ Scotch-Brite™ Scour Pad (green) abraded; sanded (600 grit sandpaper).
- Bonds were cured 60 minutes (+ 7 minutes ramp time) at 250°F (121°C).
- The polyimide and polyester films were overbonded to CRS using 3M™ Scotch-Weld™ Epoxy Adhesive DP-190.

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

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Adhesion Retention Values After Environmental Aging

Note: The following technical information and data should be considered representative or typical only and should not be used for specification purposes.

Aging Parameters	3M™ Bonding Film AF111 Peel*
30 days at room temperature (control)	33 piw
30 days at 160°F (71°C) oven	33 piw
30 days at 120°F (49°C)/100% RH	32 piw
30 days immersion in distilled water	35 piw
Hot/cold cycling	33 piw

- * Peel bonds consisted of 10 mil etched aluminum strips bonded to 0.047" FR-4. Panels were cured 60 minutes + 7 minutes (ramp time) at 250°F (121°C) and peeled at 2"/minute speed.
- Hot/cold cycle was 17 hours at 120°F (49°C) and 5 hours at -5°F (-21°C) with one hour at room temperature between temperature changes.

Aging Parameters	Bonding Film AF111 OLS*
30 days at room temperature (control)	2300 psi
30 days at 160°F (71°C) oven	2600 psi
30 days at 120°F (49°C)/100% RH	1200 psii
30 days immersion in distilled water	1600 psi
Hot/cold cycling	2400 psi

- * OLS (overlap shear) bonds consisted of 3M™ Scotch-Brite™ Scour Pad (green) abraded CRS to CRS, cured 60 minutes + 7 minutes (ramp time) at 250°F (121°C) and tested at 0.2"/minute speed.
- Hot/cold cycle was 17 hours at 120°F (49°C) and 5 hours at -5°F (-21°C) with one hour at room temperature between temperature changes.

Solvent Resistance of Cured Films After 60 Days Immersion at RT

Aging Parameters	Bonding Film AF111
Isopropyl Alcohol	No Attack
Methyl Ethyl Ketone	No Attack
Heptane	No Attack
3M™ Citrus Base Cleaner	No Attack

- Samples were cured according to data sheet instructions [60 minutes at 250°F (121°C)] and immersed in test solvents.
- After 60 days, samples were removed, dried, and examined for swelling and surface attack.

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Overlap Shear and Peel Adhesion Tested at Various Temperatures

Note: The following technical information and data should be considered representative or typical only and should not be used for specification purposes.

Test Temperature	3M™ Bonding Film AF111 OLS
-67°F (-55°C)	2700 psi
75°F (24°C)	2300 psi
180°F (82°C)	2700 psi
250°F (121°C)	2250 psi

Test Temperature	Bonding Film AF111 Peel
-67°F (-55°C)	25 piw
75°F (24°C)	33 piw
180°F (82°C)	33 piw
250°F (121°C)	20 piw

- OLS bonds were 0.5" x 1" (CRS, 3M™ Scotch-Brite™ Scour Pad [green] abraded, solvent wiped).
- Peel bonds were 0.5" wide, 10 mil etched aluminum strips bonded to 0.047" FR-4 board.
- Both OLS and peel bonds were made and tested in similar fashion described in previous sections.

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Electrical Properties

Note: The following technical information and data should be considered representative or typical only and should not be used for specification purposes.

Test	Method	3M™ Bonding Film AF111
Dielectric Constant	ASTM D-150	4.2 @ 1 kilohertz 4.0 @ 10 kilohertz 3.9 @ 100 kilohertz
Dissipation Factor	ASTM D-150	.005 @ 1 kilohertz .007 @ 10 kilohertz .011 @ 100 kilohertz
Dielectric Breakdown Strength	ASTM D-149	650 volts/mil (10 mil)
Volume Resistivity	ASTM D-257	4.1 x 10 ¹⁶ ohm-cm (10 mil)

Thermal Properties

Test	Bonding Film AF111
Weight Loss by TGA (Thermal gravimetric analysis) @ 10°C/min.	1% wt loss @ 196°C 5% wt loss @ 329°C 10% wt loss @ 364°C
Coefficient of Thermal Expansion by TMA (units/unit/°C @ 10°C/min.)	28 x 10 ⁻⁶ (-60 to 40°C)* 67 x 10 ⁻⁶ (-60 to 110°C)**
Tg (glass transition temperature) by TMA @ 10°C/min.	onset @ 107°C*
Tg by DSC @ 5°C/min.	midpoint @ 118°C* midpoint @ 114°C**

* 1st heat values

** 2nd heat values

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Storage Requirements 40°F (4°C) / 6 months from date of shipment from 3M.
0°F (-18°C) / 12 months from date of shipment from 3M.

Cleanup Uncured 3M™ Bonding Film AF111 can be removed using acetone, MEK or 3M™ Citrus Base Cleaner.*

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

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 1-800-251-8634. Address correspondence to: 3M Electronics Markets Materials Division, Building 21-1W-10, 900 Bush Avenue, St. Paul, MN 55144-1000. Our fax number is 651-733-9175. In Canada, phone: 1-800-364-3577. In Puerto Rico, phone: 1-787-750-3000. In Mexico, phone: 52-70-04-00.

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