3M™ Thermal Bonding Film 588

Product Description

3M™ Thermal Bonding Film 588 is a high strength, flexible, nitrile phenolic based thermosetting adhesive film. It can be heat or solvent activated for bonding. It can also be lightly crosslinked using a post heat exposure.

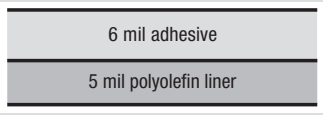
3M TBF 588 must be stored at or below 4°C (40°F) for maximum storage life.

Key Features

- Flexible
- Heat or solvent activation
- Heat crosslinkable option
- Can be die-cut

Typical Physical Properties

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

Product	3M™ Thermal Bonding Film 588	
Base Resin	Nitrile phenolic	
Adhesive Thickness	6 mil (0.15 mm)	
Tack	None	
Color	Yellow	
Construction		
	Before Crosslinking	**After Crosslinking**
Tensile (psi)	2,300	2,700
Elongation (%)	250	35
Modulus (psi)	6,700	21,800
2 Lb. Dead Load Overlap Shear Heat Resistance	85°C (180°F)	>149°C (300°F)

- Tensile and elongation conducted on Sintech 5/GL at 0.2"/minute speed. ASTM D638.
- 2 lb. dead load overlap shear conducted in oven environment (reference ASTM D4502-85).

Application Equipment Suggestions

Note: Appropriate application equipment can enhance bonding film performance. We suggest the following equipment for the user's evaluation in light of the user's particular purpose and method of application.

The type of application equipment used to bond 3M™ Thermal Bonding Film 588 will depend on the application involved and on the type of equipment available to the user. Thin films and flexible substrates can be bonded using a heated roll laminator where heat and pressure can be varied to suit the application. Larger, thicker substrates can be bonded using a heated static press or, in some cases, an autoclave. For applications where a shaped adhesive is to be transferred to a flat or three-dimensional part, a hot shoe or thermode method may be appropriate.

It is recommended that whatever method of bonding is chosen by the user, the optimum bonding conditions should be predetermined with substrates specific to user's application.

Directions For Use – Heat Activation

To make a bond using 3M TBF 588, remove the liner and place the adhesive film between the two substrates. The bond is then made through heat and pressure using a heated press, a hot roll laminator, a hot shoe thermode method or similar equipment.

Alternatively, the adhesive can be first tacked (lightly bonded) to one of the substrates using low heat, the liner can then be removed and second substrate placed to the exposed adhesive surface, and a bond made using heat and pressure.

Suggested TACKING Conditions

38°C to 49°C (100°F to 120°F) bondline temperature

2-5 seconds dwell time

5-20 psi pressure

For optimum bonding, the heat, pressure and dwell time for using 3M TBF 588 will depend upon the type and thickness of the substrates being bonded together.

A suggested starting point, however, is to use the bonding conditions described below.

Suggested BEGINNING Bonding Conditions

107°C to 149°C (225°F to 300°F) bondline temperature

2-5 seconds dwell time

15-20 psi pressure

Directions For Use – Heat Activation (continued)

One approach to establishing the correct/optimum bonding conditions for a user's application is to evaluate a series of bonding temperatures, for example 93, 107, 121, 135 and 149°C (200, 225, 250, 275 and 300°F). Time and pressure will be dictated by the thickness of the substrate and the type of substrate being bonded. Thicker substrates and surfaces that may be more difficult to bond will require longer times, higher pressures and higher temperatures. **If voids are experienced in the bondline, they can be minimized by increasing pressure.**

Once the bond is made, the bondline should be allowed to cool somewhat before stress is applied to the bond. Generally, cooling the bondline below 66°C (150°F) is adequate to allow the bonded parts to be unfixtured/unclamped and handled.

For reference, the following table shows typical bond strengths for bonds made at various temperatures. Such data can be used to evaluate optimum bondline temperatures. **It is important to note that this table is valid only for the specific substrates shown.** Varying temperature, pressure, or substrates can affect bond strengths. **User should develop a similar table with substrates specific to user's application.**

Note: Temperatures shown are bondline temperatures and not heat block or roll settings!

90° Peel Strengths of Bonds made at Various Temperatures (2 and 20 sec. Dwell at Bondline Temperature) using 3M™ Thermal Bonding Film 588

Bondline Temperature	FR-4 / Aluminum		CRS / Aluminum	
	2 sec.	20 sec.	2 sec.	20 sec.
24°C (75°F)	6 piw	4 piw	1 piw	1 piw
35°C (95°F)	6 piw	4 piw	1 piw	1 piw
46°C (115°F)	6 piw	5 piw	2 piw	3 piw
57°C (135°F)	6 piw	6 piw	4 piw	3 piw
68°C (155°F)	8 piw	9 piw	4 piw	4 piw
79°C (175°F)	12 piw	12 piw	4 piw	5 piw
90°C (195°F)	14 piw	18 piw	6 piw	5 piw
101°C (215°F)	17 piw	20 piw	7 piw	6 piw
113°C (235°F)	22 piw	20 piw	7 piw	6 piw
124°C (255°F)	24 piw	20 piw	8 piw	7 piw
135°C (275°F)	25 piw	24 piw	8 piw	7 piw
146°C (295°F)	25 piw	24 piw	13 piw	7 piw
157°C (315°F)	26 piw	24 piw	13 piw	7 piw
168°C (335°F)	27 piw	26 piw	13 piw	7 piw
179°C (355°F)	26 piw	32 piw	15 piw	7 piw

- Peel values given in piw (pounds per inch width). ASTM D1876.
- Peel bonds were 1/2" wide using 4 mil etched aluminum bonded to either FR-4 printed circuit board substrate (alcohol wiped) or cold rolled steel (MEK wiped).* Bonds made on Sencorp device using 20 lbs. pressure.

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

Directions For Use – Solvent Activation

There are advantages and disadvantages with heat and solvent activation. Under normal conditions, heat activation is the suggested method of bonding and will provide the greatest immediate adhesion strength. However, solvents such as MEK, toluene and/or acetone can also be used to activate bonding if user is working with substrates that are heat-sensitive or have irregular surface or shape.*****

The solvent may be applied to the film by brushing, wiping, spraying or dipping. It is important that the solvent be allowed sufficient activating time to solvate the adhesive and bring it to a tacky, pressure sensitive state (typically 10-30 seconds). Adhesive legs should appear during touch-testing before substrate is bonded. Bonding should occur before tackiness disappears. If film is too wet, substrate may slip from bonding position; if too dry, a good bond may not develop.

When a solvent activation method is used, maximum adhesion strength will not be achieved immediately because it will be related to the drying time of solvent from the adhesive. If the bond undergoes natural drying in ambient temperatures, bond build-up may continue for 30 days until maximum adhesion is achieved. If the bond is exposed to constant low heat (~ 66°C/ 150°F) after initial solvent activation, maximum adhesion can often be reached within 24-30 hours.

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

Directions For Use – Crosslinking

3M™ Thermal Bonding Film 588 may also be slightly crosslinked to enhance adhesion performance. Crosslinking of this film can typically be achieved by heating the bondline at 177°C (350°F) for five minutes.

Note: All reported data has not undergone crosslinking unless otherwise stated.

Typical Performance Characteristics

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

Adhesion to Various Substrates Using 3M™ Thermal Bonding Film 588		
Test Substrate	**Overlap Shear (OLS)**	**90° Peel**
Aluminum (solvent wiped)	340 psi	6 piw
Aluminum (etched)	880 psi	20 piw
Aluminum (sanded, solvent wiped)	720 psi	17 piw
Aluminum (scour pad abraded, solvent wiped)	650 psi	13 piw
FR-4 (printed circuit board substrate)	920 psi	26 piw
Phenolic Board	670 psi	18 piw
Cold Rolled Steel	450 psi	10 piw
Stainless Steel	NT	7 piw
ABS (acrylonitrile-butadiene-styrene)	NT	20 piw
Ultem 1000 (polyetherimide)	NT	22 piw
Soda Lime Glass	NT	17 piw
PVC (polyvinyl chloride)	NT	23 piw
Acrylic	NT	12 piw
Polypropylene	NT	<1 piw
HDPE (high density polyethylene)	NT	<1 piw
HIPS (high intensity polystyrene)	NT	<1 piw
EPDM (ethylene-propylene-diene monomer rubber)	NT	2 piw
Neoprene (Shore A60)	NT	3 piw
Nitrile (Shore A60)	NT	5 piw
SBR (styrene butadiene resin)	NT	14 piw
DuPont™ Kapton® 200E (polyimide film)	NT	6 piw
PET (polyester film)	NT	3 piw
PEN (polyethylene naphthalate film)	NT	4 piw
Denim Fabric	NT	14 piw

- "NT" represents "Not Tested".
- OLS values given in psi (pounds per square inch). ASTM D1002. Peel values given in piw (pounds per inch width). ASTM D1876.
- OLS bonds were 1" x 1" using 20 mil etched aluminum bonded to each test substrate. Sintech 5/GL shear rate was 0.2"/minute.
- Peel bonds were 1/2" wide using 4 mil etched aluminum bonded to each test substrate. Sintech 5/GL peel rate was 2"/minute.
- Solvent wiped (MEK or alcohol)*; 3M™ Scotch-Brite™ Scour Pad (green) abraded; sanded (500 grit sandpaper).
- Samples were bonded on Sencorp device for 5 seconds dwell (+10 seconds ramp time) at 157°C (315°F), 20 pounds pressure.

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

Typical Performance Characteristics (continued)

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

Adhesion Strength after Environmental Aging using 3M™ Thermal Bonding Film 588		
Aging Pameters	**Overlap Shear FR-4 / FR-4**	**90° Peel FR-4 / Aluminum**
30 days at room temperature (control)	1280 psi	24 piw
30 days at 71°C (160°F) oven	1200 psi	37 piw
30 days at 49°C (120°F) oven/100% RH	1100 psi	26 piw
30 days immersion in distilled water	1200 psi	24 piw

- OLS values given in psi (pounds per square inch). ASTM D1002. Peel values given in piw (pounds per inch width). ASTM D1876.
- OLS bonds were 1" x 1" using FR-4 printed circuit board substrate bonded to FR-4 (alcohol wiped)*. Sintech 5/GL shear rate was 0.2"/minute.
- OLS samples were oven bonded at 157°C (315°F) for 30 minutes. Sample was clamped between 63 mil aluminum using two #50 binder clips during bonding process.
- Peel bonds were 1/2" wide using 4 mil etched aluminum bonded to FR-4 (alcohol wiped). Sintech 5/GL peel rate was 2"/minute.
- Peel samples were bonded on Sencorp device for 5 seconds dwell (+10 seconds ramp time) at 157°C (315°F), 15 pounds pressure.

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

Adhesion Strength TESTED at Various Temperatures using 3M™ Thermal Bonding Film 588				
	OVERLAP SHEAR			
	FR-4 / Aluminum		**CRS / Aluminum**	
Test Temperature	**No X-link**	**X-linked**	**No X-link**	**X-linked**
-55°C (-67°F)	420 psi	1100 psi	60 psi	1020 psi
24°C (75°F)	1040 psi	890 psi	480 psi	800 psi
121°C (250°F)	40 psi	135 psi	8 psi	90 psi
	90 DEGREE PEEL			
	FR-4 / Aluminum		**CRS / Aluminum**	
Test Temperature	**No X-link**	**X-linked**	**No X-link**	**X-linked**
-55°C (-67°F)	3 psi	14 psi	<1 psi	6 psi
24°C (75°F)	24 psi	21 psi	5 psi	8 psi
121°C (250°F)	2 psi	5 psi	2 psi	4 psi

- OLS values given in psi (pounds per square inch). ASTM D1002. Peel values given in piw (pounds per inch width). ASTM D1876.
- OLS bonds were 1" x 1" using either FR-4 printed circuit board (alcohol wiped) or cold rolled steel (MEK wiped)* bonded to 20 mil etched aluminum. Sintech 5/GL shear rate was 0.2"/minute.
- Peel bonds were 1/2" wide using either FR-4 printed circuit board (alcohol wiped) or cold rolled steel (MEK wiped) bonded to 4 mil etched aluminum. Sintech 5/GL peel rate was 2"/minute.
- Samples not crosslinked ("no x-link") were bonded on Sencorp device for 5 seconds dwell (+10-15 seconds ramp time) at 149°C (300°F), 20 pounds pressure.
- Crosslinked ("x-linked") samples underwent Sencorp bond previously stated, plus oven bond at 177°C (350°F) (8 minutes ramp time and 5 minutes dwell at temperature). Sample was clamped between 63 mil aluminum using two #50 binder clips during bonding process.

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

Electrical Data

Test	Method	Before X-Link	After X-Link
Dielectric Constant @ 1kHz	ASTM D-150	4.1	6.4
Dissipation Factor @ 1 kHz	ASTM D-150	.097	.026
Dielectric Breakdown Strength (volts/mil)	ASTM D-149	1200 (on 5.5 mil)	1260 (on 5 mil)
Surface Resistivity (ohms/sq.)	ASTM D-257	3.20×10^{10}	8.20×10^{11}
Volume Resistivity (ohms-cm.)	ASTM D-257	3.79×10^{10}	8.32×10^{11}

Thermal Data

Test	Method	Before X-Link		After X-Link
Weight Loss by TGA (Thermogravimetric analysis)	Perkin-Elmer Series 7 RT to 600°C, 10°C/min. in air	1% wt. loss 5% wt. loss 10% wt. loss	117°C 198°C 364°C	217°C 381°C 412°C
Coefficient of Thermal Expansion by TMA (Thermomechanical analysis)	Perkin-Elmer Series 7 -40°C to 125°C @ 10°C/min. (2 heat cycles, 2nd cycle reported)	Below Tg CTE/°C Above Tg CTE/°C	192×10^{-6} 512×10^{-6}	— 271×10^{-6}
Tg (extrapolated onset)	Perkin-Elmer Series 7 -40°C to 125°C @ 10°C/min.	8°C		23°C

Storage

Store product at or below 4°C (40°F) for maximum storage life. Higher temperatures reduce normal storage life.

Shelf Life

Shelf life is 6 months from date of shipment at 23°C (75°F) and 18 months from date of shipment at 4°C (40°F).

Important Note

Please consult Federal, State, and Local Regulations. State Volatile Organic Compound (VOC) regulations may prohibit the use of certain alcohol solutions or solvents. You should check with your state environmental authorities to determine whether use of a solution or solvent is restricted or prohibited.

Regulatory

For regulatory information about this product, contact your 3M representative.

Technical Information

The technical information, recommendations and other statements contained in this document are based upon tests or experience that 3M believes are reliable, but the accuracy or completeness of such information is not guaranteed.

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3M

Electronics Materials Solutions Division
3M Center, Building 224-3N-11
St. Paul, MN 55144-1000
1-800-251-8634 phone
651-778-4244 fax
www.3M.com/electronics

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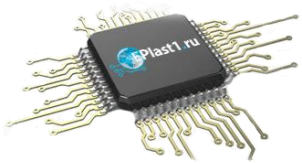

Как с нами связаться

Телефон: 8 (812) 309 58 32 (многоканальный)
Факс: 8 (812) 320-02-42
Электронная почта: org@eplast1.ru
Адрес: 198099, г. Санкт-Петербург, ул. Калинина, дом 2, корпус 4, литера А.