

3M

Scotch-Weld™

Structural Adhesive Film

AU-200

Technical Data

April, 2005

Introduction

3M™ Scotch-Weld™ Structural Adhesive Film AU-200 designates a family of thermosetting modified epoxy structural adhesives in film form which are available in two weights with a supporting carrier. 3M™ Scotch-Weld™ AU-200 films are designed for both solid panel and honeycomb sandwich constructions.

Advantages

- High bond strength from -67°F to 250°F
- High fracture toughness and peel strength
- Excellent resistance to high moisture environments before and after curing
- Short cure time at 225°F (90 minutes)
- Capable of low pressure bonding
- Vacuum cure capability
- Excellent shop open time and long shelf life

Description

The following 3M™ Scotch-Weld™ AU-200 products are included in this data sheet:

Product	Weight (± .005) Lbs./Ft.	Color	Nominal Thickness - mils
3M™ Scotch-Weld™ AU-200	0.060	Red	9.5
3M™ Scotch-Weld™ AU-200	0.085	Blue	13

Scotch-Weld™ Structural Adhesive Film AU-200

Product Performance

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

I. Typical 3M™ Scotch-Weld™ Structural Adhesive Film AU-200 Cured Free Film (unsupported) Properties: (cured 60 minutes at 250°F)

Property	Typical Value	Method
Glass Transition (Tg) Temperature Dry Wet (14 days in 70°C water)	226°F (108°C) 180°F (82°C)	DuPont™ 1090 DMA @ 5°C/min ramp
Thermal Conductivity @ 43°C	.096 $\frac{\text{btu-ft}}{\text{ft}^2 \text{ hr } ^\circ\text{F}}$	ASTM C-177
Thermal Coefficient of Expansion @ -30 to 50°C	$90 \times 10^{-6} \frac{\text{in}}{\text{in } ^\circ\text{C}}$	TMA @ 5°C/min
Volume Resistivity	4.4×10^{14} ohm-cm	ASTM D-257
Dielectric Strength @ 1 KHz @ 75°F (23°C)	1800 volt/mil	ASTM D-149

Tensile Strength and Modulus (ASTM D-638)

Cured: Free Film Strips approx. 1/4" x 3" x .01" thick

Cure: 90 minutes at 235°F

Temperature	Ultimate Strength (psi)	Modulus (psi)
-67°F	11,000	2.3×10^5
75°F	7,000	1.6×10^5
180°F	3,000	6×10^4

A. 75°F Bulk Modulus, Shear Modulus, and Poisson's Ratio – knit supported

17 ply laminate ~ 0.1 inches thick (ASTM D-3039) cure – 60 minutes at 250°F

Modulus Elasticity 161×10^3 psi

Shear Modulus 60×10^3 psi

Poisson's Ratio 0.34

B. Self Extinguishing Characteristics: knit supported

Method: FAR 25.853 – **Sample:** 1/4" x 1/2" x 4"

Cure: 60 minutes at 250°F

Sample Orientation	Flame Exposure Time (Seconds)	Self-Extinguishing Time (Seconds)
1. 4" length horizontal and 1/2" dimension vertical	15	0.5
2. 4" length horizontal and 1/2" dimension vertical	60	3.7
3. 4" length vertical	15	6.3
4. 4" length vertical	60	70

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Product Performance
(continued)

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

II. Typical Cured Bond Properties

A. Metal to Metal Overlap Shear Strength (psi) – 3M Test Method C-244 or ASTM D-1002

1. Cure Cycle: 250°F, 60 minutes, 20 psi, 1°F/minute rise rate

Primer: 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3917

Metal: 2024 T-3 ALCLAD .063" thick – unsealed Chromic Acid Anodized

Test Temperature	3M™ Scotch-Weld™ Structural Adhesive Film AU-200	
	(.06 lb/ft²)	(.085 lb/ft²)
-67°F	6200	5100
75°F	5800	5400
180°F	3800	3800

2. Cure Cycle: 250°F, 90 minutes, 25 psi, 4°F/minute rise rate

Primer: None

Metal: 2024 T-3 Bare .063" thick – FPL etched

Test Temperature	3M™ Scotch-Weld™ AU-200 (.085 lb/ft²)
-67°F	6430
75°F	5990
180°F	4600

B. Metal to Metal T-Peel Strength (piw) – 3M Test Method C-252

Cure Cycle: 250°F, 60 minutes, 20 psig, 1°F/min. rise rate

Primer: 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3917

Metal: 2024 T-3 clad .020" thick aluminum – unsealed Chromic Acid Anodized

Peel Rate: 20"/min.

Test Temperature	3M™ Scotch-Weld™ AU-200	
	(.06 lb/ft²)	(.085 lb/ft²)
-67°F	33	20
75°F	45	41
180°F	38	35
250°F	28	20

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

**C. Metal to Metal Floating Roller (Bell) Peel Strength (piw) –
3M Test Method C-260**

- 1. Cure Cycle:** 270°F, 60 minutes, 50 psi, 1°F/min. rise rate
- Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3924B
- Metal:** 2024 T-3 Bare FPL etched .025" to .063" aluminum
- Peel Rate:** 6"/min.

Test Temperature	3M™ Scotch-Weld™ Structural Adhesive Film AU-200 (.06 lb/ft²)
-67°F	78 piw
75°F	78 piw
180°F	78 piw

**D. Metal to Metal Climbing Drum Peel Strength (in•lb/in) –
3M Test Method C-2222**

- Cure Cycle:** 235°F, 90 minutes, 35 psig, 5°F/min. rise rate
- Primer:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3960
- Metal:** 2024 T-3 clad aluminum .020" to .040" FPL etched
- Peel Rate:** 3"/min. (cross head speed)
- Test Temperature:** 75 ± 5°F

Adhesive	Peel Strength (in•lb/in)
3M™ Scotch-Weld™ AU-200 (.06 lb/ft²)	80

**E. Metal to Honeycomb Climbing Drum Peel Strength (in•lb/in) –
3M Test Method C-245**

- 1. Cure Cycle:** 250°F, 60 minutes, 20 psi, 1°F/min. rise rate
- Primer for Skins:** 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3917
- Skins:** 2024 T-3 0.020" thick aluminum – Chromic Acid Anodized
- Core:** 1/4" cell – 1/2" thick – 4 mil foil – 5052 alloy – non perforated
- Test Rate:** 1.0"/min. (cross head speed)

Test Temperature	Peel Strength (in•lb/in)
	3M™ Scotch-Weld™ AU-200 (.06 lb/ft²)
-67°F	20
75°F	23
180°F	18
250°F	9

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

F. Typical Bond Strengths on Other Substrates

Adhesive: 3M™ Scotch-Weld™ Structural Adhesive Film AU-200

Primer: 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3924B

Cure Cycle: 250°F, 60 minutes, 30 psig, 5°F/min. rise rate

Substrates	3M Test Method C-244 L/T = 8 Shear (psi)		3M Test Method C-260 6"/min. Floating Roller Bell Peel (piw)
	75°F	180°F	75°F
7575 T6 Clad	.063" Thick Metal		.025" Thick Metal Peel Skin
FPL - Etch	6050	3500	65
6, 4 Titanium	.063" Thick Metal		.014" Thick Metal Peel Skin
Phosphate Fluoride Etch	6825	3650	45
301 Stainless Steel	.063" Thick Metal		.020" Thick Metal Peel Skin
Phosphate Fluoride Etch	6260	3750	60

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

III. Typical Performance after Environmental Exposure

A. Metal to Metal Overlap Shear Strength (psi) – 3M Test Method C-244

Cure Cycle: 250°F, 60 minutes, 30 psig, 5°F/min. rise rate

Primer: 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3924B

Metal: 7075 T-6 clad 0.063" thick – Chromic Acid Anodized

Adhesive: 3M™ Scotch-Weld™ Structural Adhesive Film AU-200 (.085 lb/ft²)

Specimens: Precut to 1" width prior to exposure

Test Temperature: 75°F

Environmental Exposure	Shear Strength (psi)
1. Control (No Exposure)	6345
2. 7 day immersion in JP-4	6570
3. 7 day immersion in Mil-F-5566	6365
4. 7 day immersion in Mil-H-5606	6465
5. 7 day immersion in Type III Hydrocarbon	6510
6. 30 day water immersion	5860
7. 30 day 5% Salt Spray Exposure	5930
8. Cyclic Humidity Exposure a) 15 Cycles	6245
b) 30 Cycles	5510
c) 45 Cycles	5655

*Each Cycle: 16 hours at 125°F at 95-100% RH followed by 8 hours at -67°F.

IV. Typical Vacuum Cure Performance

Cure: 250°F, 60 minutes, 5°F/min. rise rate

Primer: 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3960

Overlap Shear: 3M Test Method C-244: 2024 T-2 .063" thick aluminum

Honeycomb Peel: 3M Test Method C-245: 1/4" cell Core – 2024 T-3 .020" thick aluminum skins

Peel Rate: 3"/min. (cross head speed)

Pressure or Vacuum	3M™ Scotch-Weld™ AU-200 (.06 lb/ft ²)	
	Overlap Shear 75°F (psi)	Honeycomb Peel 75°F (in•lb/3")
A. 25 psig positive pressure	5700	77
B. 9-11" Hg	5700	65
C. 16-18" Hg	3800	54
D. 24-26" Hg	3300	45

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Product Application

Note: While this information is provided as a general application guideline based upon typical conditions, it is recognized that no two applications are identical due to differing assemblies, method of heat and pressure application, production equipment and other limitations. It is therefore suggested that experiments be run, within the actual constraints imposed, to determine optimum conditions for your specific application and to determine suitability of product for particular intended use.

I. Surface Preparation

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.

A. Aluminum: Phosphoric acid anodize (3M Test Method C-2780), Chromic acid anodize with or without a chromate seal (3M Test Methods C-2801 or C-2782) are preferred for maximum joint durability in moist environments. Optimized FPL Etch has also demonstrated improved durability performance. Optimized FPL Etch – 3M Company (3M Test Method C-2803 or ASTM D-2651)

1. Alkaline degrease – Oakite* 164 solution 9-11 oz./gallon of water at 190°F ± 10°F for 10 to 20 minutes. Rinse immediately in large quantities of cold running water (3M Test Method C-2802).

*Available from Oakite, Berkeley Heights, NJ.

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

Note: Review and follow safety and precautionary information provided by chemical supplier prior to preparation of this etch 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 to 1 liter. Heat mixed solution to 150°F to 160°F (66°C 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°F to 160°F (66°C to 71°C) for 12 to 15 minutes.

3. Rinse immediately in large quantities of clear running tap water.
4. Dry – Air dry approximately 15 minutes followed by a force dry at 140°F (maximum).
5. Current theory suggests that both surface structure and chemistry play a significant role in determining the strength and permanence of bonded structure. It is therefore advisable to bond or prime freshly cleaned surfaces as early as possible after preparing to avoid contamination and/or mechanical damage.

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Product Application (continued)

B. Aluminum Honeycomb Core

1. Soak in clean aliphatic naphtha (conforming to TT-N-95A) for five minutes at room temperature. Dry 10 minutes at 140°F (maximum).
2. Optional – Immerse in etching solution above for 2 minutes 155°F ± 5°F. Rinse, air dry and force dry in a similar manner to skins.

C. Titanium CP or 6Al 4V both Turco 5578* and improved phosphate fluoride processing have been used successfully with 3M™ Scotch-Weld™ Structural Adhesive Film AU-200.

1. Vapor hone 140 grit in water – rinse thoroughly with clear running tap water.
2. Degrease – solvent or alkaline process.
3. Immerse for 15 minutes at 185°F ± 5°F in the following bath:
Turco 5578 – 420 grams
Distilled water – Balance to make 1 liter
4. Immerse for 1 minute in 170°F ± 5°F distilled water.
5. Spray rinse for 5 minutes in hot tap water ~ 130°F.
6. Air dry for 10 to 20 minutes.
7. Force dry for 15 minutes at 140°F (maximum).
8. It is advisable to bond or prime freshly cleaned surfaces within four hours.

D. Stainless Steel – Type 301

1. Vapor hone 140 grit in water.
2. Rinse thoroughly in clear running tap water.
3. Alkaline degrease – see procedure above.
4. Rinse thoroughly in clear running tap water.
5. Immerse for 10 minutes at 75°F ± 5°F in the following bath:
Distilled Water 73-95 oz/gal
Nitric Acid 42° Be 30-50 oz/gal
Hydrofluoric Acid 70% 3-5 oz/gal
6. Rinse thoroughly in clear running tap water.
7. Air dry for 10-20 minutes.
8. Force dry for 15 minutes at 150°F.
9. Bond or prime within four hours after preparing.

E. Cured fiberglass or carbon fiber reinforced epoxy resin based reinforced plastic.

1. Abrade with 180 grit paper or Scotch-Brite™ Scour Pad (do not cut through resin into reinforcing fibers).
2. Degrease using acetone or MEK using an unsized cheesecloth pad.
3. Air dry for two hours minimum.

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Product Application (continued)

II. Primers

For most applications, use of a corrosion inhibiting primer is suggested to obtain maximum bond durability in moist, corrosive environments. 3M™ Scotch-Weld™ Structural Adhesive Primers EC-3924B, EC-3960, EC-3980 and EC-3917 have all been successfully used with 3M™ Scotch-Weld™ Structural Adhesive Film AU-200.

III. Primer Coverage

For the primers noted above, the optimum mechanical property test performance with 3M™ Scotch-Weld™ AU-200 will normally be found with a uniform primer coverage in the 1-3 g/m² range (dry weight). This is approximately 0.1 mils as measured by an Isometer. As the primer weight is increased a gradual decrease in low temperature peel strength will be found along with increasing levels of cohesive fracture in the primer layer (exception: properly controlled 180° T-Peel does not normally show this effect). Where specific tests and required strength levels are involved, a few simple experiments with varied primer coverage will be required to establish an allowable primer coverage range. Further applications can then be controlled by correlating color or thickness standards for the acceptable range.

IV. Primer Dry

The following cycle is suggested for these primers when used with 3M™ Scotch-Weld™ AU-200 film:

Air dry: 60 minutes followed by a

Force dry: 60 minutes at 250°F to 300°F.

Normally optimum performances will be found at the higher end of the force dry temperature range when used with 3M™ Scotch-Weld™ AU-200 film.

Note: Use of these primers without a force dry is not recommended in conjunction with 3M™ Scotch-Weld™ AU-200 film and is subject to very strict limitations. Consult your 3M Sales Representative.

V. Adhesive Film Application

Care should be taken during application to avoid contamination of the adhesive and substrates by any substances which will interfere with the wetting action of the adhesive.

Layup:

A. 3M™ Scotch-Weld™ AU-200 Film

1. Cut a portion of film sufficient for the assembly from the stock roll with protective liner(s) in place.
2. If the film has one protective liner, place the exposed adhesive against the substrate using the liner as a protective cover. If two liners are present, remove one and follow as above.
3. Position film and rub out all air between the adhesive and the substrate. Use of a rubber roller will facilitate this process.
4. Remove protective liner.
5. Complete assembly being careful to avoid trapping air and cure.

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Product Application
(continued)

VI. Cure Conditions & Characteristics

3M™ Scotch-Weld™ Structural Adhesive Film AU-200 is designed to provide short cure times in the 225°F to 300°F temperature range. While performance outside this cure temperature range has not been fully investigated, limited results suggest that cure temperatures as high as 350°F may be used as well as longer cure times at 200°F (6 hrs.) to obtain useful performance.

A. Weight Loss During Cure (3M Test Method C-274): Less than 1% (60 min. at 250°F)

B. Gel Time: The following times are typically required to convert the 3M™ Scotch-Weld™ AU-200 resin system to a low strength, rubbery solid on a pre-heated stage.

Temperature	Gel Time
200°F	103 minutes
225°F	47.5 minutes
250°F	20.5 minutes
275°F	10 minutes
300°F	5.5 minutes

C. Flow During Cure (3M Test Method C-261):

The following levels are typical averages for 3M™ Scotch-Weld™ AU-200 film using a cure of 235°F, 30 minutes, 35 psig, 5°F/min. rise rate

Adhesive	% Flow (area increases)
3M™ Scotch-Weld™ AU-200 (.06 lb/ft²)	350%
3M™ Scotch-Weld™ AU-200 (.085 lb/ft²)	450%

D. Cure Time and Temperature

1. For temperatures from 250°F to 300°F, a cure time of 60 minutes at temperature is suggested.
2. For temperatures between 225°F and 250°F, a cure time of 90 minutes at temperature is suggested.
3. A cure temperature of 350°F for 2 hours did not result in an overcure (gave equivalent performance to a 1 hour at 250°F cure).

Following cure, it is suggested that pressure be maintained until the assembly has been cooled to 150°F or below.

E. Heat up rate

Bond line temperature rise rates between 1°F/min. and 20°F/min. have been used successfully with 3M™ Scotch-Weld™ AU-200 film. It must be noted that hot entry cures at 300°F and above can be expected to produce reduced performance due to formation of bond line porosity.

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Product Application
*(continued)***F. Cure Pressure****1. Positive Pressure Cures**

During cure, pressure is required to keep parts in alignment and to overcome distortions and thermal expansion of the adherends. When bonding honeycomb assemblies with non-perforated core, pressure is required to overcome the thermal expansion of air in the honeycomb cells. Positive pressure between 20 and 80 psi have been used successfully with 3M™ Scotch-Weld™ Structural Adhesive Film AU-200. For very small area bonds, however, pressures at the higher end of this range may produce excessive squeeze out and adhesive bond line starvation. For large solid panel constructions which are autoclave cured, application of vacuum for 15 to 20 minutes prior to application of heat and pressure is suggested to assist in removing any residual air trapped in the assembly. Normally, the vacuum is released following application of positive pressure. For problem assemblies, maintain the vacuum during the heatup cycle to about 130°F to further assist in providing void free bonds.

2. Vacuum Curing

3M™ Scotch-Weld™ AU-200 film can be successfully cured using vacuum cure techniques. For performance comparable to positive pressure cures, 3M™ Scotch-Weld™ AU-200 film should be cured using a vacuum level in the range of 8-12 inches of mercury. Higher vacuum levels yield excessive porosity and corresponding strength reductions.

Storage

Storage Stability – Storage at 0°F or below is recommended for 3M™ Scotch-Weld™ AU-200 film to obtain maximum storage life. 3M™ Scotch-Weld™ AU-200 films can be left out of cold storage (80°F maximum) for 20 days without adversely affecting its performance.

Shelf Life

Standard shelf life of 3M™ Scotch-Weld™ AU-200 at 0°F or below is 12 months from date of shipment in the original unopened container.

Note: 3M™ Scotch-Weld™ AU-200 film should be permitted to thoroughly warm to room temperature before being used in order to prevent moisture condensation. (Do not open protective container prior to reaching ambient conditions).

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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. Address correspondence to: 3M Aerospace and Aircraft Maintenance Division, 3M Center, Building 223-1N-14, St. Paul, MN 55144. If you are outside of the U.S., please contact your nearest 3M office or branch.

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AS9100

This product was manufactured under a 3M quality system registered to AS9100 standards.



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