

3M

Scotch-Weld™

Structural Adhesive

EC-2086

Technical Data

November, 2004

Introduction

3M™ Scotch-Weld™ Structural Adhesive EC-2086 is a one-part, 100% solids thermosetting liquid adhesive.

Advantages

- Exceptionally high strength properties at service temperatures from -70°F to 200°F (-56°C to 93°C).
- Higher impact, peel, and bond strength properties than normally attainable with epoxy based adhesives.
- Paste viscosity which allows the use of EC-2086 on vertical surfaces without run-off during cure.
- No volatile by-products given off during cure.
- Good adhesion to steel.
- Easy application by knife coating, trowel, pump and high pressure injection methods.
- Excellent retention of strength after aging in many environments.

Product Description

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

Color:	Gray
Solvent:	None
Base:	Modified Epoxy
Consistency:	Paste
Net Weight:	12 lbs./gallon

3M™ Scotch-Weld™ Structural Adhesive EC-2086

Product Application

Proper adhesive application is as important as proper bond design and adhesive choice to obtain maximum joint properties. Improper adhesive application techniques can result in partial or complete failure of an assembly.

3M™ Scotch-Weld™ Structural Adhesive EC-2086 will give excellent properties under many application conditions. The product performance data reported in a later section (Test Results) was developed using the following suggested procedures. Variations from these procedures should be fully evaluated to insure bond properties sufficient to meet the requirements of your particular assembly.

I. Surface Preparation

Cleaning Procedure for Aluminum*

1. Vapor Degrease – Perchloroethylene condensing vapors for 5-10 minutes.
2. Alkaline Degrease – Oakite No. 164 solution (9-11 oz./gallon of water) at 190°F ± 10°F (88°C ± 5°C) for 10-20 minutes. Rinse immediately in large quantities of cold running water.
3. Acid Etch – Place panels in either of the following solutions for 10 minutes at 150°F ± 5°F (66°C ± 2°C).

	<u>A (FPL Etch)</u>	<u>B</u>
Distilled Water	30 parts by wt.	30 parts by wt.
Sulfuric Acid (Conc.)	10 parts by wt.	10 parts by wt.
Sodium Dichromate	1 part by wt.	4 parts by wt.

4. Rinse – Rinse panels in clear running water.
5. Dry – Air dry - 15 minutes
Force dry - 10 minutes at 150°F ± 10°F (66°C ± 5°C)
6. It is advisable to coat the freshly cleaned surfaces with adhesive within 4 hours after surface preparation.

***Note:** Prior to using degreaser or preparing and using acid etch, read and follow material suppliers environmental, health and safety recommendations. Proper protective equipment for eyes, skin, and respiratory system should be used.

II. Adhesive Layup

Care should be taken to avoid contaminating adhesive and cleaned aluminum by any substance which will hinder wetting action.

Adhesive Application

EC-2086 can be applied by a spatula, knife coat, notched trowel, or by extruding into place. Standard equipment is available which allows pumping directly from five-gallon pails.

Bond Line Thickness

Optimum performance is obtained with a 2-5 mil cured bond line thickness.

Clean-Up

Excess adhesive and equipment may be cleaned up, prior to curing, with *Ketone type solvents.

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

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Product Application
(continued)

III. Cure Cycle

General Cure Requirements

Time, temperature and pressure determine the final bond properties. These properties may also be effected by the type of curing equipment used for each specific application. In general, the cure properties of 3M™ Scotch-Weld™ Structural Adhesive EC-2086 are as follows:

Flow and Cure Initiation Temperatures

Normal flow and cure initiation temperatures for EC-2086 are as follows:

Flow Temperature: 60°F (15°C)
Cure Initiation Temperature: 325-335°F (163-168°C)

Cure Pressure

The only pressure needed during the cure of EC-2086 is that required to keep parts in alignment and to overcome distortion and thermal expansion in the adherends.

Cure Temperature

The cure temperature may be varied from 330°F to 500°F (165°C to 260°C), depending on the materials being bonded, equipment available and bond properties desired. EC-2086 will wet the surface to which it has been applied. Heating at temperatures above 325°F (163°C) will chemically convert the adhesive into a high strength solvent-resistant bond.

The following is a guide to the effect of bondline temperature during cure on 75°F (24°C) overlap shear strengths:

Bond Line Temperature	Time at Temperature	75°F (24°) Shear Strength
350°F (177°C)	40-60 minutes	5500 psi
375°F (191°C)	20-30 minutes	5500 psi
400°F (204°C)	15-20 minutes	5300 psi
425°F (218°C)	10-15 minutes	4300 psi
450°F (232°C)	5-7 minutes	3500 psi

The time required to reach the specified bond line temperature is not included. Time lag for the parts to reach temperature will depend on relative mass and efficiency of the heat source. Temperature of the bond line should be determined experimentally by thermocouple measurements. Cure temperatures in excess of 400°F (204°C) yield useful, but lower than optimum strengths. At these temperatures the indicated time cycles should not be exceeded.

Cure Time

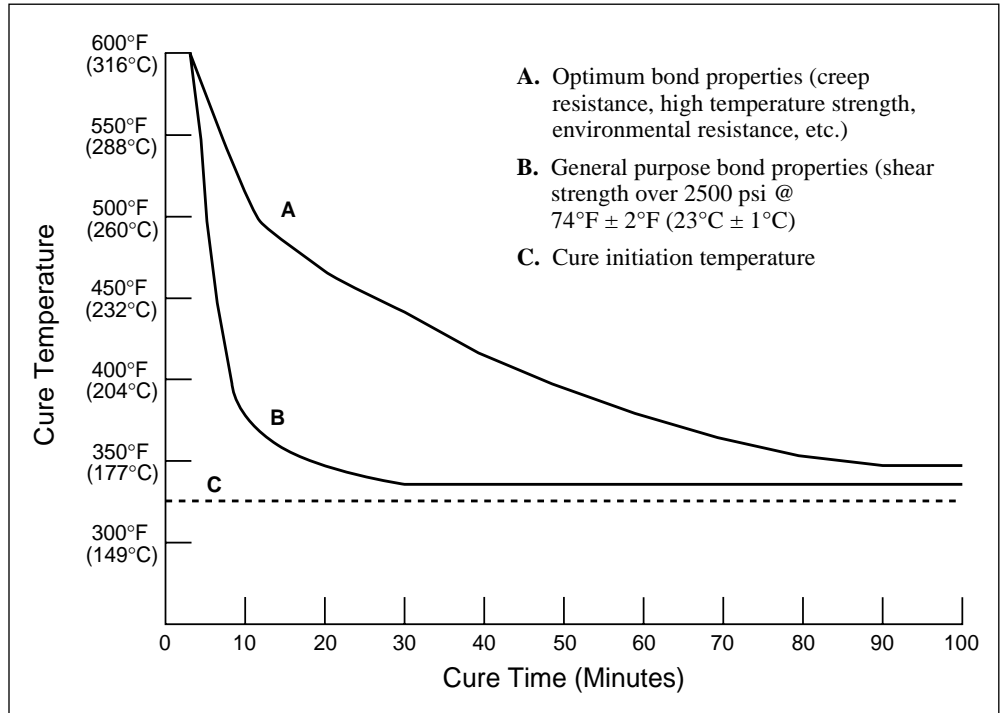
Cure time depends on the cure temperatures used, methods of heat application, production limitations and bond properties required. Since no two bonding operations are exactly alike, it is suggested that a few simple experiments be conducted, varying both temperature and cure time to determine optimum conditions for the particular application. Figure 1 is a guide from which an approximate cure cycle can be taken for various cure times or temperatures.

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Product Application (continued)

III. Cure Cycle (continued)

Figure 1 – Curing Temperature vs Curing Time for 3M™ Scotch-Weld™ Structural Adhesive EC-2086.



Suggested Cure Cycle

The following press cure cycle is suggested to obtain dense glue lines and was used to obtain the strengths reported in the Test Results section:

1. Apply a pressure of 25 psi prior to reaching a bond line temperature of 150°F (66°C) and maintain throughout the press cure cycle. (Pressure was used to insure flat test panels.)
2. Raise the bond line temperature from ambient to 350°F (177°C) at a rate of 10°F ± 2°F (-12°C ± 1°C).
3. Cure for 60 ± 1 minutes at 350°F ± 2°F (177°C ± 1°C).
4. Cool to below 200°F (93°C) bond line temperature prior to release of pressure. (In laboratory tests, panels have been removed at 350°F (177°C) with no adverse effects.)

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Test Results

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

Etched Aluminum Overlap Shear Strength

Test Temperature	Test Results
-67°F (-55°C)	3000 psi
75°F (24°C)	5000 psi
180°F (82°C)	5000 psi
250°F (121°C)	2200 psi
350°F (177°C)	500 psi

Cure Cycle: 1 hour @ 350°F (177°C), 25 psi.

Etched Aluminum Overlap Shear Strength After Environmental Aging

Environment	Time	Test Results at 75°F (24°C)
Salt Spray @ 95°F (35°C)	30 days	5064 psi
Tap Water @ 75°F (24°C)	30 days	5784 psi
100% Relative Humidity @ 120°F (49°C)	30 days	4720 psi
Hydraulic Oil @ 75°F (24°C)	30 days	5710 psi
White Gas @ 75°F (24°C)	30 days	6024 psi

Solvent Wiped Cold Rolled Steel Overlap Shear Strength

Test Temperature	Test Results
-40°F (-40°C)	3340 psi
75°F (24°C)	2700 psi
180°F (82°C)	2360 psi
250°F (121°C)	480 psi
350°F (177°C)	130 psi

Cure Cycle: 1 minute @ 450°F (232°C), 50 psi.

Solvent Wiped Steel T-Peel

Test Temperature	Test Results
75°F (24°C)	50 piw

Cure Cycle: 1 minute @ 450°F (232°C), 50 psi.

Etched Aluminum Overlap Shear Freon 22 Resistance

Control	Tested @ 75°F (24°C)		
	30 days	60 days	1 year
4650 psi	4470 psi	4140 psi	4225 psi

Cure Cycle: 10 minutes @ 400°F (204°C), 50 psi.

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Test Results (continued)

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

Etched Aluminum Overlap Shear After Long Term Environmental Aging

Environment	Tested 75°F (24°C)		
	90 days	180 days	365 days
Tap Water @ 75°F (24°C)	5962 psi	6152 psi	6100 psi
100% Relative Humidity @ 120°F (49°C)	3670 psi	3328 psi	2850 psi
Salt Spray @ 95°F (35°C)	4830 psi	4692 psi	2634 psi

Solvent Wiped Steel T-Peel

.248 BTU/HR/SQ. FT./°F/FT @ 75°F (24°C)

Coefficient of Thermal Expansion

47 x 10 ⁻⁶ in./in./°C between 0 to 80°F (-18 to 27°C)

Electrical Properties

	Test Temperature	
	73°F (23°C)	140°F (60°C)
Dielectric Constant	10.8	11.4
Dissipation Factor	0.016	0.228
Arc Resistance	34	—
Dielectric Strength (Volts/Mil)	123	—
Surface Resistivity (500 Volts DC)	1 x 10 ¹⁷ ohms	—
Volume Resistivity (500 Volts DC)	3.6 x 10 ¹⁴ ohms-cm	—

Storage

Refrigerated storage at 40°F (4°C) or below is suggested for optimum storage life. If 3M™ Scotch-Weld™ Structural Adhesive EC-2086 is refrigerated, it should be permitted to thoroughly warm to room temperature before opening in order to prevent moisture condensation of the adhesive surface. Rotate stock on a “first in – first out” basis.

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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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