



# Scotch-Weld™ Epoxy Adhesive

## 2216 B/A

Technical Data

October 2018

**Product Description** 3M™ Scotch-Weld™ Epoxy Adhesive 2216 B/A is a flexible, two-part, room temperature curing epoxy with high peel and shear strength, available in three versions. 2216 B/A Gray meets DOD-A-82720.

**Typical Uncured 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™ Scotch-Weld™ Epoxy Adhesive |                 |                  |                   |                      |                |
|----------------------------------------------------------------------|---------------------------------|-----------------|------------------|-------------------|----------------------|----------------|
|                                                                      | 2216 B/A Gray                   |                 | 2216 B/A Tan NS  |                   | 2216 B/A Translucent |                |
|                                                                      | Base                            | Accelerator     | Base             | Accelerator       | Base                 | Accelerator    |
| <b>Color:</b>                                                        | White                           | Gray            | White            | Tan               | Translucent          | Amber          |
| <b>Base:</b>                                                         | Modified Epoxy                  | Modified Amine  | Modified Epoxy   | Modified Amine    | Modified Epoxy       | Modified Amine |
| <b>Net Wt.: (lb/gal)</b>                                             | 11.1-11.6                       | 10.5-11.0       | 11.1-11.6        | 10.5-11.0         | 9.4-9.8              | 8.0-8.5        |
| <b>Viscosity: (cps) (Approx.)<br/>Brookfield RVF #7 sp. @ 20 rpm</b> | 75,000 - 150,000                | 40,000 - 80,000 | 75,000 - 150,000 | 550,000 - 900,000 | 11,000 - 15,000      | 5,000 - 9,000  |
| <b>Mix Ratio: (by weight)</b>                                        | 5 parts                         | 7 parts         | 5 parts          | 7 parts           | 1 part               | 1 part         |
| <b>Mix Ratio: (by volume)</b>                                        | 2 parts                         | 3 parts         | 2 parts          | 3 parts           | 1 part               | 1 part         |
| <b>Work Life:<br/>100 g Mass @ 75°F (24°C)</b>                       | 90 minutes                      | 90 minutes      | 120 minutes      | 120 minutes       | 120 minutes          | 120 minutes    |

### Features

- Excellent for bonding many metals, woods, plastics, rubbers, and masonry products.
- Base and Accelerator are contrasting colors.
- Good retention of strength after environmental aging.
- Resistant to extreme shock, vibration, and flexing.
- Excellent for cryogenic bonding applications.
- Excellent for potting parts subject to thermal cycling.
- The tan NS Adhesive is non-sag for greater bond-line control.
- The translucent can be injected.
- Meets DOD-A-82720.

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### Typical Cured Physical Properties

| Product                         | 3M™ Scotch-Weld™ Epoxy Adhesive |             |                  |
|---------------------------------|---------------------------------|-------------|------------------|
|                                 | 2216 Gray                       | 2216 Tan NS | 2216 Translucent |
| Color                           | Gray                            | Tan         | Translucent      |
| Shore D Hardness<br>ASTM D 2240 | 50-65                           | 65-70       | 35-50            |
| Time to Handling Strength       | 8-12 hrs.                       | 8-12 hrs.   | 12-16 hrs.       |

### Typical Cured Electrical Properties

| Product                            | 3M™ Scotch-Weld™ Epoxy Adhesive              |                                                 |
|------------------------------------|----------------------------------------------|-------------------------------------------------|
|                                    | 2216 Gray                                    | 2216 Translucent                                |
| Arc Resistance                     | 130 seconds                                  |                                                 |
| Dielectric Strength                | 408 volts/mil                                | 630 volts/mil                                   |
| Dielectric Constant @ 73°F (23°C)  | 5.51—Measured @ 1.00 KHz                     | 6.3 @ 1 KHz                                     |
| Dielectric Constant @ 140°F (60°C) | 14.17—Measured @ 1.00 KHz                    | —                                               |
| Dissipation Factor 73°F (23°C)     | 0.112 Measured @ 1.00 KHz                    | 0.119 @ 1 KHz                                   |
| Dissipation Factor 140°F (60°C)    | 0.422—Measured @ 1.00 KHz                    | —                                               |
| Surface Resistivity @ 73°F (23°C)  | 5.5 x 10 <sup>16</sup> ohm—@ 500 volts DC    | —                                               |
| Volume Resistivity @ 73°F (23°C)   | 1.9 x 10 <sup>12</sup> ohm-cm—@ 500 volts DC | 3.0 x 10 <sup>12</sup> ohm-cm<br>@ 500 volts DC |

### Typical Cured Thermal Properties

| Product                             | 3M™ Scotch-Weld™ Epoxy Adhesive                    |                                                     |
|-------------------------------------|----------------------------------------------------|-----------------------------------------------------|
|                                     | 2216 Gray                                          | 2216 Translucent                                    |
| Thermal Conductivity                | 0.228 Btu-ft/ft <sup>2</sup> h°F                   | 0.114 Btu-ft/ft <sup>2</sup> h°F                    |
| Coefficient of Thermal<br>Expansion | 102 x 10 <sup>-6</sup> in/in/°C<br>between 0-40°C  | 81 x 10 <sup>-6</sup> in/in/°C<br>between -50-0°C   |
|                                     | 134 x 10 <sup>-6</sup> in/in/°C<br>between 40-80°C | 207 x 10 <sup>-6</sup> in/in/°C<br>between 60-150°C |

### Typical Cured Outgassing Properties

Outgassing Data  
NASA 1124 Revision 4

|                                           | % TML | % CVCM | % Wtr |
|-------------------------------------------|-------|--------|-------|
| 3M™ Scotch-Weld™ Epoxy Adhesive 2216 Gray | .77   | .04    | .23   |

Cured in air for 7 days @ 77°F (25°C).

### Handling/Curing Information

#### Directions for Use

1. For high strength structural bonds, paint, oxide films, oils, dust, mold release agents and all other surface contaminants must be completely removed. However, the amount of surface preparation directly depends on the required bond strength and the environmental aging resistance desired by user. For suggested surface preparations of common substrates, see the following section on surface preparation.
2. These products consist of two parts. Mix thoroughly by weight or volume in the proportions specified on the product label and in the uncured properties section. Mix approximately 15 seconds after a uniform color is obtained.

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### Handling/Curing Information (continued)

3. For maximum bond strength, apply product evenly to both surfaces to be joined.
4. Application to the substrates should be made within 90 minutes. Larger quantities and/or higher temperatures will reduce this working time.
5. Join the adhesive coated surfaces and allow to cure at 60°F (16°C) or above until firm. Heat, up to 200°F (93°C), will speed curing.
6. The following times and temperatures will result in a full cure:

| Product          | 3M™ Scotch-Weld™ Epoxy Adhesive |             |                  |
|------------------|---------------------------------|-------------|------------------|
|                  | 2216 Gray                       | 2216 Tan NS | 2216 Translucent |
| Cure Temperature | Time                            | Time        | Time             |
| 75°F (24°C)      | 7 days                          | 7 days      | 30 days          |
| 150°F (66°C)     | 120 minutes                     | 120 minutes | 240 minutes      |
| 200°F (93°C)     | 30 minutes                      | 30 minutes  | 60 minutes       |

7. Keep parts from moving until handling strength is reached. Contact pressure is necessary. Maximum shear strength is obtained with a 3-5 mil bond line. Maximum peel strength is obtained with a 17-25 mil bond line.
8. Excess uncured adhesive can be cleaned up with ketone type solvents.\*  
Adhesive Coverage: A 0.005 in. thick bondline will typically yield a coverage of 320 sq. ft/gallon

### Application and Equipment Suggestions

These products may be applied by spatula, trowel or flow equipment. Two-part mixing/proportioning/dispensing equipment is available for intermittent or production line use. These systems are ideal because of their variable shot size and flow rate characteristics and are adaptable to many applications.

### Surface Preparation

For high strength structural bonds, paint, oxide films, oils, dust, mold release agents and all other surface contaminants must be completely removed. However, the amount of surface preparation directly depends on the required bond strength and the environmental aging resistance desired by user.

The following cleaning methods are suggested for common surfaces.

#### Steel or Aluminum (Mechanical Abrasion)

1. Wipe free of dust with oil-free solvent such as acetone or alcohol solvents.\*
2. Sandblast or abrade using clean fine grit abrasives (180 grit or finer).
3. Wipe again with solvents to remove loose particles.
4. If a primer is used, it should be applied within 4 hours after surface preparation.

\*When using solvents, extinguish all ignition sources, including pilot lights, and follow the manufacturer's precautions and directions for use. Use solvents in accordance with local regulations.

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## Surface Preparation (continued)

### Aluminum (Chemical Etch)

Aluminum alloys may be chemically cleaned and etched as per ASTM D 2651. This procedure states to:

1. Alkaline Degrease – Oakite 164 solution (9-11 oz/gal of water) at 190°F ± 10°F (88°C ± 5°C) for 10-20 minutes. Rinse immediately in large quantities of cold running 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 to 1 liter. Heat mixed solution to 66 to 71°C (150 to 160°F). 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 etch aluminum panels, place them in FPL etch solution heated to 66 to 71°C (150 to 160°F). Panels should soak for 12 to 15 minutes.

3. Rinse: Rinse panels in clear running tap water.
4. Dry: Air dry 15 minutes; force dry 10 minutes (minimum) at 140°F (60°C) maximum.
5. If primer is to be used, it should be applied within 4 hours after surface preparation.

### Plastics/Rubber

1. Wipe with isopropyl alcohol.\*
2. Abrade using fine grit abrasives (180 grit or finer).
3. Wipe with isopropyl alcohol.\*

### Glass

1. Solvent wipe surface using acetone or MEK.\*
2. Apply a thin coating (0.0001 in. or less) of 3M™ Scotch-Weld™ Structural Adhesive Primer EC-3901 to the glass surfaces to be bonded and allow the primer to dry a minimum of 30 minutes @ 75°F (24°C) before bonding.

\*When using solvents, extinguish all ignition sources, including pilot lights, and follow the manufacturer's precautions and directions for use. Use solvents in accordance with local regulations.

# 3M™ Scotch-Weld™ Epoxy Adhesive 2216 B/A

Typical  
Adhesive  
Performance  
Characteristics

## A. Typical Shear Properties on Etched Aluminum ASTM D 1002 Cure: 2 hours @ 150 ± 5°F (66°C ± 2°C), 2 psi pressure

| Test Temperature | Overlap Shear (psi)             |                          |                          |
|------------------|---------------------------------|--------------------------|--------------------------|
|                  | 3M™ Scotch-Weld™ Epoxy Adhesive |                          |                          |
|                  | 2216 B/A Gray Adhesive          | 2216 B/A Tan NS Adhesive | 2216 B/A Trans. Adhesive |
| -423°F (-253°C)  | 2440                            | —                        | —                        |
| -320°F (-196°C)  | 2740                            | —                        | —                        |
| -100°F (-73°C)   | 3000                            | —                        | —                        |
| -67°F (-53°C)    | 3000                            | 2000                     | 3000                     |
| 75°F (24°C)      | 3200                            | 2500                     | 1700                     |
| 180°F (82°C)     | 400                             | 400                      | 140                      |

| Test Temperature | Shear Modulus<br>(Torsion Pendulum Method) |
|------------------|--------------------------------------------|
| -148°F (-100°C)  | 398,000 psi (2745 MPa)                     |
| -76°F (-60°C)    | 318,855 psi (2199 MPa)                     |
| -40°F (-40°C)    | 282,315 psi (1947 MPa)                     |
| 32°F (0°C)       | 218,805 psi (1500 MPa)                     |
| 75°F (24°C)      | 49,580 psi (342 MPa)                       |

## B. Typical T-Peel Strength ASTM D 1876

| Test Temperature | T-Peel Strength (piw) @ 75°F (24°C) |                          |                          |
|------------------|-------------------------------------|--------------------------|--------------------------|
|                  | 3M™ Scotch-Weld™ Epoxy Adhesive     |                          |                          |
|                  | 2216 B/A Gray Adhesive              | 2216 B/A Tan NS Adhesive | 2216 B/A Trans. Adhesive |
| 75°F (24°C)      | 25                                  | 25                       | 25                       |

# 3M™ Scotch-Weld™ Epoxy Adhesive 2216 B/A

Typical  
Adhesive  
Performance  
Characteristics  
(continued)

## C. Overlap Shear Strength After Environmental Aging-Etched Aluminum

| Environment                              | Time                          | Overlap Shear (psi) 75°F (24°C)  |                                |                                |
|------------------------------------------|-------------------------------|----------------------------------|--------------------------------|--------------------------------|
|                                          |                               | 3M™ Scotch-Weld™ Epoxy Adhesive  |                                |                                |
|                                          |                               | 2216<br>B/A Gray<br>Adhesive     | 2216<br>B/A Tan NS<br>Adhesive | 2216<br>B/A Trans.<br>Adhesive |
| 100% Relative Humidity<br>@ 120°F (49°C) | 14 days<br>30 days<br>90 days | 2950 psi<br>1985 psi<br>1505 psi | 3400 psi<br>2650 psi           | 1390 psi                       |
| *Salt Spray @ 75°F (24°C)                | 14 days<br>30 days<br>60 days | 2300 psi<br>500 psi<br>300 psi   | 3900 psi<br>3300 psi           | 1260 psi                       |
| Tap Water @ 75°F (24°C)                  | 14 days<br>30 days<br>90 days | 3120 psi<br>2942 psi<br>2075 psi | 3250 psi<br>2700 psi           | 1950 psi                       |
| Air @ 160°F (71°C)                       | 35 days                       | 4650 psi                         | 4425 psi                       |                                |
| Air @ 300°F (149°C)                      | 40 days                       | 4930 psi                         | 4450 psi                       | 3500 psi                       |
| Anti-icing Fluid @ 75°F (24°C)           | 7 days                        | 3300 psi                         | 3050 psi                       | 2500 psi                       |
| Hydraulic Oil @ 75°F (24°C)              | 30 days                       | 2500 psi                         | 3500 psi                       | 2500 psi                       |
| JP-4 Fuel                                | 30 days                       | 2500 psi                         | 2750 psi                       | 2500 psi                       |
| Hydrocarbon Fluid                        | 7 days                        | 3300 psi                         | 3100 psi                       | 3000 psi                       |

\*Substrate corrosion resulted in adhesive failure.

## D. Heat Aging of 3M™ Scotch-Weld™ Epoxy Adhesive 2216 B/A Gray (Cured for 7 days @ 75°F [24°C])

| Overlap Shear (psi) | Time aged @ 300°F (149°C) |         |         |         |
|---------------------|---------------------------|---------|---------|---------|
| Test Temperature    | 0 days                    | 12 days | 40 days | 51 days |
| -67°F (-53°C)       | 2200                      | 3310    | 3120    | 2860    |
| 75°F (24°C)         | 3100                      | 5150    | 4930    | 4740    |
| 180°F (82°C)        | 500                       | 1000    | 760     | 1120    |
| 350°F (177°C)       | 420                       | 440     | 560     | —       |

# 3M™ Scotch-Weld™ Epoxy Adhesive 2216 B/A

## Typical Adhesive Performance Characteristics (continued)

### E. Overlap Shear Strength on Abraded Metals, Plastics, and Rubbers.

Overlap shear strengths were measured on 1" x 1/2" overlap specimens. These bonds were made individually using 1" by 4" pieces of substrate (Tested per ASTM D 1002).

The thickness of the substrates were: cold rolled, galvanized and stainless steel – 0.056-0.062", copper – 0.032", brass – 0.036", rubbers – 0.125", plastics – 0.125". All surfaces were prepared by solvent wiping/abrading/ solvent wiping.

The jaw separation rate used for testing was 0.1 in/min for metals, 2 in/min for plastics, and 20 in/min for rubbers.

| Substrate                                           | Overlap Shear (psi)@75°F (24°C) |                          |
|-----------------------------------------------------|---------------------------------|--------------------------|
|                                                     | 3M™ Scotch-Weld™ Epoxy Adhesive |                          |
|                                                     | 2216 B/A Gray Adhesive          | 2216 B/A Tan NS Adhesive |
| Aluminum/Aluminum                                   | 1850                            | 2350                     |
| Cold Rolled Steel/Cold Rolled Steel                 | 1700                            | 3100                     |
| Stainless Steel/Stainless Steel                     | 1900                            |                          |
| Galvanized Steel/Galvanized Steel                   | 1800                            |                          |
| Copper/Copper                                       | 1050                            |                          |
| Brass/Brass                                         | 850                             |                          |
| Styrene Butadiene Rubber/Steel                      | 200*                            |                          |
| Neoprene Rubber/Steel                               | 220*                            |                          |
| ABS/ABS Plastic                                     | 990*                            | 1140*                    |
| PVC/PVC, Rigid                                      | 940*                            |                          |
| Polycarbonate/Polycarbonate                         | 1170*                           | 1730*                    |
| Acrylic/Acrylic                                     | 1100*                           | 1110*                    |
| Fiber Reinforced Polyester/<br>Reinforced Polyester | 1660*                           | 1650*                    |
| Polyphenylene Oxide/PPO                             | 610                             | 610                      |
| PC/ABS Alloy / PC/ABS Alloy                         | 1290                            | 1290                     |

\*The substrate failed during the test.

## Storage

Store products at 60-80°F (16-27°C) for maximum storage life.

## Shelf Life

When stored at the recommended temperatures in the original, unopened containers, the shelf life is 24 months from date of manufacture from 3M.

# 3M™ Scotch-Weld™ Epoxy Adhesive 2216 B/A

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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.

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## Technical Information

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ISO 9001

This Industrial Adhesives and Tapes Division product was manufactured under a 3M quality system registered to ISO 9001 standards.



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