Strain Gage Applications with M-Bond AE-10, AE-15 and GA-2 Adhesive Systems

GENERAL DESCRIPTION

The three adhesives described in this bulletin, M-Bond AE- 10, AE-15, and GA-2, are all 100%-solids epoxy systems for use with strain gages and special-purpose sensors. The gage installation procedure described is appropriate for each adhesive, the primary differences in the systems being in mixing instructions, pot life, cure cycles, and, to some extent, elongation properties. Each system is effective from the cryogenic region to +200°F [+95°C].

For proper results, the procedures and techniques presented in this bulletin should be used with qualified Micro-Measurements installation accessory products (refer to Micro-Measurements Accessories Catalog A-110). Accessories used in this procedure are:

- CSM Degreaser or GC-6 Isopropyl Alcohol
- CSP-1 Cotton Applicators
- PCT-2M Gage Installation Tape
- Silicon-Carbide Paper
- MJG-2 Mylar Tape
- M-Prep Conditioner A
- HSC Spring Clamp
- M-Prep Neutralizer 5A
- GT-14 Pads and Backup Plate
- GSP-1 Gauze Sponges

Handling Precautions

While these bonding agents are considered relatively safe to handle, contact with skin and inhalation of their vapors should be avoided. Immediate washing with ordinary soap and water is effective in cleansing should skin contact occur. For eye contact, rinse thoroughly with a copious amount of water and consult a physician. For additional health and safety information, consult the material safety data sheet, which is available upon request.

MIXING INSTRUCTIONS AND ADHESIVE CHARACTERISTICS

A. General

1. Each kit contains materials for mixing six batches of adhesive. Mixing instructions for M-Bond AE-10 and M-Bond AE-15 Bulk are included below.

2. Any resin removed from refrigeration must be allowed attain room-temperature equilibrium before being opened.

3. Mix adhesives thoroughly for five minutes according to instructions. If a room-temperature cure is used, allow the freshly mixed adhesive to stand an additional five minutes before use.

4. The pot life for Systems AE-10 and GA-2 can be prolonged by occasionally stirring to prevent localized exotherm in the center of the resin system, or by pouring it out onto a chemically clean metal plate.

Note: During storage, crystals may form in the Resin AE. These crystals do not affect adhesive performance, but should be reliquefied prior to mixing by warming the resin jar to +120°F [+50°C] for approximately one-half hour. Allow the resin to return to room temperature before adding curing agent; excess heat will shorten mixed pot life.

B. M-Bond AE-10 Adhesive Kit

AE-10 will cure at +70°F [+20°C] in 6 hours, with approximately 6% elongation capability and essentially creep-free performance. Elongation capability of approximately 10% can be obtained by extending the cure time to 24 to 48 hours at +75°F [+24°C].* To mix, fill one of the calibrated droppers with Curing Agent 10 exactly to the number 10 and dispense the contents into the center of the jar of Resin AE. Immediately cap the bottle of Curing Agent 10 to avoid moisture absorption. Mix thoroughly for 5 minutes, using one of the plastic stirring rods. The pot life or working time after mixing is 15 to 20 minutes. Discard the dropper after use.

M-Bond AE-10 Bulk is packaged with 200 grams of resin, 40 grams of Curing Agent 10, and three calibrated pipettes. The mix ratio is 10.0 parts by weight of AE Resin to 1.5 parts by weight of Curing Agent 10. Mix thoroughly for five minutes, then allow the mixture to stand for an additional five minutes before use. When mixing quantities greater than 10 grams of AE Resin, the normal pot life of 15-20 minutes will be shortened accordingly.

*Refer to Application Notes B-129 and TT-605 for discussions of high-elongation strain measurements.

C. M-Bond AE-15 Adhesive Kit

AE-15 requires moderately elevated curing temperatures, and is recommended for critical installations, such as strain gage transducers, where zero shift and hysteresis

must be minimized. The AE-15 system is also useful with high elongation strain gages at strain levels up to approximately 10% to 15% at +70°F [+20°C], and at strain levels up to 15% at +200°F [+95°C]. To mix, fill one of the calibrated droppers with Curing Agent 15 exactly to the number 15 and dispense the contents into the center of the jar of Resin AE. Immediately cap the bottle of Curing Agent 15 to avoid moisture absorption. Mix the Resin AE and the Curing Agent 15 thoroughly for 5 minutes, using one of the plastic stirring rods. The pot life is approximately 1-1/2 hours at +70°F [+20°C]. Discard the dropper after use.

M-Bond AE-15 Bulk is packaged with 200 grams of resin, 25 grams of Curing Agent 15, and three calibrated pipettes. The mix ratio is 10.0 parts by weight of AE Resin to 0.8 parts by weight of Curing Agent 15. Mix thoroughly for five minutes, then allow the mixture to stand for an additional five minutes before use. When mixing quantities greater than 10 grams of AE Resin, the normal pot life of 15-20 minutes will be shortened accordingly.

D. M-Bond GA-2 Kit

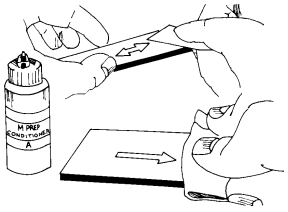
GA-2 is a partially filled 100%-solids epoxy adhesive. Resin GA-2 with Hardener 10-A will have approximately 10% to 15% elongation capabilities when cured for 40 hours at +70°F [+20°C], and approximately 6% elongation capabilities when cured for 6 hours at +70°F [+20°C]. To mix, fill one of the calibrated droppers with Hardener 10-A exactly to the number 10, and dispense the contents into the jar of Resin GA-2. Immediately cap the bottle of Hardener 10-A to prevent moisture absorption. Mix the Resin GA-2 and the Hardener 10-A thoroughly for 5 minutes using one of the plastic stirring rods. Pot life is approximately 15 minutes at +70°F [+20°C]. Discard the dropper after use.

GAGE INSTALLATION PROCEDURE

Step 1

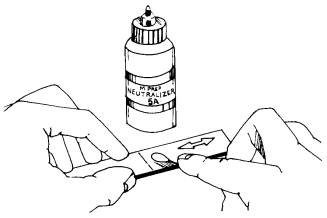
The surface preparation technique used is the same basic cleaning procedure described in Micro-Measurements Application Note B-129, *"Surface Preparation for Strain Gage Bonding"*. The initial step is to thoroughly degrease with solvents such as CSM Degreaser or GC-6 Isopropyl Alcohol. CSM Degreaser is preferred whenever possible since this is a very active degreaser. The substitution of GC-6 as a degreasing agent should be considered for materials that may be sensitive to strong solvents. Any degreasing should be done with clean solvents. Thus the use of a "one-way" container, such as the aerosol can, is highly advisable.

Step 2



Dry-abrade the gaging area with 220- or 320-grit silicon-carbide paper to remove any scale or oxides on the base material. Apply M-Prep Conditioner A and wet-abrade the gage area. Keep the surface wet while abrading. Remove the residue and Conditioner by slowly wiping through the gaging area with a gauze sponge. The wet-abrade and wiping procedure should then be repeated with 400-grit silicon-carbide paper. With a 4H (hard) drafting pencil on aluminum or a ballpoint pen on steel, burnish whatever alignment marks are needed on the specimen. Rewet the surface with Conditioner A and scrub with cotton tipped applicators until a clean applicator is no longer discolored by the scrubbing. Remove the residue and Conditioner by slowly wiping through the gaging area with a gauze sponge. Do not wipe back and forth over the gage area since this may allow contaminants to be redeposited on the cleaned area.

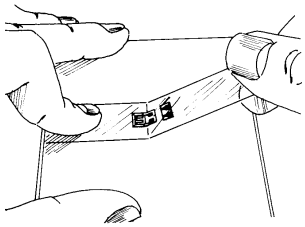
Step 3



Apply a liberal amount of M-Prep Neutralizer 5A to the gage area. Keeping the surface wet, scrub with cotton tipped applicators. Do not allow evaporation of the cleaning material on the specimen surface since this would leave a thin, unwanted film between the adhesive and the specimen. Remove the Neutralizer by slowly wiping through the gage area, allowing the gauze sponge to absorb the Neutralizer. Do not wipe back and forth over

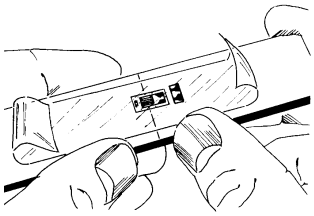
the gage area since this may allow contaminants to be redeposited on the cleaned area.

Step 4



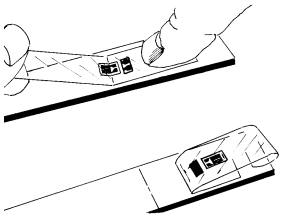
Remove the gage from its transparent envelope by grasping the edge of the gage backing with tweezers, and place bonding side down on a chemically clean glass plate or empty gage box. If a solder terminal is to be incorporated, position it on the plate adjacent to the gage as shown. A space of approximately 1/16 in [1.6 mm] should be left between the gage backing and terminal. Use 4 to 6 in [100 to 150 mm] of PCT-2M Gage Installation tape as a carrier to aid in positioning the strain gage and terminal. [When cure temperatures exceed +175°F [+80°C], MJG-2 mylar tape must be substituted for the gage installation tape.] Tack one end of the tape to the glass plate behind the gage and terminal, and wipe forward onto the terminal and gage. Carefully lift the tape at a shallow angle (about 45 degrees to the glass plate), bringing the gage up with it.

Step 5



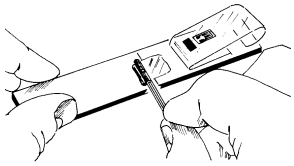
Position the gage/tape assembly so the triangle alignment marks on the gage are over the layout lines on the specimen. Holding the tape at a shallow angle, wipe the assembly onto the specimen surface. If the assembly appears to be misaligned, lift one end of the tape at a shallow angle until the assembly is free of the specimen. Realign properly and firmly anchor down at least one end of the tape to the specimen. This realignment can be done without fear of contamination by the tape mastic if the recommended gage installation tape is used. This tape will retain the mastic when removed.

Step 6



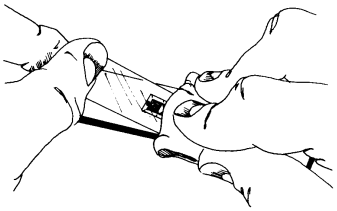
Lift one end of the tape at a shallow angle to surface (about 45 degrees) until gage and terminal are free of specimen surface. Tuck the loose end of the tape under and press to the surface so the gage lies flat with the bonding side exposed. In some cases this may be difficult because of space limitations. If this situation occurs, leave enough slack in the tape to allow a finger to be slipped behind the gage to support it while applying the adhesive.

Step 7



Coat the specimen, back of the gage, and terminal strip with the prepared adhesive. The mixing rod can be used to apply a thin layer of adhesive over each surface. Be careful not to pick up any unmixed components of the adhesive. To ensure this, it is advisable to wipe the mixing rod clean and then pick up a very small amount of the adhesive from the center area of the adhesive jar. Immediately after coating the gage and specimen with adhesive, proceed without delay to Step 8. This will limit the absorption of moisture by the uncured adhesive, and the gage installation tape will serve as a temporary moisture barrier during curing.

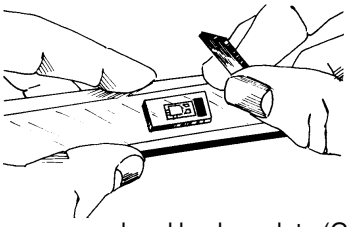
Step 8



Lift the tucked-over end of tape and bridge it over the adhesive at approximately a 30-degree angle. With a piece of gauze, slowly make a single wiping stroke over the gage/tape assembly, bringing the gage back down over the alignment marks on the specimen. Use a firm

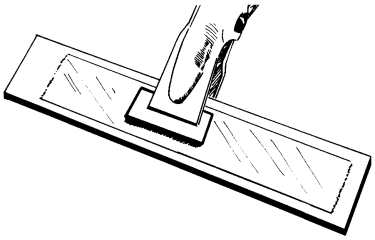
pressure with your fingers when wiping over the gage, since the adhesive is quite viscous. A very thin layer of adhesive is desired for optimum bond performance.

Step 9



Place a silicone gum pad and backup plate (GT-14) over the gage installation. The silicone gum should be soft (Durometer A40-60) and at least 3/32 in [2.5 mm] thick. This will allow the clamping force to be exerted evenly over the gage. The area of the silicone gum pad should be used to compute the final clamping pressure.

Step 10



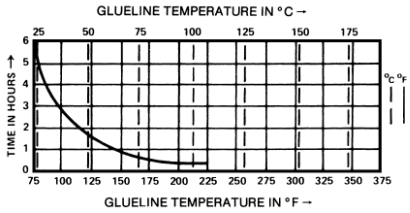
Apply force by spring clamp or dead weight until a clamping pressure of 5 to 20 psi [35 to 135 kN/m2] is attained. Take special care in making sure the clamping pressure is equal over the entire gage. Unequal clamping pressure may result in an irregular glueline. Take steps to ensure that the clamps will not slide out of position during cure. A few strips of tape to assist in holding the clamps or backup plate in place during cure may be helpful. Cure the installation in accordance with the recommended cure schedule below.

Step 11

The gage and terminal strip are now solidly bonded in place. To remove the tape, pull it back directly over itself, peeling it slowly and steadily off the surfaces. This technique will prevent possible lifting of the foil on open-faced gages or otherwise damaging the installation. It is not necessary to remove this tape immediately after gage installation. The tape will offer mechanical protection for the grid surface, and may be left in place until it is removed for gage wiring.

RECOMMENDED CURE SCHEDULES

M-Bond AE-10 and GA-2

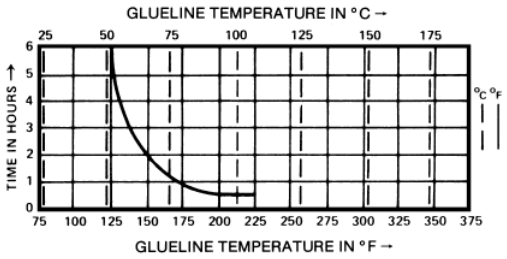


Caution: These systems may not cure properly below +70°F [+20°C]. Postcuring the installation for two hours at least +25°F [+15°C] above the maximum operating temperature with the clamping fixture removed will provide essentially creep-free performance.

M-Bond AE-15

Caution: To ensure proper polymerization, the cure cycle should start within 1.5 hours after mixing.

Note: Do not exceed +225°F [+105°C] cure temperature.



FINAL INSTALLATION PROCEDURE

1. Select appropriate solder and attach leadwires. Remove solder flux with RSK Rosin Solvent. See Catalog A-110 for these materials.

2. Select and apply protective coating. See Catalog A-110.

3. Micro-Measurements gages have been treated for optimum bonding conditions and require no precleaning before use unless contaminated during handling. If contaminated, the back of any gage may be cleaned with a cotton applicator slightly moistened with Neutralizer 5A.