ADHESIVE APPLICATION GUIDELINES

CONTENTS

SYRINGE RECEIVING, STORAGE AND THAWING

Incoming inspection

The "ice cube" monitor packed in the shipping carton indicates whether it has been exposed to thawing conditions. When it is packed, the cube has sharp edges and corners. If the cube experiences high temperatures for extended times, its corners and edges will melt and become rounded.

There should be no visible separation of adhesive from the walls of the syringe barrels or bubbles in the adhesive.

Freezing and storage

Store frozen syringes in a freezer promptly after receiving. Syringes should be stored vertically, tip down.

Shelf life

Shelf life of adhesive in syringes when frozen at -40 °C is 12 months.

Thawing time

Adequate time must be allowed for the material to thaw before use. Thawing typically takes about 15-30 minutes for small syringes (3-5 cc). Thawing time depends on storage and ambient temperatures and the volume and density of the adhesive in the syringe.

No re-freezing

Material remaining in a syringe after use should not be frozen for later use. Multiple freeze/thaw cycles can cause voids and air bubbles.

JAR STORAGE

Shelf life

Shelf life of most Diemat adhesives stored in sealed jars at room temperature (20-25 °C) is six months. For some adhesives, shelf life at room temperature is three months; please consult the product data sheet.

Solvent will evaporate from open jars. For longest storage life, minimize the number of times the jar is opened and the time that the jar is open.

Rolling

Diemat recommends that jars containing adhesives be rolled before use. Rolling maintains uniform particle dispersion and removes air bubbles. Jars may be stored (rolled continuously at low RPM) on a roller such as Diemat's 8010.

If a jar has not been stirred or rolled for a long time (weeks, depending on the adhesive), filler particles may settle to the bottom and form a solid mass that is difficult to break up simply by rolling. In this case, thorough but gentle manual stirring is needed, followed by rolling for at least 16 hours to mix the adhesive uniformly and remove air bubbles.

Freezing not recommended

Diemat recommends not freezing adhesives packaged in jars.

EXPIRATION DATE

Diemat's expiration dates for jars and syringes are conservative. However, we do not recommend using material past its expiration date.

DIE

Material

The die's coefficient of thermal expansion (CTE) must be close enough to the CTE of the substrate so that thermally induced stress is limited to a safe amount (see "Dimensions", below).

Certain semiconductor materials have an affinity for certain ingredients in adhesives. For example, gold metallization attracts the resin in DM6030 adhesives and can cause migration or bleeding. This effect can be reduced by (1) pre-heating the curing oven to an intermediate temperature, (2) minimizing open and staging times, and (3) decreasing the amount of adhesive dispensed. For more information, contact Diemat.

Dimensions

The **length** of the die affects the stress imposed on the bondline as the die cools after curing. During curing, the die and substrate expand according to their respective coefficients of thermal expansion (CTE). Large die sizes require the use of soft (low-modulus) adhesives, or that the CTE of the die be similar to the CTE of the substrate. If the CTE mismatch is too great for the die size, the bond can fail, and the die can separate from the substrate. Diemat's Application Specific Size Chart shows for popular Diemat products the recommended maximum die sizes for various CTE mismatches of die and substrate materials.

The **width** of the die determines how far the solvent in the adhesive must travel to leave the bondline. Diemat's product data sheets and Application Specific Size Chart show the recommended upper limit to the die size for proper solvent removal.

The bondline of a **thin** die is closer to the top of the die, so it is easier for resin to migrate to the top of the die. Controlling the amount of adhesive dispensed is thus more critical for thin dice.

Backside coating

The metallization or other coating on the back of the die affects adhesion. Most Diemat adhesives bond very well to gold. They also bond well to many unplated surfaces; this can save a metallization step when compared to using solder for die attachment.

Cleanliness

Surfaces must be clean to ensure a good bond. The back of the die must be free of residue from packaging materials such as gel pack or dicing tape.

Substrate

Material

The substrate's coefficient of thermal expansion (CTE) must be close enough to the CTE of the die that thermally induced stress is limited to a safe amount (see "Die – Dimensions", above).

Plating

Plating is not needed, as Diemat's products adhere well to bare ceramic and semiconductors.

In general, Diemat adhesives adhere better to plating than to metal oxides such as copper oxide. Most Diemat adhesives adhere well to gold and silver.

Cleanliness

Surfaces must be clean to ensure a good bond. Conventional techniques and cleaning solutions, such as isopropyl alcohol, may be used where appropriate.

Ambient Environment

Temperature and humidity affect the evaporation rate of solvent. Higher temperature and lower humidity will promote evaporation, which will reduce the open time of solvent-based adhesive.

DISPENSING

Mixing

If packaged in **jars**, Diemat's conductive adhesives must be mixed completely so as to uniformly distribute filler particles and other ingredients. Manual stirring must be gentle to avoid trapping air in the adhesive, but thorough enough to mix in all settled solids. A square-tipped metal spatula such as the Fisher Scientific model 14-375-20 is recommended to reach all solids on the bottom and sidewalls. Storing jars on a roller such as Diemat's 8010 maintains uniform particle dispersion and removes air bubbles.

Before Diemat adhesives are packaged in **syringes**, they are mixed thoroughly, degassed and frozen. They should be frozen until use but not mixed further.

Dispensing equipment

Various Diemat products may be applied via needle dispensing, stamping/pin transfer, jetting, screen printing, or manually. Some adhesives have been especially formulated for certain types of equipment, and should be used on compatible equipment. (For example, DM6030Hk-PT was designed for pin transfer / epoxy stamping machines.)

Dispense pattern and amount

Enough adhesive must be used under the die to create adequate bond line thickness (see below) and a fillet around the perimeter of the die. A uniform fillet of adhesive should surround the perimeter of the die (or the smaller of the two components being bonded). The height of the fillet should be approximately 50% of the die thickness. This fillet shape promotes solvent removal during curing and mechanically anchors the component to the substrate.

The dispense pattern should be compatible with the amount of adhesive and the size and shape of the die.

Bond line thickness

Adhesives containing filler need a minimum bond line thickness (BLT) to cover the filler particles and wet the surfaces being bonded. Bond lines that are too thin do not have enough resin to form a good bond for adhesion and thermal transfer. Typical minimum recommended bondline thickness (as applied "wet", before curing) is in the range of 1-2 mils (25-50 microns). Cured BLT should be at least 0.8 mils (20 microns). These are typical guidelines; always follow the specific guidance in the product's data sheet.

If the substrate is warped, care must be taken that the minimum BLT is achieved at all points across the bond.

Syringe working life

Because dense silver particles in conductive adhesives will settle over extended time, the working life of the syringe after thawing is 8-16 hours.

Material remaining in a syringe should not be frozen and re-used because multiple freeze/thaw cycles can cause voids and air bubbles.

PROCESSING

Open time

Open time is the time after dispensing the adhesive and before placing the die on the adhesive. It is limited by evaporation of solvent from the adhesive. If the adhesive dries out, it will not fully wet the die, resulting in poor adhesion and thermal performance.

For smaller die sizes, where the ratio of surface area to volume of the dispense pattern is larger, solvent evaporates quickly, and open time must be short.

Certain Diemat products have been engineered for long open time, including DM6030Hk-SD. Please see each product's data sheet for recommended open times.

Staging time

Staging time is the time between placing the die on the adhesive and starting the cure process. If the staging time is too long, fillers can settle, certain ingredients can bleed and migrate from the bondline, or the adhesive can dry out. If filler ingredients settle, adhesion and thermal performance can decrease. Bleeding can interfere with wire bonding. Drying out can reduce adhesion and conductivity. The smaller the amount of adhesive dispensed, the faster it can dry out. Certain Diemat products have been engineered for longer staging time, including DM6030Hk-SD. Please see the product's data sheet for recommended staging times.

Curing equipment

Processes using batch ovens often need long staging times, to allow for a batch to cure in an oven. Conveyor furnaces and ovens enable a continuous process, where staging time can be very short, which contributes to high-quality bonds.

Ramp rate

Many Diemat adhesives contain solvents. The ramp rate to peak curing temperature is critical to properly remove the solvent. The ramp rate must be slow enough to allow the solvent to escape before the resin cures. Ramp rate is more critical with larger components, where the solvent must travel a longer path to escape. Each product's data sheet contains a recommended range of ramp rates.

Cure temperature and dwell time

The peak curing temperature and dwell time are key factors when curing the resin. Typically, Diemat's data sheets contain three sets of recommended temperature/time combinations. These temperatures refer to the bondline temperature, which may vary from the oven's temperature indicator reading. To measure the process temperature accurately, place a thermocouple as close as possible to the bondline and monitor with a recording device.

Measuring bond line temperature is especially important if your assembly, work holder, or fixture has a high thermal mass, or if the oven is loaded excessively.

Minimize the number and durations of door openings during the profile, as the oven and bonded parts may take a while to restore the proper temperature. If the oven temperature drops while the oven is opened during curing, the profile may need to be extended.

Forced-air circulation and exhaust

Many Diemat adhesives contain solvents. These must be removed during the cure profile so that the resin can cure completely. Fan circulation and exhaust ventilation will remove the solvent as it leaves the bondline.

Fan circulation also promotes even temperature distribution and control.

Variation in exhaust flow rate can lead to variability in cure quality.

Clean air intake

The air intake for the oven ventilation must be located away from sources of contamination such as oven exhaust, chlorinated solvent vapors from cleaning stations, and oil fumes from pumps.

Curing atmosphere

Diemat adhesives may be cured in standard ambient air. Dry air and nitrogen are acceptable but not required. Vacuum curing is not recommended, particularly for adhesives containing solvents.

Outgassing of co-cured materials

Other materials that are being cured near the Diemat adhesive may outgas chemicals that could interfere with the curing and interface bonding of the Diemat adhesive. Please consult Diemat for further details.

Epoxy resin bleeding

Under certain processing conditions, a portion of the resin component of a filled epoxy adhesive can migrate or "bleed" from where it was dispensed to adjacent areas, before or during the curing process. This resin bleeding is caused by a difference in surface energy between the adhesive and the surface to which it is applied. Materials with high surface energies, such as gold and ceramics, have higher energies than epoxy adhesives. These high surface-energy materials attract the resin, which can travel across a substrate or leadframe and up the side of a die or the wall of a package cavity.

The migrated resin can cover bond pads on a die or leadframe, substrate, or package and interfere with wirebonding. Migration of resin from the bondline can reduce the adhesive's wetting of die and substrate and reduce the bond's adhesive strength and increase its thermal resistance.

For further information on epoxy resin bleeding, including materials and processing techniques to mitigate it, consult the Diemat document "Epoxy Resin Bleeding: Causes and Mitigation".

ADHESION TESTING

Test method and equipment

Bond strength can be tested via shear or tensile methods. Shear testing is more common; tensile is used for testing larger components (greater than 10 mm or 400 mils long).

In shear testing, the die is pushed in a direction parallel to the substrate. Diemat's shear test method is similar to that specified in MIL-STD-883F, Method 2019.7.

In tensile testing, the die is pulled in a direction perpendicular to the bondline. Diemat's tensile test method is similar to that specified in MIL-STD-883F, Method 2027.2.

Test temperature and timing

Adhesion strength is greater at room temperature than at higher temperatures. Assemblies tested directly after removal from a curing oven while still warm will measure lower in bond strength.

After the assembly is cured and returns to room temperature, bond strength can increase for the next 16 hours. Adhesion testing should be delayed if maximum values are required.

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Revised: 030808