

Two-Part, Thermally Conductive, Liquid Dispensable Gap Filler Materials

Introduction

Effective thermal management is key to ensuring consistent performance and long term reliability of many electronic devices. With the wide variety of applications requiring thermal management, the need for alternative thermal material solutions and innovative material placement methods continues to grow. In response, Bergquist has developed a family of dispensable liquid polymer materials with unique characteristics especially designed for ultimate thermal management design and component assembly flexibility.

Two-Part Gap Fillers

Bergquist two-part, cure-in-place materials are dispensed as a liquid onto the target surface. As the components are assembled, the material will wet-out to the adjacent surfaces, filling even the smallest gaps and air voids. Once cured, the material remains a flexible and soft elastomer; designed to assist in relieving coefficient of thermal expansion (CTE) mismatch stresses during thermal cycling. Gap Filler is ideally suited for applications where pads cannot perform adequately, can be used to replace grease or potting compounds and is currently used in power supply, telecom, digital, and automotive applications.

Liquid Gap Filler Key Performance Benefits

Ultra Low Modulus: Minimal Stress During Assembly

Because Gap Filler is dispensed and wet-out in its liquid state, the material will create virtually zero stress on components during the assembly process. Gap Filler can be used to interface even the most fragile and delicate devices.

Excellent Conformability to Intricate Geometries

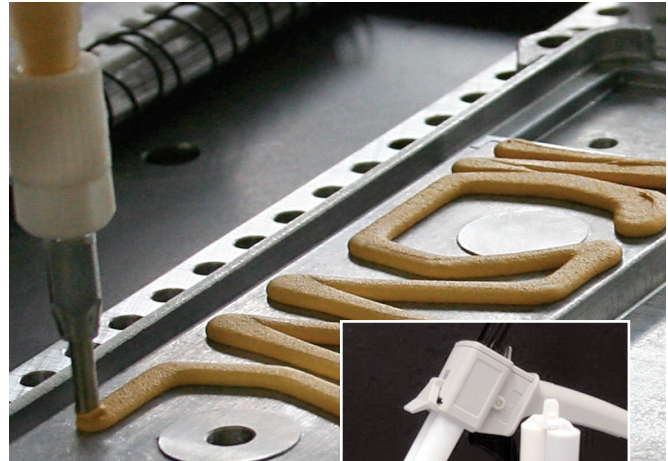
Liquid Gap Filler materials are able to conform to intricate topographies, including multi-level surfaces. Due to its increased mobility prior to cure, Gap Filler can fill small air voids, crevices, and holes, reducing overall thermal resistance to the heat generating device.

Customizable Flow Characteristics

Although Gap Fillers are designed to flow easily under minimal pressure, they are thixotropic in nature which helps the material remain in place after dispensing and prior to cure. Bergquist Gap Filler offerings include a range of rheological characteristics and can be tailored to meet customer specific flow requirements from self-leveling to highly thixotropic materials that maintain their form as dispensed.

Single Solution for Multiple Applications

Unlike pre-cured gap filling materials, the liquid approach offers infinite thickness options and eliminates the need for specific pad thicknesses or die-cut shapes for individual applications.



Gap Filler solutions provide easy dispensing and efficient heat transfer in electronic applications

Efficient Material Usage

Manual or semi-automatic dispensing tools can be used to apply material directly to the target surface resulting in effective use of material with minimal waste. Further maximization of material usage can be achieved with implementation of automated dispensing equipment, which allows for precise material placement and reduces the application time of the material.

Material Characteristics

Thixotropic Behavior

Bergquist Gap Fillers are thixotropic to varying degrees, meaning that dispensed material will retain its shape until an outside force is applied to wet-out the material to the adjacent surfaces. These materials have a relatively high at-rest viscosity. However, when a shear force is applied, such as during the dispensing process, the viscosity decreases, allowing for ease of dispensing. After dispensing, the material viscosity will rebound, allowing the material to remain in place on the assembly and hold its shape without running or dripping.

Viscosity Dependence on Shear Rate

Due to the thixotropic characteristics of most Gap Fillers, special consideration should be given to the test method(s) used to determine viscosity of these materials. Because the material viscosity is dependent on shear rate, different measurement equipment testing under varying shear rates will produce varied viscosity readings. When comparing apparent viscosities of multiple materials, it is important to ensure that the data was generated using the same test method and test conditions (therefore the same shear rate). Bergquist test methods and conditions are noted in the individual product data sheets.

Slump Resistance

Slump resistance is defined as the measure of a material's internal cohesive characteristics (material consistency) combined with its target adhesive characteristics (ability to adhere to the target surface). This characteristic is intended to provide an indicator of how the material will behave in the assembly process, after dispensing and prior to cure. Bergquist offers products across a range of slump resistance levels; refer to product data sheets and Slump Testing Application Note for further information.

Pot Life and Cure Time

Two-part Gap Filler systems begin curing once the two components are mixed together. Bergquist defines the pot life of a two-part system as the time for the viscosity to double after parts A and B are mixed. Pot life is heavily dependent on temperature. Pot life will decrease at temperatures above 25°C and increase at temperatures below 25°C. Bergquist defines the cure time of a two-part material as the time to reach 90% cure after mixing. Two-part Gap Fillers will cure at room temperature (25°C), or cure time can be accelerated with exposure to elevated temperatures. Bergquist materials are available in several pot life and cure time variations; see product data sheets for specifics.

Adhesion

Although Gap Fillers are not designed as structural adhesives, when cured, they have a low level of natural tack, which will allow the material to adhere mildly to adjacent components. This aids in keeping the material in the interface throughout repeated temperature cycling and eliminates pump-out from the interface. Factors affecting adhesion include surface cleanliness, geometry, and texture.

Shelf Life

Bergquist two-part liquid Gap Filler material has a defined shelf life measured from the date of manufacture, when stored in the original sealed container in a climate controlled environment at 25°C and 50% Relative Humidity. Shelf life for specific Bergquist materials is identified on product data sheets. Short periods of time above the recommended storage temperature, such as during shipping, have not been shown to affect the material characteristics.

Bergquist does not advocate using material beyond the recommended shelf life and is unable to recertify material that has expired. In order to ensure timely use of product, Bergquist recommends a first-in-first-out (FIFO) inventory system. Bergquist is not able to ensure the full stated shelf life from the time of customer receipt. Bergquist will ship these products with no less than 80% of the stated shelf life remaining.

Separation/Settling

Under normal storage conditions at 25°C there will be minimal settling of most Gap Fillers during the shelf life. However, some amount of settling (typically up to 5% by weight) is inherent with highly filled materials and cannot be avoided. When dispensing from a new cartridge or pail, it is recommended to purge sufficient material until a uniform consistency is achieved.



Container Sizes (left to right): 50cc, 200cc, 400cc, 600cc.

Usage Recommendations

Containers

Sample Sizes: Bergquist typically supplies samples of two-part systems in 50cc dual cartridges (25cc each of parts A and B).

Order Sizes: Bergquist offers a wide range of container sizes for its products. Dual cartridges are available in 200cc (100 cc each of parts A and B) and 400cc (200 cc each of parts A and B) sizes. Gap fillers are also available in kits of 1200cc (two stand-alone 600cc containers, one of each part), 2-gallon (two one-gallon pails, one of each part), and 10-gallon (two 5-gallon pails, one of each part) sizes for volume production. Other special and custom container sizes are available upon request.

Shipping and Storage

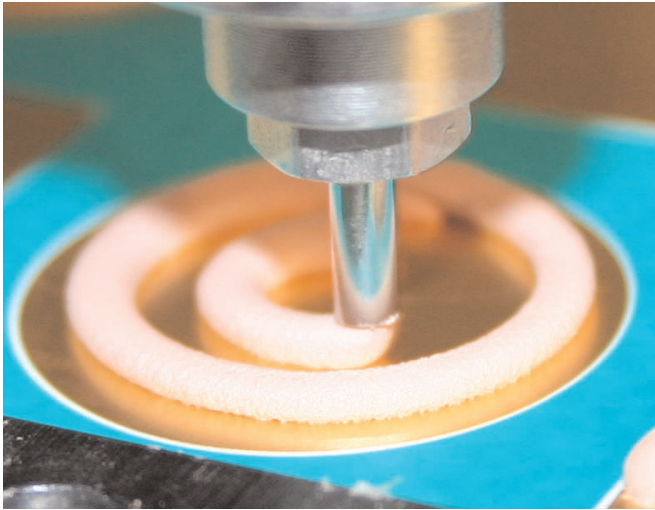
Unless otherwise indicated on product data sheets, two-part Gap Fillers should be stored in the original sealed container in a climate controlled environment at or below 25°C and 50% relative humidity. If stored at reduced temperatures, materials should be placed at room temperature and allowed to stabilize prior to use. Unless otherwise noted, all cartridges and tubes should be stored in Bergquist defined packaging with the nozzle end down to help minimize air voids within the material and help minimize potential silicone migration around the end caps/plugs.

Operating Temperature Ranges

For silicone based Gap Fillers, the continuous use operating temperature range is typically from -60°C to 200°C (-76°F to 392°F) for extended periods of time, except when otherwise noted on product specific data sheets. Note however, that at both the low and high end of the temperature spectrum, the behavior of the materials and the performance in specific applications can require additional attention to ensure suitability for the conditions.

Mixing Tolerances

Two-part materials must be mixed to a 1-to-1 ratio by volume within a $\pm 5\%$ tolerance to ensure proper cured hardness, pot life, and cure time. If light colored streaks or marbling are present in the material, there has been inadequate mixing. In order to ensure consistent material characteristics and performance, Bergquist two-part systems are always to be used with matching part A and B lot numbers.



Static Mixing Nozzles

Disposable plastic static mixing nozzles are used to mix parts A and B together at the desired ratio. Static mixers can be attached to the ends of cartridges or mounted on automated dispensing equipment. They are reliable, accurate and inexpensive to replace after extended down times. Unless otherwise indicated, mixing nozzles with a minimum of 21 mixing elements are recommended to achieve proper mixing. When first using new two part containers, Bergquist recommends purging sufficient material through a static mixer until a uniform color is noticed, to ensure complete mixing.

Material should not sit idle in the mixing tube longer than the stated pot life of the material, otherwise material will begin to thicken and eventually cure in the mixer. If this occurs the mixer should be disposed of and replaced with a new mixer. As temperature increases, pot life decreases. Therefore, if the ambient temperature at the point of dispensing is greater than 25°C , there may be a need to change out the mixing nozzle more frequently than the stated pot life would indicate. The actual frequency of mixer change-out should be determined by the customer, based on their specific plant operating conditions.

Dispensing

Manual: Bergquist offers applicator guns and static mixing equipment for product supplied in dual cartridge form. The use of industry standard applicator guns and static mixing nozzles are an inexpensive means for dispensing product for sampling and low volume production. Manual hand triggered guns are available for 50cc, 200cc, and 400cc cartridge sizes. Pneumatic operated guns are also available for 200cc and 400cc cartridge sizes.

Automated: Bergquist Gap Filler supplied in high volume container kits can be dispensed via automated dispensing equipment for high-speed in-line manufacturing. Bergquist containers are designed for use in dispensing units for quick and easy loading and unloading. High volume container sizes are 1200cc, 2-gallon, and 10-gallon kits.

Automated Dispensing Equipment Alliances

Bergquist has aligned with several experienced automated dispensing equipment vendors to further assist our customers in creating an optimized dispensing process. For information regarding dispensing equipment, contact your local Bergquist representative.

Surface Preparation

All surfaces should be thoroughly cleaned and degreased with solvents such as acetone, isopropyl alcohol (IPA), mineral spirits, naphtha, or methyl ethyl ketone (MEK). Allow surface to dry completely prior to applying material. Depending on the surface, certain cleaning techniques may give better results than others. Customers should determine the best cleaning technique for their application.

De-Airing

Air entrainment in the material should be avoided whenever possible. Proper design and use of dispensing equipment can help to minimize the introduction of air. The absence of air will optimize thermal and electrical performance and minimize the probability for corona, arcing, and electrical failure in high-voltage applications. Bergquist takes every precaution to minimize the presence of air in its liquid material.

Chemical Exposure

Bergquist cured liquid elastomers are generally very resistant to fuels, solvents, oils, acid, and alkali solutions. The exception is strong oxidizing agents, such as concentrated sulfuric acid solutions, which may decompose the elastomer systems. Solvents and fuels may cause the elastomers to swell and become soft under heavy exposure. However, when the elastomers are allowed to dry out they will return to their original size and hardness. Note however, that Bergquist Gap Fillers are designed for intermittent exposures only. Bergquist recommends that customers test the material in the application under actual service conditions to confirm compatibility.

Compatibility

The following is a list of general categories of compounds that may inhibit the rate of cure or poison the curing catalyst in Gap Filler products. It is important to avoid use of these compounds in cleaning or priming parts that will be in contact with Gap Filler products.

Compounds Containing Unsaturated Bonds

- Alkynes
- Acrylates
- Alkenes and Olefins

Compounds Containing Nitrogen

- Amines
- Oximo, Nitroso, Hydrazo, Azo compounds
- Amides
- Chelates
 - EDTA
 - NTA
- Nitriles
- Cyanates

Compounds Containing Sulfur

- Sulfides
- Thio compounds

Compounds Containing Phosphorous

- Phosphines
- Phosphites

Organotin Compounds

- Tin alkoxides
- Tin carboxylates

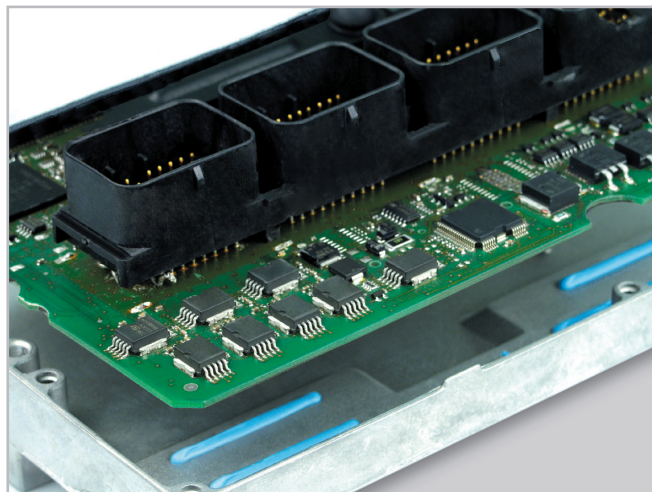
If there are potential compatibility questions or concerns, it is recommended that a test be run to determine suitability in a given application. Incomplete surface cure at the interface between the questioned substrate and Bergquist material indicates an incompatibility.

Rework and Material Removal

When manufacturing electronic components/devices, it is often desirable to salvage or reclaim damaged or defective units. Most rigid potting or epoxy adhesive materials will not allow for any material removal without first damaging the electronic components they are applied to. In contrast, Bergquist Gap Filler may be removed with relative ease in many applications, allowing for rework.

The following steps can be utilized to remove material from the interface needing rework.

- Separate the two halves of the assembly interfaced by the Gap Filler. This process is under the customer's discretion with respect to the sensitivity of the application and its components. Solvents such as MEK, Toluene, and IPA can be used to weaken the Gap Filler interface bond if necessary. Disassembly may be performed with the help of thin putty knives or thread saws, being sure to work against the heat sink side of the interface.
- Once disassembled, cut or peel away the bulk material.
- Remove remaining material using mechanical means such as rubbing or gentle scraping with a non-marking tool. Additional solvent can be used to improve the ease of removal.
- Proceed with repair.
- Re-apply new material to the clean and dry surfaces and reassemble the application.



Bergquist Gap Filler 3500S35 in a PCB to housing application.



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