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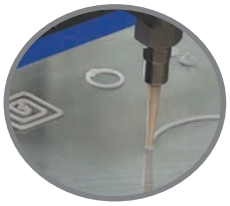
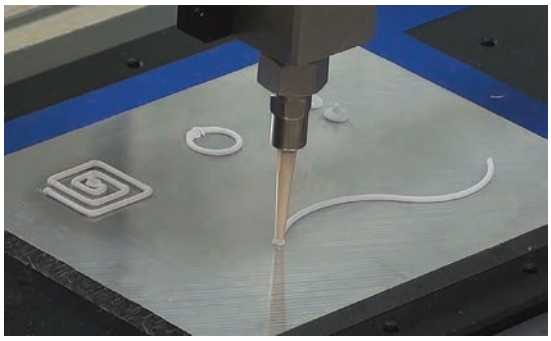
Dispensing Thermal Interface Material (TIM)

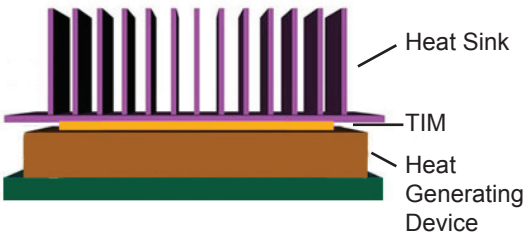

Dispensing Common Liquid Thermal Interface Material (TIM)

What is TIM?

Thermal Interface Materials (TIMs) are thermally conductive compounds designed to fill gaps between heat generating electronic devices (semiconductors) and a heat sink or outer case. They are ideal for filling variable thickness gaps and providing very low stress on embedded components, providing long term reliability for many electronic devices. As electronic devices continue to get smaller and more powerful, the need for TIM dispensing solutions grows.



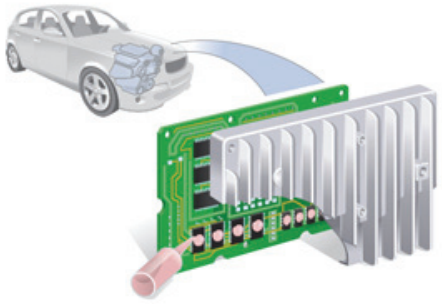
Liquid TIM is generally offered in single component or 2-component chemistries. Single component varieties are often pre-cured, resin based pastes or greases. They are heavily filled with ceramic particles (commonly aluminum oxide) for conducting heat. They may also be filled with glass beads which act as spacers for electrical isolation. From a processing standpoint, the advantages of a single component TIM include; 1) no post dispense cure required, 2) fewer pumping components required, and 3) no precision meter mixing equipment necessary.



Two component varieties are also generally heavily ceramic filled, resin based pastes. The 2-component materials generally have better flow characteristics than the single component varieties, allowing for higher dispense rates. However, processing them requires more complex equipment to properly proportion the individual components.

Typical TIM Applications

TIM serves as a conduit for dispelling heat between a semiconductor and the outer case or heat sink, and can be used wherever there is a need to dissipate heat from an electronic device. Due to their highly flexible nature, they offer protection from extreme temperature cycling, thermal shock, and vibration. Consequently, they are widely used in automotive, industrial, and consumer electronics applications. Examples include engine control modules, power supplies, LED modules, televisions and cellular phones.



Artwork courtesy of Parker Chomerics

- ▲ LED
- ▲ Industrial
- ▲ Military
- ▲ Aerospace
- ▲ Telecommunications
- ▲ Automotive
- ▲ Consumer Electronics

Challenges of TIM Dispensing

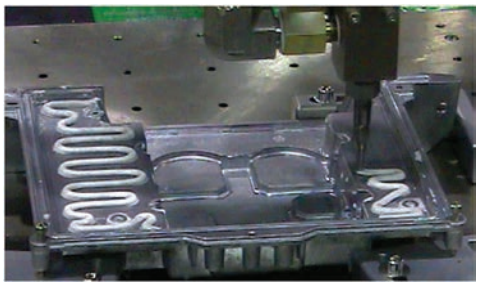
Due to the heavily filled, highly abrasive nature of TIM, processing these materials requires specialized equipment for transferring and dosing. There are two major considerations that must be taken into account when specifying process equipment; 1) separation of the fillers from the resin, and 2) material shear. Neglecting to consider these two issues will result not only in poor process equipment performance, but also poor material performance or even failure. Subsequently you may experience equipment down time, excessive maintenance, replacement expenditures, and most importantly product failure.

Separation of the filler from the resin means the material is no longer homogeneous. A non-homogeneous product will produce inconsistent material properties (thermal conductivity and electrical isolation) which is naturally undesirable (and unacceptable) from a product quality standpoint. Secondly, excessive material separation leads to binding and eventual failure of the processing equipment such as pumps, valves, and metering components.

Shear is another major consideration. Processing equipment which imparts excessive shear to the TIM will also affect the material properties by breaking down the fillers and embedded

spacers. Industry standard reciprocating pumps traditionally used for sealants and adhesives will often completely alter the appearance of the material because it has been sheared so extensively. A pump causing that much shear is destined to a short life expectancy as the moving parts grind away at the abrasive fillers.

Other challenges of TIM dispensing include getting acceptable life out of the seals in the pumps and valves, achieving desirable rate of dispense, dosing consistent volumes, and preventing tails or stringing from the dispense valve.



Dispensing TIM onto aluminum casting

Considerations for Specifying Equipment for TIM Applications

Beyond concerns about material separation and shear, there are other considerations which must be taken into account when selecting an appropriate TIM dispensing solution. Among these are:

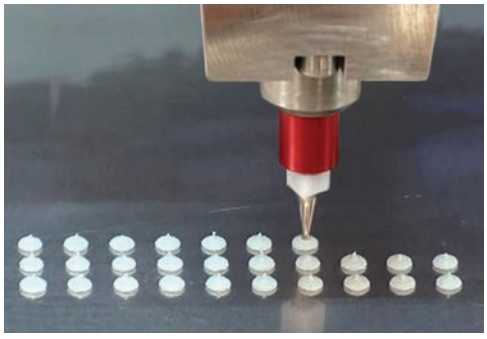
1) Container type, size, and availability
2) Cycle time / dispense rate
3) Dispense accuracy/precision
4) Maintenance intervals and costs

TIM is packaged in a variety of different ways, options are dependent on many factors including:

1) Single component or 2-component
2) Low volume applications or high volume applications
3) Pre-cured or “cure in place”
4) Manufacturer preferences and global location
5) Process equipment considerations

Typical packaging used for automated dispensing include 20oz. plastic cartridges, 1-gallon steel pails, and 5-gallon steel or plastic pails.

Dispense rate is also very important when cycle time is an issue. As dispense rate increases, so does the system pressure. The process equipment and/or the TIM container must be rated for the pressure required to achieve the desired dispense rate. Some of the more economical TIM equipment designs pressurize the supply container itself, while other more expensive equipment transfers the material from the supply container to a secondary high pressure pump. The type of pump design can also play a big role in achieving the desired dispense rate. There are “continuous” type pumping solutions which can pump an infinitely large volume, versus a “shot” type pump which can only dispense a discrete volume of material. These “shot” type pumps also require a recharge time, which may have an impact on the total cycle time.



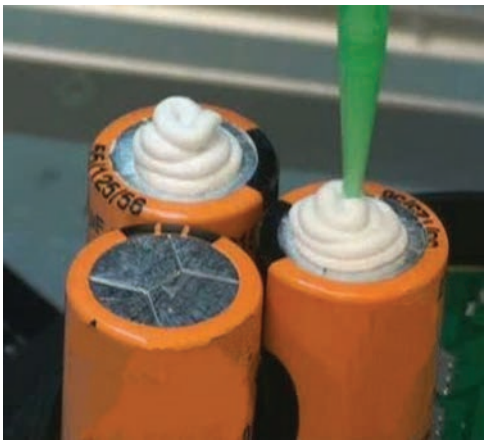
Dispensing 12 mg dots

Determining the level of dispense accuracy/precision required for the application can have a big impact on the process equipment selection and thereby cost of the equipment. More forgiving applications may only require a simple “time and pressure” solution, meaning that the material is placed under pressure and then forced out of an applicator valve for a predetermined period of time. While this setup can be relatively simple and inexpensive, the repeatability of such a system cannot be expected to yield better than +/- 10% repeatability. More stringent applications require a “metered” solution, incorporating the use of a positive displacement pump, which could include rod-displacement or progressive cavity pump technology. A metering pump could be expected to achieve +/- 5% repeatability or better, depending on application and material specifications. The cost difference between the “time and pressure” and “metered” systems can be substantial so it is extremely important to identify the true requirements for the application.

Finally, maintenance intervals and subsequent operation costs are always a consideration in any equipment purchase. Simple time and pressure solutions are obviously going to be easier

and less expensive to maintain. Metering equipment on the other hand, is generally much more complex, thereby requiring more expensive components and rebuild time.

In summary, properly identifying the key requirements for the given application is critical to making the "correct" TIM process equipment selection. Failure to do so can result in struggling with either equipment that is too simple to perform the job, or too expensive to justify and maintain.



Dispensing TIM onto a capacitor

Preferred Process Equipment for TIM Applications

Time and Pressure Systems

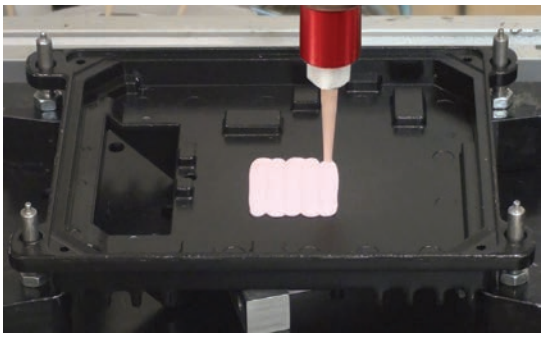
Bearing in mind the challenges of TIM dispensing discussed earlier, the preferred process equipment using the time and pressure method consists of a mechanical ram to force the TIM directly out of the original container. Most commonly this will be a 20oz plastic cartridge, 1-gal steel pail, or 5-gal steel pail. The TIM is "extruded" from the container rather than pumped in the traditional sense, meaning there are no reciprocating or rotating parts involved.

Simply extruding the material through high pressure hose to an applicator valve places very little shear on the abrasive fillers in the TIM, while eliminating any wear issue that would be associated with a traditional pump. The actuator for the mechanical ram can be driven by hydraulic or pneumatic cylinders. The moving parts in the applicator valve should be constructed of carbide for long service life.

Metering Systems

Preferred metering system configurations for TIM dispensing come in the form of an electro-mechanically actuated ram pump feeding a carbide constructed applicator valve, a progressive cavity pump, or some combination of ram and progressive cavity pump. The overall design should be engineered on a case by case basis, considering the application and process requirements.

The electro-mechanical ram pump design uses a heavy duty lead screw driven by a servo motor to force (or "ram") a plunger or follower plate into the original material container. The TIM is extruded from the container in the same way as the time and pressure systems, but at a controlled rate. The ram is driven closed loop for very precise control over the dispense rate and volume. Once extruded from the container, the material is forced through a high pressure hose and to a carbide constructed applicator valve.



Dispensing TIM onto metal housing

Progressive cavity pumps operate similar to an auger. They are constructed of two basic elements; 1) a steel rotor, and 2) an elastomeric stator. They handle abrasive materials very well, provide very precise, pulseless flow, and impart very little shear on the TIM. The flow rate is directly proportional to the rotation of the pump.

For metering applications, the progressive cavity pump is operated by a closed loop servo motor for very precise control over the dispense rate and volume. The applicator valve is generally not required for progressive cavity systems.

References:

Parker Chomerics
The Bergquist Company

PVA Options for Thermal Interface Materials

Automated dispensing of TIMs has many challenges based on the material composition, target dispense amount and desired process repeatability. PVA has developed various tools, for accurately dispensing TIM materials, that are easy to operate and maintain. These systems handle multiple package sizes and provide a wide range of dispensed shot capability.

Options for Single Part TIMs

High Flow Dispense Valve
- SB300-C Dispense Valve

Progressive Cavity Pumps
- VPX-450 Volumetric Pump

Simple Tme & Pressure Systems
- 20oz. cartridge ram pump, pneumatic driven
- PVA-1GPU One Gallon Hydraulic Metering Pump
- PVA-5GPU Five Gallon Hydraulic Metering Pump

Positive Displacement Metering Systems
- 20oz. cartridge ram pump, servo driven
- Closed loop progressive cavity metering system

SB300-C Dispense Valve

VPX-450 Volumetric Pump

PVA-1GPU One Gallon Hydraulic Metering Pump

Options for 2-Part TIMs

Plural Component Mixing Valve
- PC200-TCM 2-Part Dispense Valve

Progressive Cavity Pumps
- VPX-2K Volumetric Pump

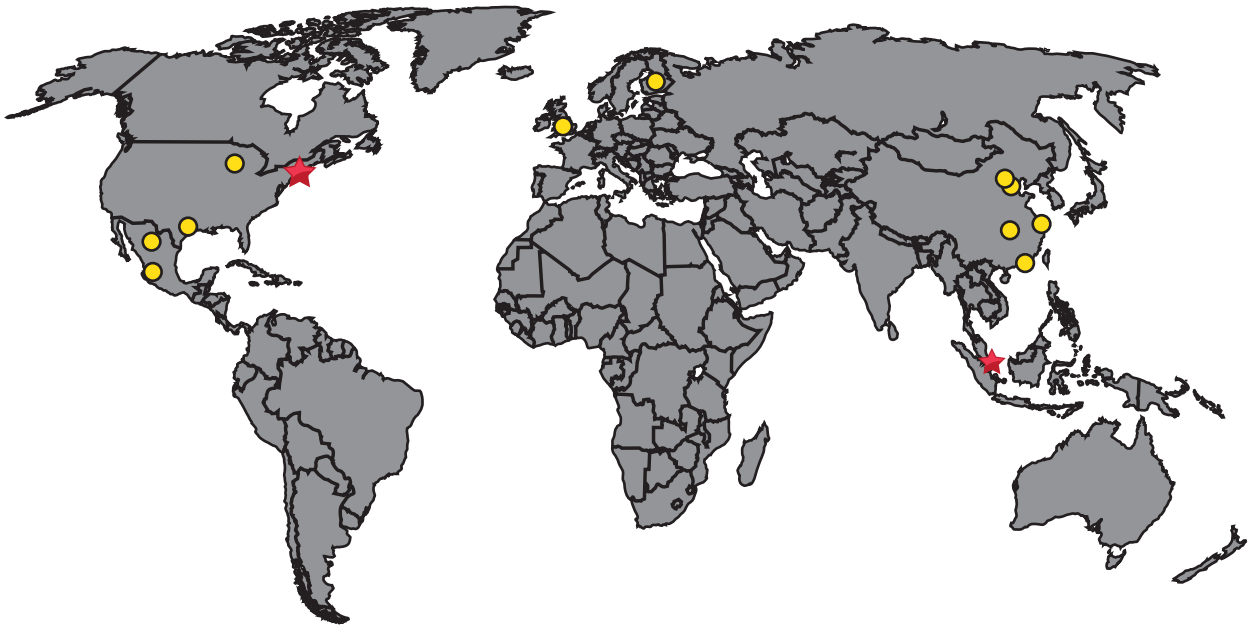
Positive Displacement Metering Systems
- PV202K-TCM Cartridge Drive System
- 2-part metering head mounted inside workcell in combination with two 5-gal pail pumps

PC200-TCM 2-Part Dispense Valve

VPX-2K Volumetric Pump

PV202K-TCM Cartridge Drive System

Contact our experts to help you determine the right process and equipment for your dispensing needs: info@pva.net



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