Thermally Conductive Adhesives

In the realm of thermal interface materials (TIMs) there are a number of different options including: adhesives, pads, greases, phase change materials (PCMs), gels and tapes. You might be asking "With all these options, where would I use a thermally conductive adhesive?" The short answer is – almost anywhere you need to get heat across an interface. In this short paper we'll take a closer look at what makes certain TIMs particularly suitable for certain applications and, specifically, where adhesives are useful.

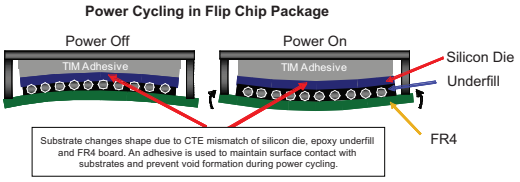
Proper TIM selection is based on many factors including power density, heat dissipation, bond line thickness (BLT), processing requirements, reworkability and user preferences. TIM usage and applications can be broken down into three general categories:

1. Pads and gels are generally used in applications with large gaps or sensitive components that require cushioning.
2. Greases or PCMs are generally used in applications with high thermal dissipation and thin bond lines that require conformable intimate contact between substrates.
3. Adhesives may be the best choice for applications where components do not have hardware for mechanical attachments or where micro movement of substrates requires adhesion to maintain surface contact with substrates.

Often the categories are not as clearly defined as above, and different TIMs can be used interchangeably depending on the combination of requirements and user preference.

Let's take a look at some specific examples where a thermally conductive adhesive might be used and why.

- TIM 1 adhesive for semiconductor packaging – Conductive adhesives are often used as the interface between the silicon chip and lid or heat spreader. One reason an adhesive is desirable is because the silicon chip flexes during power cycling due to the CTE mismatch between different components of the device. Adhesion of the TIM helps to prevent delamination and maintain good surface contact with the substrates.



- In some applications a thermally conductive adhesive can be used to replace solder. One example is in heat sink construction. Traditionally the joint between a heat pipe and the finned heat sink has been a solder joint; however, an adhesive can be used instead for cost savings or other reasons. One customer recently changed to a thermally conductive adhesive in this application because it allowed them to make a more aesthetically pleasing heat sink.

- Thermally conductive adhesives are used in a wide variety of applications to replace screws, bolts, clamps or other forms of mechanical attachment devices.
- Thermally conductive adhesives are often used in automotive electronics to conduct heat away from chips, large capacitors and inductors, while at the same time replacing screws to attach the board down to a metal substrate or housing.
- Thermally conductive adhesives are also used on larger capacitors and inductors both to pull heat away and to act as vibration isolators to "fixture" or "stake" the taller components to prevent them from coming into contact with nearby components or module features.
- In some cases where an application demands a thermally conductive adhesive in one area of a device and a non-conductive adhesive in another area, the customer may choose to use the thermally conductive adhesive for both purposes rather than investing time and cost in a second dispense station.
- Some thermally conductive adhesives in the Dow Corning product line also have electrical conductivity (*Dow Corning*® DA-6534 Adhesive) and in this case can be used not only to conduct heat away but also as an electrical ground to the board.

Besides the thermal properties of these adhesives, they have the added benefit of being silicones. Silicones generally can be made softer with more elongation than organic adhesives and epoxies. These characteristics provide a cushion for components that many customers value because it increases device reliability.

When evaluating a thermally conductive adhesive there are six basic attributes to take into account:

- Thermal conductivity
- Bond line thickness
- Adhesion strength
- Elongation
- Modulus or hardness
- Cure conditions

If you are already using silicone adhesives for other applications, you will recognize that the difference here is the thermal component. It is important to note that because conductive adhesives are loaded with conductive filler particles, they will generally be harder and have less elongation than their unfilled counterparts.

On the next page, you can see the complete line of Dow Corning thermally conductive adhesives. For information on other properties, please refer to product data sheets.

Product	Thermal Conductivity (W/mK)	Form	Cure Conditions
Dow Corning® TC-2030 Adhesive	2.6	Two-part	60 min @ 130° C
Dow Corning® 1-4173 Thermally Conductive Adhesive	1.9	One-part	20 min @ 150° C
Dow Corning® 3-6752 Thermally Conductive Adhesive	1.72	One-part	3 min @ 160° C
Dow Corning® SE 4486	1.59	One-part	RTV 48 hrs @ RT*
Dow Corning® 3-6753 Thermally Conductive Adhesive	1.1	Two-part	10 min @ 150° C
Dow Corning® 3-6751 Thermally Conductive Adhesive	1.1	Two-part	10 min @ 150° C
Dow Corning® 3-6605 Thermally Conductive Adhesive	0.85	Two-part	15 min @ 150° C
Dow Corning® SE 9184 White RTV	0.84	One-part	RTV 48 hrs @ RT*
Dow Corning® Q1-9226 Thermally Conductive Adhesive	0.74	Two-part	30 min @ 150° C

* Cure time for moisture cure adhesives depends on many factors, including ambient temperature, material thickness and relative humidity of cure environment.

Adhesives for Semiconductor Packaging

Product	Thermal Conductivity (W/mK)	Form	Cure Conditions
Dow Corning® DA-6534 Adhesive	6.8	One-part	120 min @ 150° C
Dow Corning® SE 4450 Thermally Conductive Adhesive	1.92	One-part	30 min @ 150° C
Dow Corning® EA-6247 Thermally Conductive Adhesive	1.79	One-part	20 min @ 150° C
Dow Corning® TC-1013	1.2	One-part	60 min @ 150° C

LIMITED WARRANTY INFORMATION – PLEASE READ CAREFULLY

The information contained herein is offered in good faith and is believed to be accurate. However, because conditions and methods of use of our products are beyond our control, this information should not be used in substitution for customer's tests to ensure that our products are safe, effective and fully satisfactory for the intended end use. Suggestions of use shall not be taken as inducements to infringe any patent.

Dow Corning's sole warranty is that our products will meet the sales specifications in effect at the time of shipment.

Your exclusive remedy for breach of such warranty is limited to refund of purchase price or replacement of any product shown to be other than as warranted.

DOW CORNING SPECIFICALLY DISCLAIMS ANY OTHER EXPRESS OR IMPLIED WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY.

DOW CORNING DISCLAIMS LIABILITY FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES.

AMPM028-09 Form No. 11-1751-01

DOW CORNING

We help you invent the future.™