

Discussion on silicone thermal interface materials - Questions and Answers

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Every day, Dow Corning receives numerous requests for our guidance on the use and performance of silicone thermal interface materials. Now you can have the answers to some of your most frequently asked questions right at your fingertips – from Dow Corning experts. Look below for the latest advice on the issues most important to you and your business.

My bond line thickness (BLT) is 30 microns and we have determined that we need a grease but are concerned about pump-out. Does Dow Corning have a solution?

First, let me define pump-out. Pump-out most generally refers to the heating and cooling of a device during on and off periods which cause an expansion and contraction to occur at the thermal interface. This pumping effect can push the material away from the interface and cause a hot spot. This is mostly a concern in high end devices. Sometimes people confuse pump-out with an uncured matrix dripping or spilling onto other devices. For low BLT applications <100 microns this is not a concern because as with most thermal greases there is a strong capillary action and surface energy which prevents grease dripping or migrating even when vertically mounted.

Now to address your question, there are two options to assess when pump-out is concerned:

1. Standard thermal greases are susceptible to pump-out that is generally associated with expansion and contraction during power cycling of any device which pushes the grease away from the interface. Next generation thermal greases from Dow Corning have been developed to minimize or eliminate this pump-out phenomenon by adjusting the rheological properties of the grease.
2. Another option is to utilize a thermal gel which can be screen printed and applied in the same manner as a grease. It has extremely low modulus to overcome the interfacial resistance but the gel will lightly cure in place at the operating temperature of the device thus preventing any chance for pump-out.

Once our device is in use how can we estimate the end of life performance for various thermal material options?

There are generally two methods for assessing the end of life performance of thermally conductive materials: Material Level Heat Aging Studies performed by the material supplier and Device Level Testing typically done by the device manufacturer.

Let's start with the Material Level Heat Aging Studies:

1. First there is an 85°C/85% relative humidity test for a specified period of time 500-1000 hours that tries to accelerate the aging process of the material. This test is done by taking initial measurement of the material, exposing it to 85/85 conditions and then taking measurements every 100 hours through the duration of the test to understand the erosion of the thermal materials. Other heat aging studies such as bake testing, where the material is subjected to 150°C for a 1000 plus hours are also used to understand the potential long term reliability of a thermal interface material.
2. Device level testing: this is done by building a Thermal Test Vehicle (TTV) which mimics the scale and performance requirements of the actual intended device. This TTV has thermal couples and heating elements built into the device to allow for power cycling and

temperature measurement in order to assess the long term impact of power cycling. These devices can also be subjected to heat aging studies to further accelerate material failure.

Will a silicone thermal interface material contaminate my device?

There are a lot of concerns or stories about silicone migration, bleed out and silicone oil negatively impacting electronic components. Historically, when electronic devices relied on mechanical switching devices, early silicone polymers were not well stripped of contaminants. There could sometimes be problems with these contaminants volatilizing and condensing onto the switching devices causing failure or electrical contact. Today's silicone polymers go through extensive stripping processes and contaminant species are controlled. Also, device design has improved to a point where the technology is not as susceptible to any potential silicone contaminants. Having said this, there are some applications such as optical disk drives where material contaminants from any source can foul the optical reader and cause failure over time. In this case, it is recommended that engineering specify controlled silicone polymers for use in these applications.

I am concerned about drying out or separation of my thermal interface material. How can these be avoided?

Many manufacturers, in order to get as much filler as possible into the formulation to increase thermal conductivity, will add solvent to the system to lower viscosity and then allow the solvent to evaporate out over time. The solvent also aids in dispensing and applying the thermal interface material. Often there are complaints of drying out and dispensing the material. This condition can occur when material has been mishandled or left open for long periods of time or is used outside of its shelf life. Dry-out also becomes a problem when the material is applied to a heat sink and left open but not applied to the device until after the solvent has evaporated. Without the solvent, the material will not flow into the intended surface area thus minimizing the effective thermal performance.

This problem can be avoided by minimizing the open

time or by utilizing a non-solvent based thermal interface material. Dow Corning has thermal greases and thermally conductive filler systems that do not require the use of solvents to improve the processability of the material.

What things do I need to look for if I have a need for high temperature stability?

Let's first define temperature stability. Some customers are interested in the ability of a polymer to refrain from degrading at a sustained high temperature. Others are more interested in thermal stability in the context of drying out our volatilization of smaller polymers in the system that can lead to drying out of material and then thermal performance.

With respect to thermal degradation of the polymer, the first thing you need to pay attention to is whether the thermal interface material is an organic or silicone material. Typically, organic materials such as epoxies and urethanes become brittle at temperatures above 120°C. Silicones, on the other hand, are more stable at high temperatures and do not exhibit any of the cracking and crazing associated with thermal degradation that organics experience. In general, organic TC greases can only be used at temperatures up to about 120°C. Standard silicone polymers will not typically show this kind of thermal degradation in use at temperatures less than 200°C.

In the context of volatilization and drying out, the higher the operating temperature, the more likely you can volatilize off larger and larger secondary and tertiary polymers in the matrix. Asking for the Thermogravimetric Analysis (TGA) data on your candidate materials will give you a good indication as to how much volatilization will occur at your anticipated operating temperature. Silicone thermal materials can be designed to withstand high temperatures by using high performance polymers and ensure that any loose polymers are reacted into the polymer matrix.

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