The Hot Spot Solution:
How to Properly Dispense Thermally Conductive Pastes

It weighed over a ton and was big enough to fill an entire living room: The Z3 by Konrad Zuse – the world's first program-controlled computer – had a memory capacity of only 64 words but was able to multiply and divide as well as extract the square root of a value within three seconds. For comparison: A commercially available smartphone nowadays has more processing power than the Apollo Guidance Computer (AGC) – the on-board computer to navigate the Apollo space probe to the moon in 1969.

The trend is obvious: Whether it is in the automotive industry, in communication electronics or in the area of eMobility – new appliances and products become progressively smaller. At the same time, more and more functions should be packed into minimal space. But how can electronic components, assemblies and systems be downsized without them overheating, losing performance or even cause malfunctions?

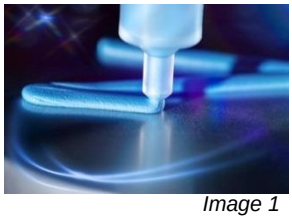

Image 1

In the light of continuously smaller assemblies and rising power density, the issue of thermal management becomes more and more important.

Thermally conductive materials (Image 1) are essential for minimizing heat buildup within electronic components or to effectively dissipate heat. They usually are highly abrasive potting materials with a concentration of special fillers which guarantee a reliable heat transfer between two parts – between a PCB and a heatsink, for instance. This way, the potting materials support the prevention of performance loss and malfunctions of electronic parts caused by overheating. Those materials are commonly referred to as Gap Fillers or thermal interface materials (TIM). Usually they are one or two component potting media, based on silicone, epoxy or polyurethane. Through the addition of additives or fillers, the properties of the thermally conductive pastes can be precisely modified and adjusted to the respective application.

Customized systems technology is key

The thermal conductivity of these pastes is established with fillers like aluminum oxide (Image 2), graphite, silver or boron nitride. These fillers often exhibit very high degrees of

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hardness, as well as sharp edges. When choosing systems for preparing and dispensing thermal pastes, it is imperative to look for manufacturing equipment which is specifically tailored to the application. Otherwise, users face the risk of high maintenance and repair costs.

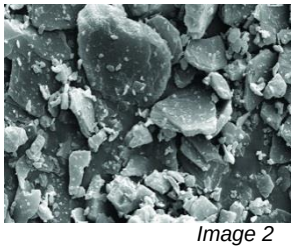

Image 2

Aluminum hydroxide filler, 2000x resolution

The use of single component materials is quite common, since they do not require mixing and thus are supposedly easier to process. In comparison to 2C systems, however, more elaborate logistics are required in this case. Depending on whether cross-linking reactions are initiated through humidity, UV rays or temperature, certain precautions have to be taken so that the curing process of the material does not start prematurely. This may involve continuous cooling of the medium or special storage conditions for pails and cartridges. 2C thermal interface materials, on the other hand, often feature preferable material properties. Additional benefits for operators are shorter curing times and reduced VOC emissions.

Thermal pastes vs. pads and foils

In contrast to solid, die-cut pads or foils for heat dissipation, thermally conductive pastes offer the possibility to realize individual contours on the component and thus enable more design freedom. Due to their conformability, thermally conductive pastes are best suited for components with complex topography or surface texture. Additionally, the fluidity of the material when compressed after its application allows for an improved compensation of possible tolerances. Especially sensitive electrical parts are exposed to less assembly stress, which considerably reduces the risk of rejects. When using pastes, users benefit from an increased performance, since pastes possess a higher thermal conductivity than pads or foils. Further advantages are lower storage costs, reduced or even nonexistent expenditures for handling and assembly as well as the good automation capacity of the material application.

For a process reliable application with a reproducible outcome quality, it is crucial that the material is able to be dispensed by machine. If the thermal interface material is too viscous because of an extremely elevated filler ratio, it can barely be processed anymore. Manual

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application may cause fluctuating material quantities as well as insufficient application accuracy. This could lead to inadequate or not reproducible outcome qualities. In the case of highly filled media, there is also the problem of phase separation or filler sedimentation. Here, the deployment of a proper material preparation system is imperative in order to prevent poor potting results and rejects in the end.

New complete solution for thermal management tasks

When applying thermal pastes, the motto is: As thin as possible and as thick as necessary. While a thin layer impedes complete contact, a thick layer reduces heat dissipation. In order to meet the market's demands for a process reliable entry-level solution for the application of highly viscous thermally conductive pastes, a fully pre-configured and parametrized dispensing and potting cell which is adjusted to approved 1C and 2C thermal interface materials by well-established manufacturers before delivery is now available from a manufacturer based in Germany. Their modular system, the DispensingCell (Image 3) is built from standardized modules. Apart from high quality components, users especially benefit from the system's fast availability. Thanks to Plug and Produce, a fast production launch is guaranteed as well.

Image 3

The new DispensingCell is a fully pre-configured and parameterized entry-level solution, which has been optimized for thermal management tasks.

At this time the DispensingCell is available in three sizes. The single system components can be precisely adjusted to the necessary performance, the required dispensing range and the respective, tested potting material. Kanban and lean production are the basis for short delivery times and an attractive price-performance ratio.

The piston dispenser Dos P016 TCA is able to dispense materials up to three times faster compared to the standard variant.

Image 3

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The optimized piston dispenser (Image 4) offers high dispensing speeds. With this system, thermally conductive potting materials can be applied up to three times faster – and that at a consistently high dispensing accuracy. This is proven by several test series with thermally conductive, silicone-based 2C gap filler. Depending on the version, the piston dispenser was able to reach dispensing speeds of 2.0 ml/s with an accuracy of ± 0.03 g (quantity per shot: 2.3 to 40.8 g) or 0.5 ml/s with an accuracy of ± 0.015 g (quantity per shot: 0.32 to 5.7 g)(Images 5a/5b).

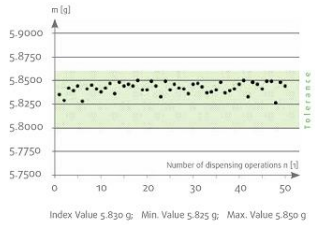

Image 5a

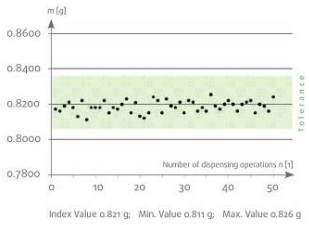

Image 5b

Results of the test series with a highly filled 2C silicone material: These weighing samples show that the Dos P016 TCA is able to achieve top dispensing accuracies.

Conclusion

Because of the increased miniaturization of electric components for mobile devices or automotive applications, the implementation of an effective thermal management is gaining importance. Thermally conductive pastes not only offer high performance and freedom of design; they can also be adapted to the respective task. Due to their high viscosity and the substantial amount of abrasive fillers, dispensing these materials often poses a challenge. But with the proper system technology, economical processes as well as excellent, repeatable dispensing results can be realized.

Images: Scheugenpflug

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About Scheugenpflug:

The Scheugenpflug AG (Neustadt/Donau) is a leading manufacturer of precision engineered systems and machines for efficient adhesive bonding, dispensing and potting processes. The product and technology range extends from cutting-edge material preparation and feeding units and high performance manual work stations to modular in-line and automation solutions, specially tailored to customer specifications. Scheugenpflug systems are used in the automotive and electronics industries as well as the telecommunications sector, medical technology and the chemical industry. The company has four additional locations in the USA, China and Mexico as well as numerous service locations and sales partners all over the world. Due to its considerable expansion Scheugenpflug was able to double its number of employees within 5 years and now employs more than 450 staff.

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