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Beyond Silicone: Elements of New and Improved Thermal Interface Materials

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Typical thermal interface pastes share a common ingredient: silicone. Often a general compound in the adhesion process, silicone-based greases and gels provide a basic utility for heat fluctuation and aid thermal conductivity.

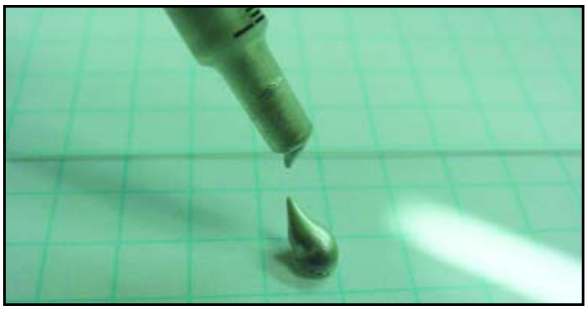
It is not without its faults, however. The adhesive lifespan of silicone-based material and unwanted phase changes compromise the longevity of a typical silicone paste. If voids are created in the interface layer, the material runs the risk of reflecting energy and generating no heat resistance.

This often leads to less thermal conductivity, compromising the circuit boards and other projects. For both hobbyists and corporations, this is one flaw that cannot be ignored.

Durability Over Time

Common material classes combine epoxy strength with the flexibility of modified polyolefins, or polyacrylates, to provide not only low thermal resistance, but also low thermal impedance across different interface boundaries. Traditional silicone binder gels and greases lose their liquid resin viscosity over long heat sink exposure. If larger than 0.8 mil (20 µm), the paste will "migrate" from the interface gap.

The demand for these materials to provide low thermal resistance and custom conductivity requires another kind of compound. AIT's portfolio of greases and gels is designed to offer solutions for heating on the back side of the chip in place. This versatility can conduct high levels of electricity, while retaining much lower thermal readings.



Metal-based thermal greases and pastes offer a higher-conductivity and longer-lifespan alternative to many silicone-based materials.

AIT's patented COOL-GEL and COOL-GREASE are composed of hybrid materials that provide stronger resistance and reduce "pump-out," which causes trouble for most low-thermal pastes. AIT's COOL-GEL offers flexible, epoxy-based resins for resistance greater than 5 psi. This flexible material differs from its silicone cousin in its strength of adhesion. Most greases and gels, while easy to rearrange, often find that their adhesive properties deteriorate faster than pads or phase changing materials over excessive heat sink periods.

The combination of materials present in AIT's stress-free COOL-GEL is designed to ensure a potent conductor to varying thermal temperatures, without compromising long-term duration. For this reason, COOL-GEL is excellent for high-powered chips and thermal potting compounds.

COOL-GEL products were designed to be used as a thermal grease replacement where there is a concern of contamination, but these gels are also proving to be a great solution for large areas, such as in solar panels, potting

large power devices or other sensitive devices that cannot sustain the pressure required for a thermal pad. With thermal conductivity readings at 12 W/m-°C, it offers increased resistance.

The demand for thermal interface materials (TIMs) is integral to the development of solar panels and military-grade devices. It is imperative that the adhesives used in these devices possess a duration and strength that can last beyond the lifetime of initial use for a device. When considering which adhesive to use, the choice in pastes can be subjective to the needs of the client.

AIT's COOL-GREASE is popular among hobbyists and PC gamers.

Metal- and Ceramic-Based TIMs

What cannot be compromised, however, is the quality of the adhesive. Traditionally, silvers and silicones were often thought to be the best electric conductor for TIMs, as their resistance readings have always been the lowest of commercial pastes.

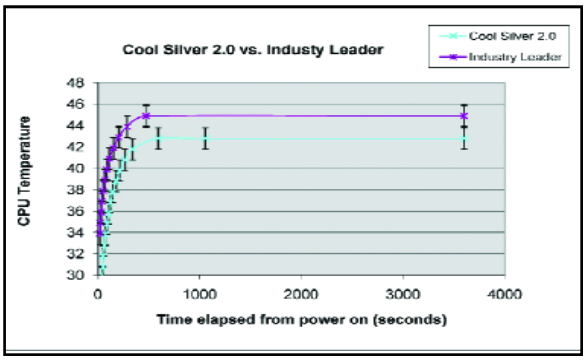
AIT's greases and gels take these factors into account. Especially with military-grade technology, a different solution is required that conforms best to the demands of a strong thermal activity. Rather than requiring phase change, AIT's COOL-GEL reacts to the pressure sensitivity of thermal conductivity to perform upon immediate usage.

There are some materials, such as silver and diamond, that exceed normal viscosity levels of heat sink in traditional thermal compounds. Ceramic-based gels work best for PCs and CPUs. The hobbyist market relies heavily on silver-based pastes. For this reason, COOL-GREASE is a popular product among PC gamers, who value even slight differences in heat resistance for long sessions of high-performance computing. The durability that AIT's greases provide to the gaming community is a testament to the success of its application. Users generally report levels of conductivity at 20 W/m-°C.

One of the advantages that AIT's TIMs offer is a custom solution for both professionals and amateurs. Because these greases and gels share hybrid components that help to strengthen their overall design, it ensures that materials that share the same heat sink and conductivity properties can be combined into a stronger product. This makes designing solutions for substrate surfaces and fillers more intimate, creating a unique solution for specific needs.

The company's greases and gels must meet the customer's needs, while matching the lifespan of the devices in which they are used. This is where thermal pads could take center stage, as their lifespan ranges slightly higher than greases. With every job being unique, however, thermal pastes must also be considered.

A product may not always be on a circuit board. Sometimes it may be mounted by screws or bolts, or may be placed on an uneven surface. This is where the faults of a silicone-based adhesive strike — susceptibility to thermal conductivity and overall quality of the paste compromise this design. Metal-based pastes have stronger designs at the molecular level, which can improve adhesive properties, as well as maintain a longer lifespan than the greases and gels.



CPU temperature graph comparing AIT's Cool Silver 2.0 TIM and a commercial competitor over time.

AIT strives to deliver what silicone-based gels and adhesives lack — improved molecular structure, heat flux and lifespan. Its line of hybrid, metal-based pastes ensures conductivity between surfaces, while maintaining excellent temperatures for devices. AIT's products are designed to provide custom solutions and structurally sound adhesives for any particular application.

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