

Phase Change and Differential Phase Change

At room temperature Thermaphase is a flexible, easy to handle membrane. It is "manufacturing friendly". Thermaphase is placed between an electronic component device and a heat sink. Heat and pressure are applied and the thermal resistance between component and heat sink, decreases to a very low value.

Thermaphase Can Operate in Two Phase Change Modes

Simple Phase Change:

After installation of the Thermaphase interface at room temperature, the thermal resistance is initially pretty high even when the required closure force is applied. This is because the Thermaphase cannot make intimate thermal contact until it melts (changes from the solid to the liquid phase). There are two ways to get heat to melt the Thermaphase compound. You can simply apply power to the component during final device test. Heat generated by the component will melt the Thermaphase. When it melts, it flows into all of the surface imperfections of component and heat sink. The interface becomes thinner as the morphologically controlled particles in the viscoelastic transport medium flow laterally and vertically into the imperfections of the surfaces. When this happens the thermal resistance of the interface decreases dramatically. If the normal operating temperature of the electronic component is above the phase change (melt) temperature of the Thermaphase, the compound will operate in the molten state. Excess material will form a thixotropic bead around the component perimeter and polymerize to form a seal around the perimeter. Most phase change materials on the market can only operate in this simple mode.

Note: The heat to melt the Thermaphase can come either from the electronic component, or from externally applied heat.

Differential Phase Change:

Thermaphase initially has considerably higher thermal resistance before it is reflowed. This means that the component can heat to a temperature higher than the phase change temperature. When the Thermaphase reflows, it creates a very low thermal resistance between component and heat sink. This causes the component to cool to a temperature below the Thermaphase phase change temperature. If the phase change temperature of the Thermaphase and the operating temperature of the component are chosen correctly, the Thermaphase interface will return to the solid state. The thermal conductivity of the compound is very similar in the solid and the molten state. However, there are situations where it is advantageous to have the compound operate in the solid state. In the solid state, out gassing is greatly reduced. This can be very important in space applications, and in applications such as with laser diodes, plasma deposition equipment, where minimum out gassing is important.

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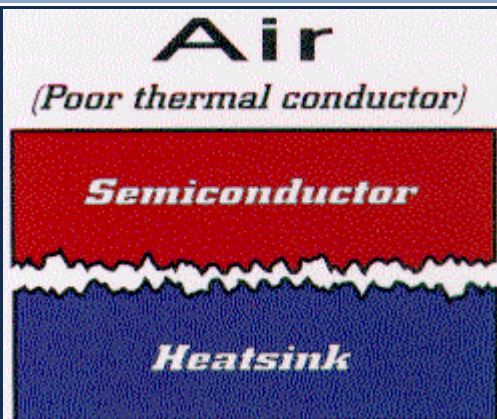
Whether used in the Simple Phase Change Mode (molten) or the Differential Phase Change Mode (returns to solid state), Thermaphase initially has high thermal resistance. which decreases dramatically when the interface flows into the surface

pores and irregularities of component and heat sink. Here is how it works...

Prior to initial reflow of Thermaphase, the thermal resistance between the semiconductor and heat sink is high because the surfaces of both semiconductor and heat sink have millions of micropores filled with air in the surfaces of both semiconductor and heat sink. Here is how it works.

Semiconductor tries to heat beyond normal operating temperature

When power is applied to the electronic component the first time, it tries to heat to a temperature beyond its normal operating range. This makes the Thermaphase change from a solid to an easily flowable thixotropic state. The Thermaphase flows and replaces the air in all of the millions of tiny micropores on the component and heat sink surfaces with Thermaphase compound. The thermal resistance of the compound is hundreds of times lower than air.



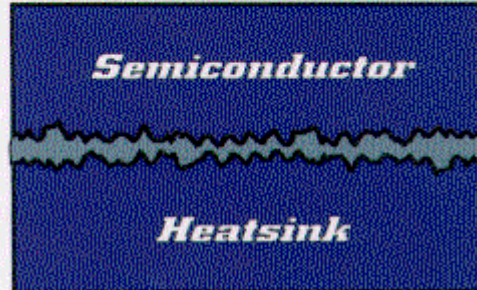
Thermaphase reflows and cools semiconductor

When the Thermaphase reflows and replaces the air in the surface pores with thermally conductive compound, the component sees a very low thermal resistance path to the heat sink. This cools the component to normal operating temperature. Thermaphase can return to the solid state depending on phase change and component operating temperature.

On subsequent heats up, the component doesn't heat beyond its normal operating range temperature. Thermaphase can operate at use temperatures up to 200°C.



(Hundreds of times lower thermal resistance than air.)



Since Thermaphase is a thermoplastic material it can be reflowed an unlimited number of times. Our Free Standing Film Thermaphase materials can be applied to circuit boards or to heat sinks by several methods which give the designer new options unavailable with any other product.

The surfaces of semiconductor and heat sinks look smooth, visually, but in reality they are rough. They have millions of micropores in their surfaces. If the surfaces of all these micropores are not contacted with thermally conductive material, the thermal resistance of the interface will be high. This is because there will be air in the micropores and air is a very poor thermal conductor.



Getting into intimate contact with pores is not an easy job. No one does it better than Thermaphase. Particle morphology, flow characteristics, visco-elastic properties, and many other technical aspects are integral to the superior thermal performance of these products.