Thermally Conductive Silicones

Ref: TB2007-12
Date: October 2018
Version: 3.0

Introduction

Developments in modern electronics - smaller and faster - have made necessary the use of more effective ways to remove the excess heat which is generated. New compounds are required to transmit the heat away from the sensitive circuitry to a heat sink, without sacrificing the electrical integrity or adversely affecting delicate microelectronics, or the electric currents flowing through them. The environments in which they operate are often extremely adverse e.g. under bonnet automotive applications and aerospace.

© Wacker Chemie AG

Why use a silicone based thermal conductor?

Silicones as a chemical family are extremely versatile substances and are considered to be very environmentally friendly; most silicone products are solvent free, non-volatile and pose no hazard to the ecosystem. Cured silicone rubbers are not biodegradable or affected by weathering, ozone and exposure to UV. They are resistant to extreme changes in temperature (typically –60°C to +250°C) and provide protection against moisture, chemical attack, shocks and vibration.

Of prime importance to the electronics engineer are their electrical insulating properties, which typically have a volume resistivity in excess of $10^{15}\Omega\cdot cm$. Cured silicone elastomers can be formulated to produce a wide range of products, including micro thin coatings, flexible adhesive sealants, soft cured gels and rubbers of varying hardness.

Addition cure rubbers using platinum catalysts are completely neutral, non-corrosive materials which can be designed to cure at room temperature or accelerated by heating at moderate temperatures and are reversion resistant. Condensation cure systems cure at room temperature, and the catalyst and cross-linkers can be adjusted to vary cure speeds in both one and two part systems for a variety of application methods.

What is Acceptable Thermal Conductivity?

Thermal conductivity is a measure of a substance or formulated product’s ability to transmit heat. The units employed are W/m·K (Watts per meter degrees Kelvin). Some illustrative examples of the thermal conductivities of some common materials are listed in Table 1:

Material	W/m·K
Air	0.025
Oil	0.15
Silicone rubber (unfilled)	0.2
Glass	1.1
Stainless steel	15
Aluminium	220

Table 1 – Thermal conductivity of common substances

As can be seen, a typical unfilled silicone rubber has a thermal conductivity of approximately 0.2 W/m·K and even a highly filled silicone elastomer can barely exceed 0.4 W/m·K. For many years the thermal conductivity of most silicone elastomers and sealants seldom exceeded 0.8 W/m·K, with only special products reaching values as high as 1.2W/m·K. Modern advances mean that typical values for **WACKER silicone products** range from 0.3 up to 4.3 W/m·K.

A winning combination!

Combining performance conductive fillers with the unique properties of silicone elastomers makes silicone thermally conductive compounds the ideal choice.

Single part adhesives such as **WACKER Semicosil 975 TC** and **WACKER Elastosil RT 747 TC** (with a range of 1.3 to 4.3 W/m·K) can be used to bond components to heat sinks or provide seals and gaskets.

A paste compound **WACKER Semicosil 961 TC** can be used to eliminate air gaps, improving thermal conductivity and electrical insulation, whilst facilitating easy removal.

Entire PCBs can be potted in a two part **WACKER Elastosil RT 428** (0.3 W/m·K) to provide efficient heat dissipation and environmental protection. Two part compounds such as **WACKER Elastosil RT 675** (1.2 W/m·K) with excellent adhesion can be used to encapsulate and bond PCBs within their heat sinking structures.

Our product specialists would be happy to discuss your particular application to determine what material might be most suitable. **Contact us for further information and assistance.**