THERMAL MANAGEMENT & ELECTRONICS COOLING

A **quickguide** to electronic cooling using thermal interface materials and metal substrates

Chemo Electric
expect knowledge ...

THERMAL MANAGEMENT

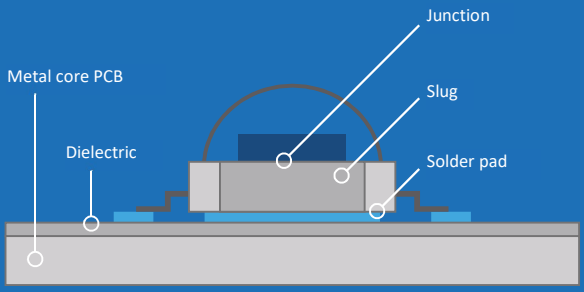
Often forgotten by electronics designers, managing the heat of the application is a key factor for success. When the temperature of the components is under control and kept within manufacturers specifications, the application can run stable and for as long as the lifetime of the components.

The earlier you include thermal management into the design, the better and in most cases more cost effective.

Metals are good at transporting heat and therefore very often used in heat sinks. Copper is very good but expensive and quite heavy. Aluminium is lower cost and lighter. However metals are relatively hard and it is difficult to create a good thermal connection with electronic components. This is why thermally conductive interface materials are used between the components and the heat sinks.

As a general rule, the thinner you make the thermal interface material, the better the performance.

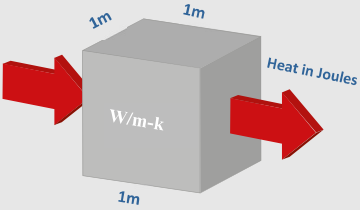
In some applications and for some components, like LED lighting applications, the heat needs to be pulled out of the component. Here it is an advantage to solder the LEDs onto a metal core PCB. Then the heat can flow from the LED, through the metal and interface material and finally into the heat sink.

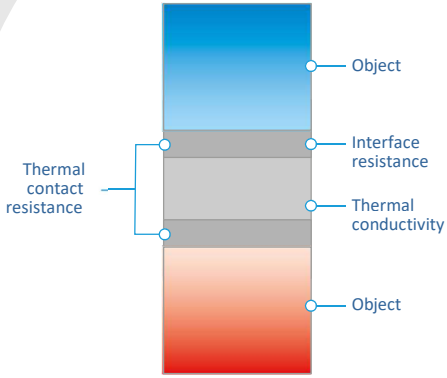


LED mounted on metal core PCB keeps the temperature lower for better performance and longer life time.

THERMAL CONDUCTIVITY

The property of the material





THERMAL IMPEDANCE

The thermal value of the total specific application °C/W

Thermal Selection and Calculations

When deciding what thermal interface material is optimal for your application, keep this in mind:

- What thermal performance do I need?
- Pad or a liquid paste?
- Do I need electrical insulation?
- What temperatures and vibrations are there?

When selecting a material for the thermal performance, in general, the better the performance, the higher the cost. When comparing different brands, you need to make sure that you are comparing the same things:

THERMAL CONDUCTIVITY
This is the property of the material itself.

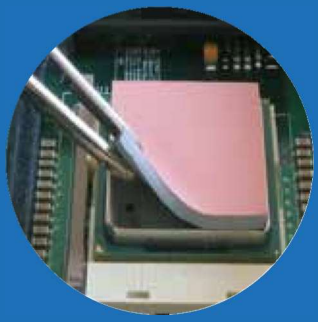
THERMAL RESISTANCE
This is the value of the resistance preventing the heat from flowing through a material, it varies with thickness.

THERMAL IMPEDANCE
This is the total thermal property of a specific application, taking area, thickness, time and pressure into account.

Thermal Interface

HARD PADS

- Easier replacement
- Electrically insulating



SOFT PADS

- Thick pads
- Filling gaps

ULTRASOFT PADS

- Less component stress
- Less thermal resistance

PHASE CHANGE MATERIALS

- Better wet-out since melting
- Only available as super thin pads
- Also with integrated insulating film

Materiales Types

LIQUID PASTES (1-component)

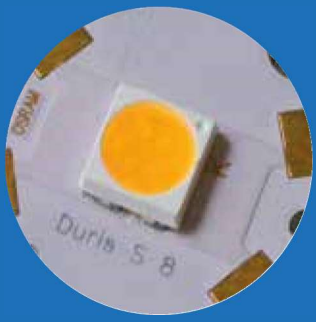
- Lower cost
- Simpler dispensing tools
- Simplified logistics

LIQUID PASTES (2-component)

- Cures into a pad-like material
- Withstands vibrations
- No pump-out

DOUBLE SIDED ADHESIVE TAPES

- Pressure Sensitive Adhesives with really good adhesion



LIQUID ADHESIVES

- 1-component adhesives need heat to cure
- 2-component adhesives get really hard

Material hardness vs. thermal performance

When looking at a surface in a microscope, even flat surfaces has structures, causing air to be trapped between components and the heat sink. Air is a very good insulator.

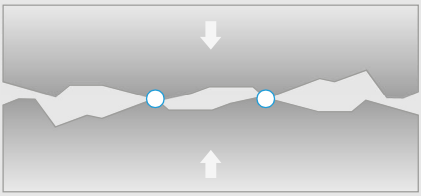
The purpose of the thermal interface material is to fill the air pockets and increase the heat flow.

The softer the material, the better it fills out these air pockets. On the other side, the more fillers that are put into the material, the harder the material gets. So finding the balance between softness and thermal performance is important.

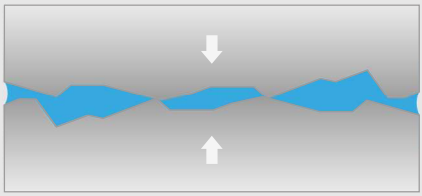
Test methods
When comparing different materials, it is often not as easy as comparing data sheets. You have not only to compare the terminology and values, you also need to see what test method was used. By changing test method you can get values up to 100x better. ASTM and ISO are two well known standards, and as long as it is the same standard, it is fine to compare.

Thermal Simulation vs Real Life tests
Thermal simulation is a good method to get an idea of what kind of thermal interface is needed. But, since so many factors influence the thermal performance in each application, in terms of surface, thickness, compression etc., some real live tests are the only way to ensure a proper thermal design.

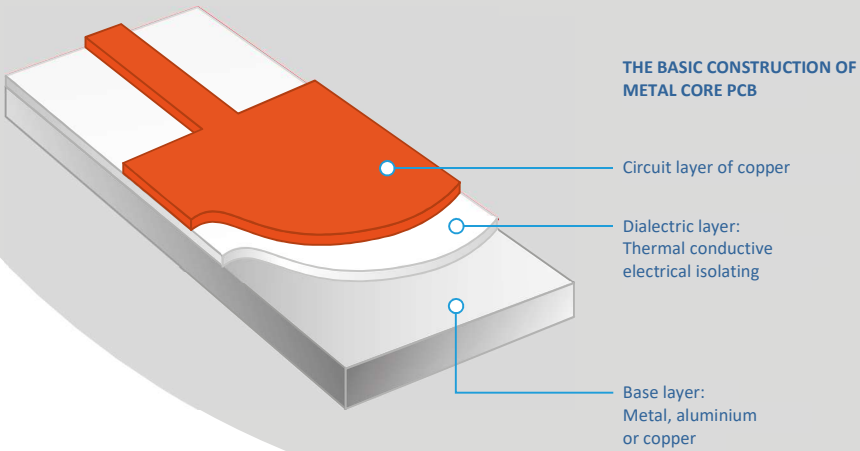
SURFACES OF TWO PARTS SEEN UNDER MICROSCOPE



Gaps filled with air give higher resistance.



Gaps filled with thermal interface material give less resistance by replacing the air.



Metal Core PCBs (insulated metal substrates)
When cooling some type of components, it's more effective to solder them directly to a PCB made of copper or aluminium, than using a normal FR4 board and implement thermal vias or more space demanding heat sinks.

Typical markets and applications:

- Cooling LEDs
- Power conversion
- Welding equipment
- Motor drives

The key benefits are that you can reduce the PCB size, lower the component temperatures, and by that also increase the component stability and lifetime. Some other benefits are better mechanical durability and reduce the sizes of the heat sinks.

Today there are many manufacturers of IMS, especially in Asia after the boom of LED lighting. The hardest part is to find a good and reliable source that can produce PCBs with high and consistent quality, and at an acceptable price level.

Vallentin Elektronik
Founded in 1977, Vallentin Elektronik has been servicing the Danish market with electronic components and thermal management products for almost 30 years.

Chemo Electric
Founded in 1963 with focus on servicing the white goods industry with mainly cables and harnesses.
In 2007 acquired by Swedish concern Addtech and integrated into the component group.

In 2017 Chemo Electric and Vallentin Elektronik merged to form a strong partner to the Danish and International electronic industry.

Good knowledge, fast deliveries and always with a smile on our faces, we are helping big and small companies to design durable and competitive products.

Chemo Electric
expect knowledge ...

Chemo Electric A/S
Hassellunden 14
DK-2765 Smørum
Denmark

Tel. +45 3677 3044
www.chemolec.dk