

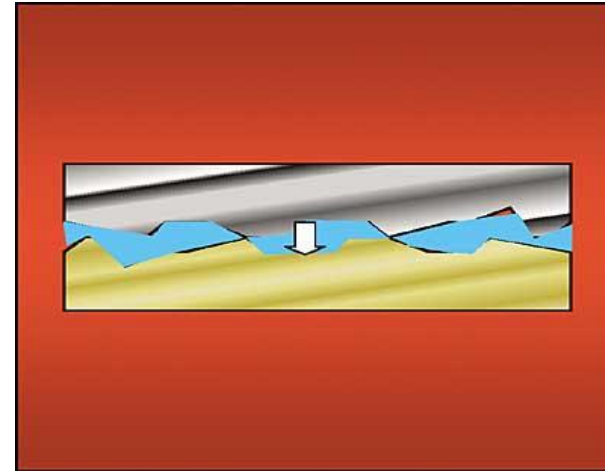
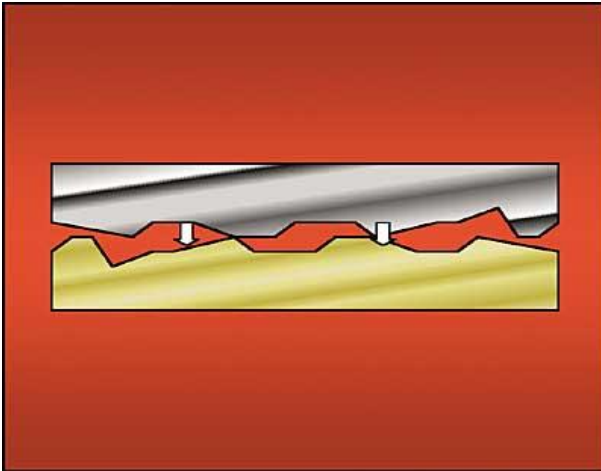
Messung der Wärmeleitfähigkeit von Thermal Interface Materials (TIM)

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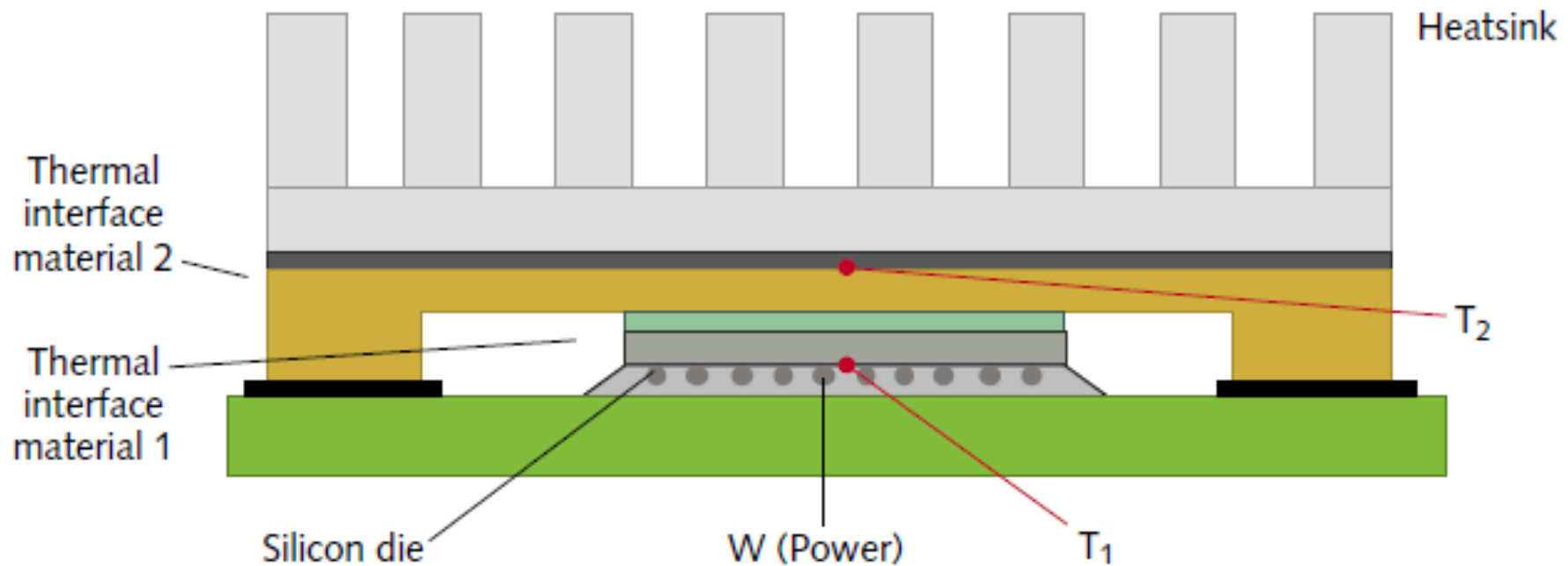
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Thermal Interface Materials (TIM)



- Usage in Power Electronics
- Thermal Pastes, Greases, Pads etc.
- Thermal Conductivity AND Contact Resistance important
- Standardized Measurement Method ASTM D5470-12

Typical CPU Architecture

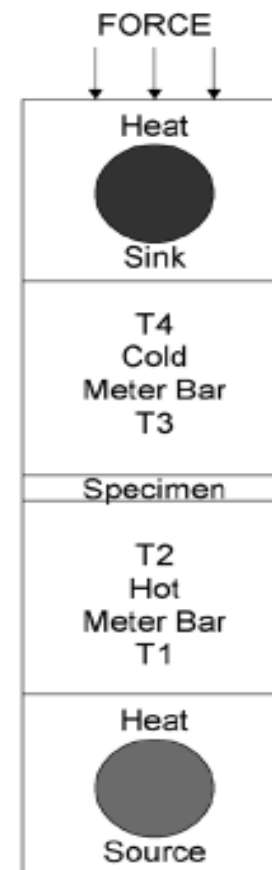


ASTM D5470-12

Standard Test Method for Thermal Transmission Properties of Thermally Conductive Electrical Insulation Materials

Instrument According ASTM D5470-12

- Two meter bars
 - (At least) two temperature sensors each
 - One heated one cooled (temperature stability ± 0.2 K)
 - $5 \mu\text{m}$ parallelity, $R_a 0.4 \mu\text{m}$
- Contact force necessary
- Isolation or guard heater for the meter bars are not necessary



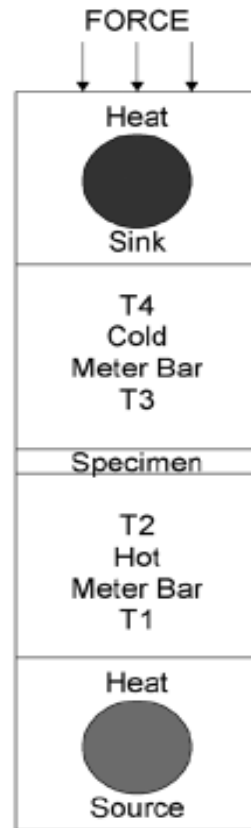
Calculations according ASTM D5470-12

Calculation of thermal impedance

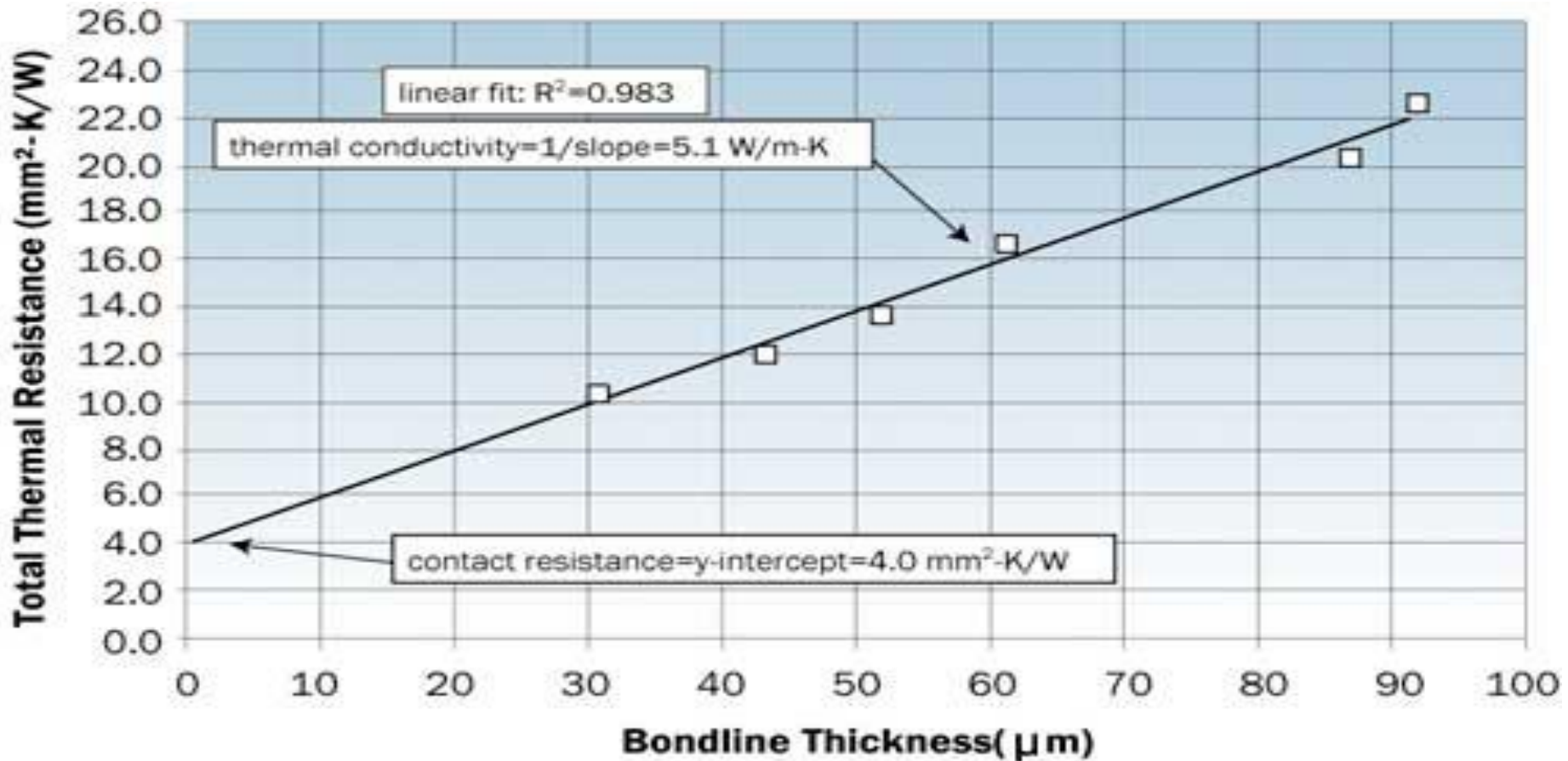
$$\theta = \frac{A}{\Phi} * (T_H - T_C) \left[\frac{K \cdot m^2}{W} \right]$$

$$\Phi_{12} = \frac{\lambda_{12} * A}{d} * (T_1 - T_2)$$
$$\Phi_{34} = \frac{\lambda_{34} * A}{d} * (T_3 - T_4)$$
$$\Phi = \frac{\Phi_{12} + \Phi_{34}}{2}$$

- Φ_{12} Heat flux hot meter bar [W]
- Φ_{34} Heat flux cold meter bar [W]
- Φ Heat flux specimen [W]
- λ_{12} thermal conductivity hot meter bar $\left[\frac{W}{m \cdot K} \right]$
- λ_{34} thermal conductivity cold meter bar $\left[\frac{W}{m \cdot K} \right]$
- A contact area of meter bar [m²]



Evaluations according ASTM D5470-12



Linseis Instrument Setup

Electromechanic actuator
contact force up to 2.5 kN
Pressure up to 1 MPa to 5 MPa

Load cell for
contact force control

Cooled heat flow meter bar
(easy exchangeable)

Heated heat flow meter bar
(easy exchangeable)

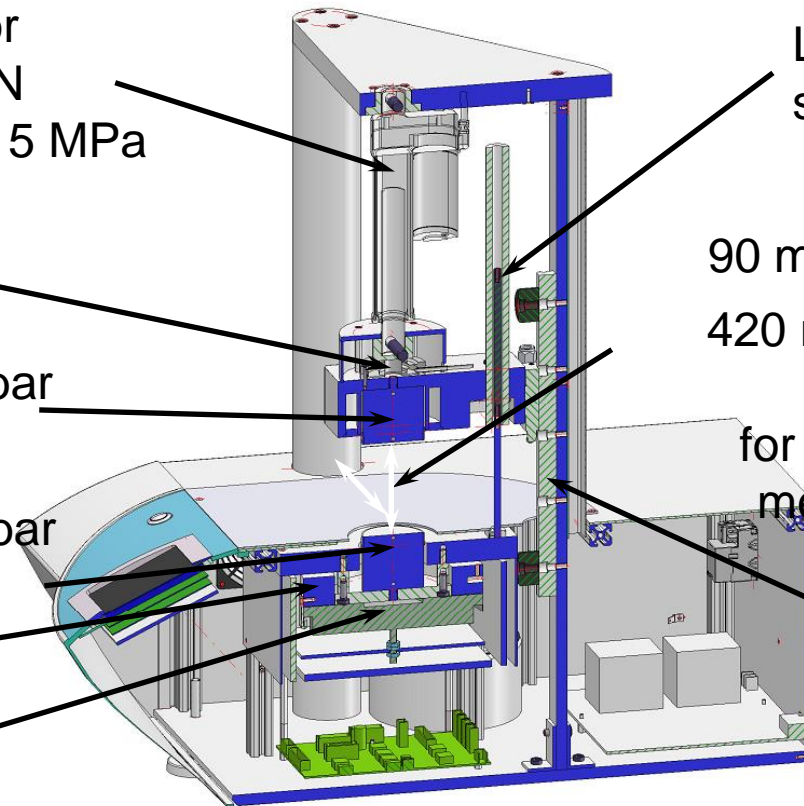
Guard heater

Two zone hotplate

LVDT for distance control/
sample thickness

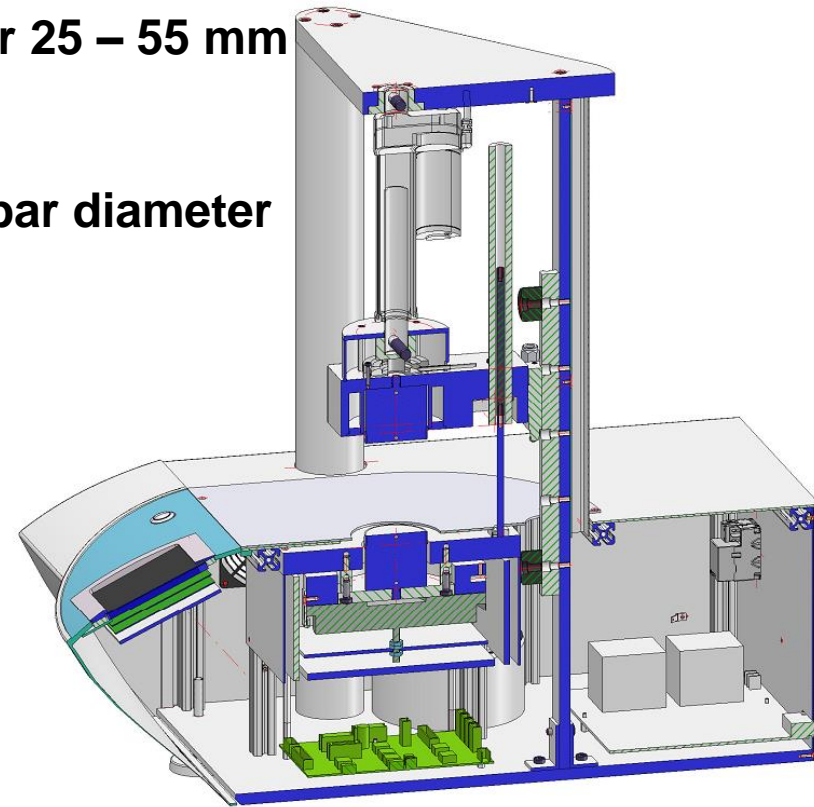
90 mm meter bar distance
420 mm distance between
columns
for improved access to
measurement system

Linear guides

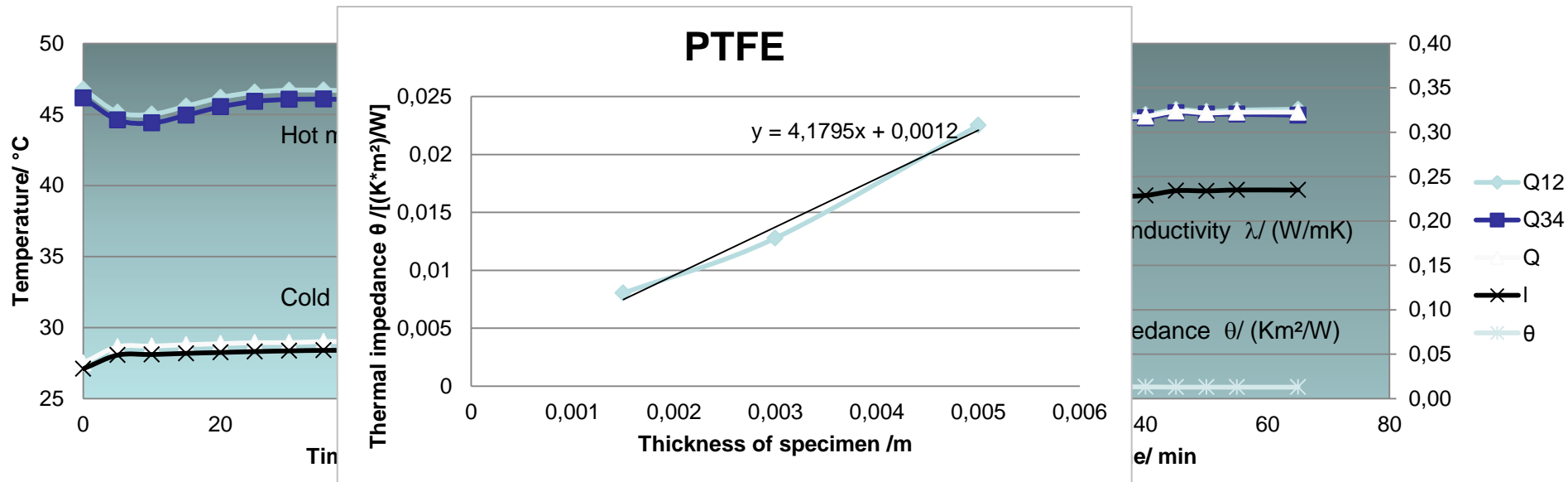


Linseis Specifications

- **Meter bars:**
 - **Easy exchangeable meter bars diameter 25 – 55 mm**
 - **Guard heater and isolated meter bars**
- **Contact force up to 2.5 kN**
 - **pressure 1-5 MPa depending on meter bar diameter**
 - **Contact force accuracy 1%**
- **LVDT for distance control accuracy 0.25%**
- **Temperature RT to 200 °C**
- **Sample thickness up to 90 mm**



Measurement of a PTFE Standard



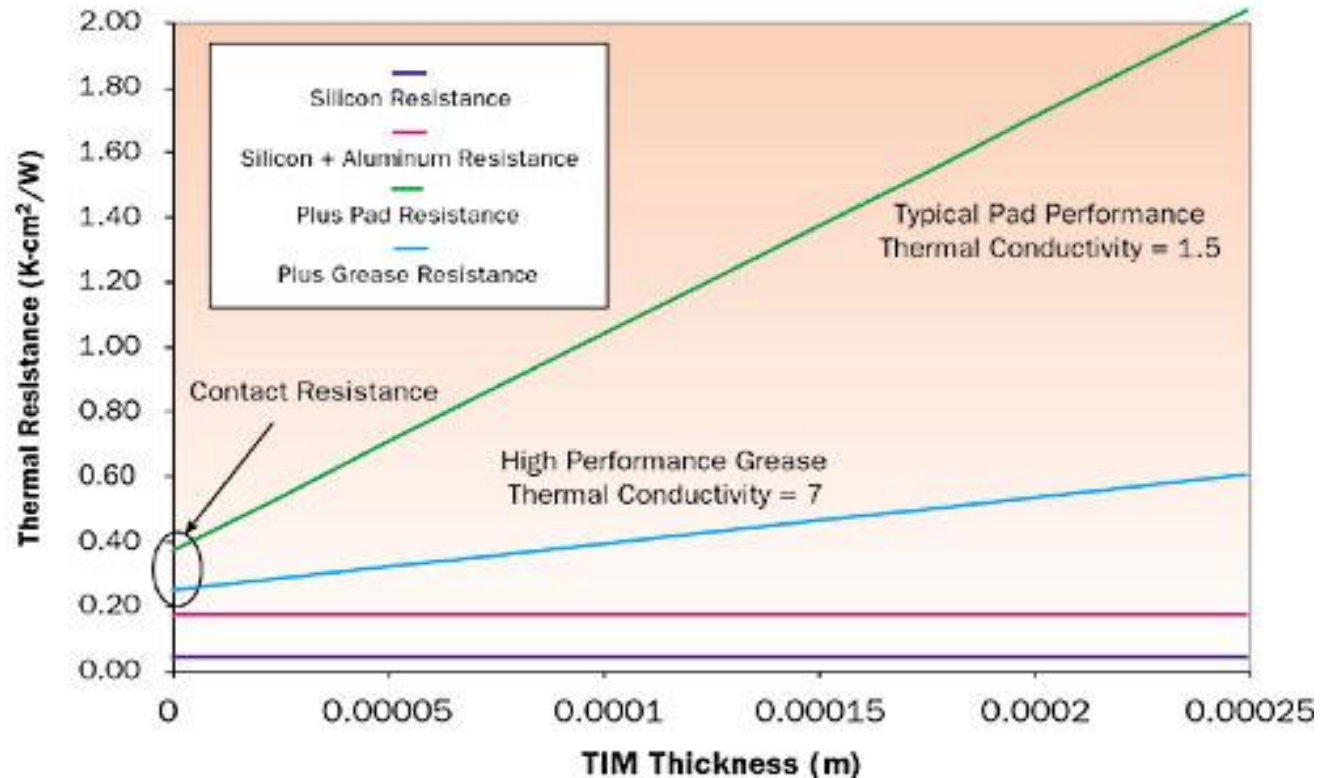
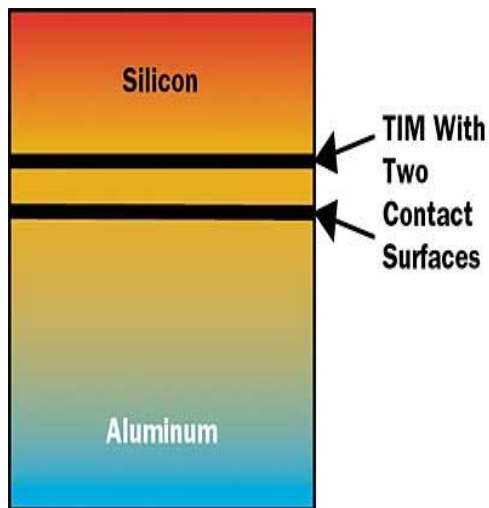
Steady State Measurement

PTFE slice, dia 55mm height 3mm

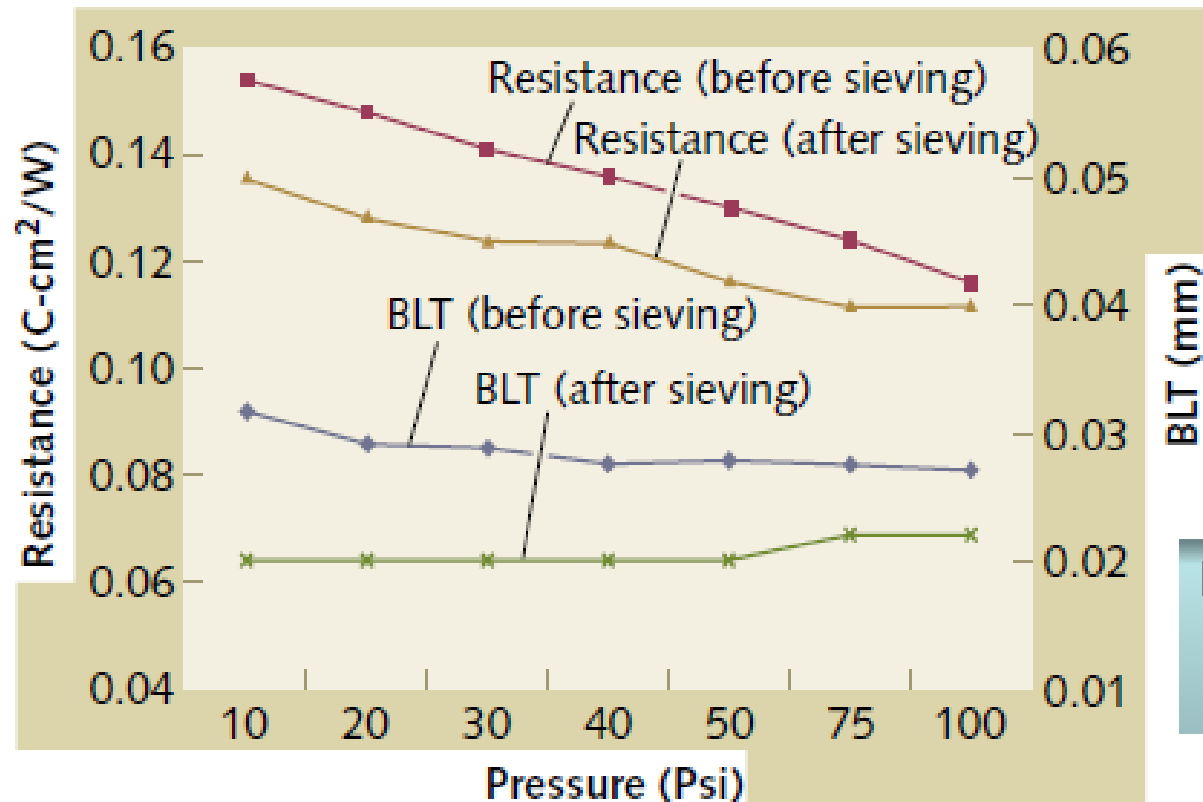


Result: $\lambda = 0.239 \text{ W/m}^{\circ}\text{K}$

Measurement of a typical Stack



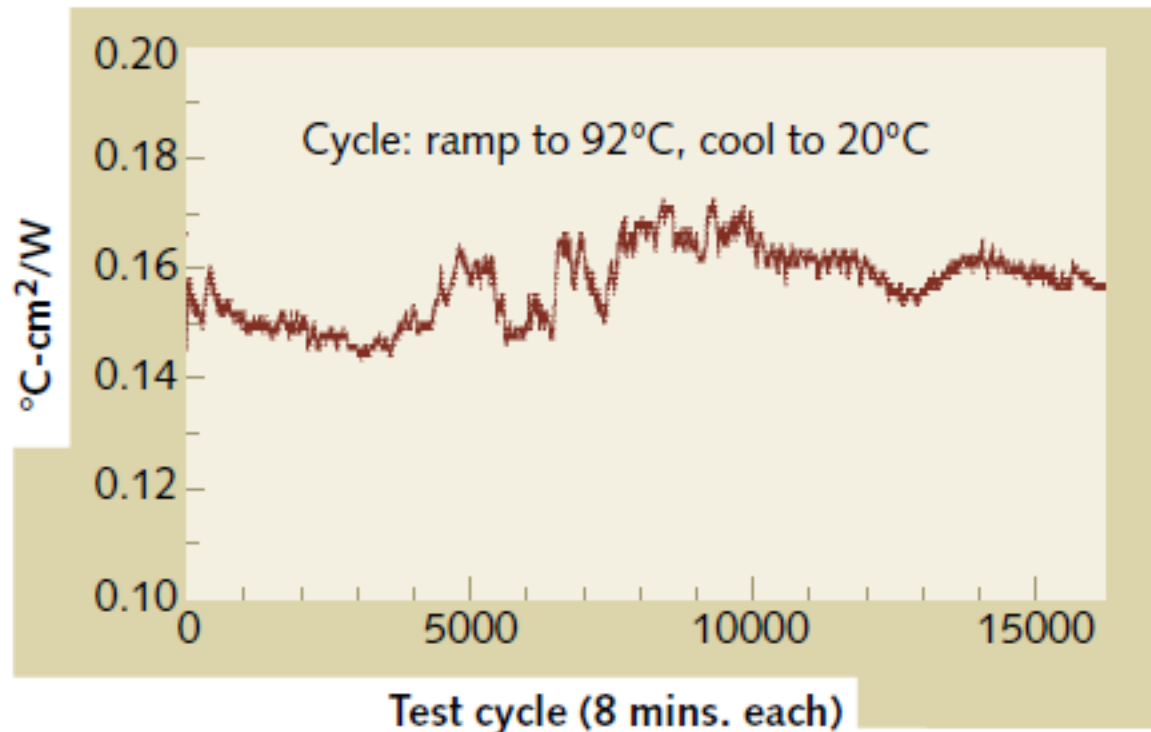
Pressure Dependent Measurements



Polymer Material with Filler

2 Filler Particle Sizes

Time Dependent Measurements



Power Cycling Test

2000 cycles ~ 1 year
under normal operating
conditions

->Life Time Prediction

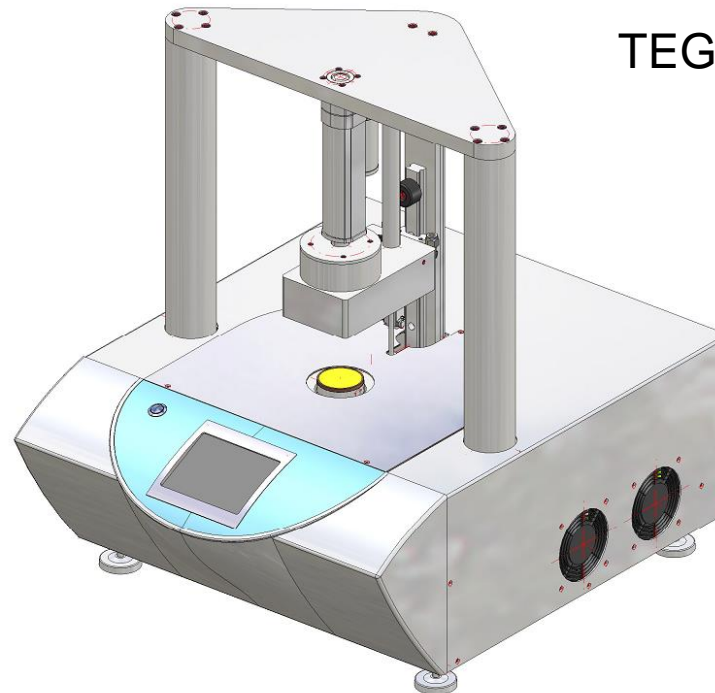
Thermally Conductive Grease

More Applications

Thermal interface materials

- Solid
- Pastes
- Liquid

Thermal conductivity
measurement



TEG

Peltier elements

Batteries

Electrical modules

Thank you for your attention!

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