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Measuring thermal conductivity of PCMs

Common method:

- Laser Flash measurement

Problems: - Sample can‘t be measured as solid AND melt

- Indirect determination of thermal conductivity (measurement of thermal diffusivity)

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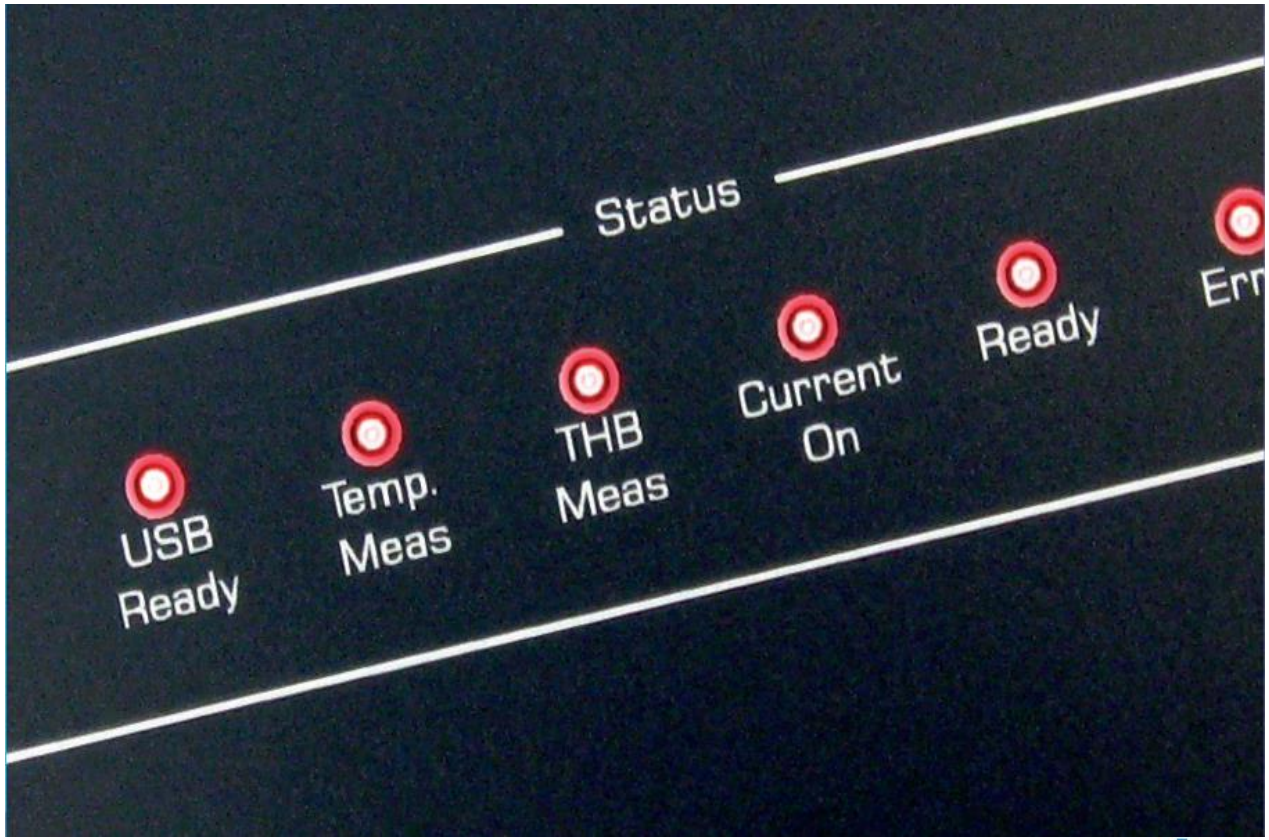
Alternative:

THB - 500 • TRANSIENT HOT BRIDGE

Measuring instrument for thermal conductivity, thermal diffusivity and specific thermal capacity



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What means THB

Transient Hot Bridge

The Transient Hot Bridge method, which is used to measure the thermal transport properties of materials, is an enhancement of the Hot Wire or the Transient Hot Strip method (DIN EN 993-14, DIN EN 993-15). The measuring methods mentioned are transient, time depended measuring methods. The advantage of these methods compared to stationary methods is a much shorter measuring time, and the thermal diffusivity is measured in parallel to the thermal conductivity.

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Two types of absolute measurements

Steady state:

- **Guarded Hot Plate (GHP)**

Transient state:

- **Hot probe**
- **hot wire, hot strip**
- **hot plane, hot disk®**
- **Laser flash**

- **Clear mean, simply evaluation of the λ and its δλ**
- **long measuring time**
- **sample preparation**
- **complex realization**

- **Short measuring time**
- **simple preparation**
- **small samples**
- **complex evaluation**

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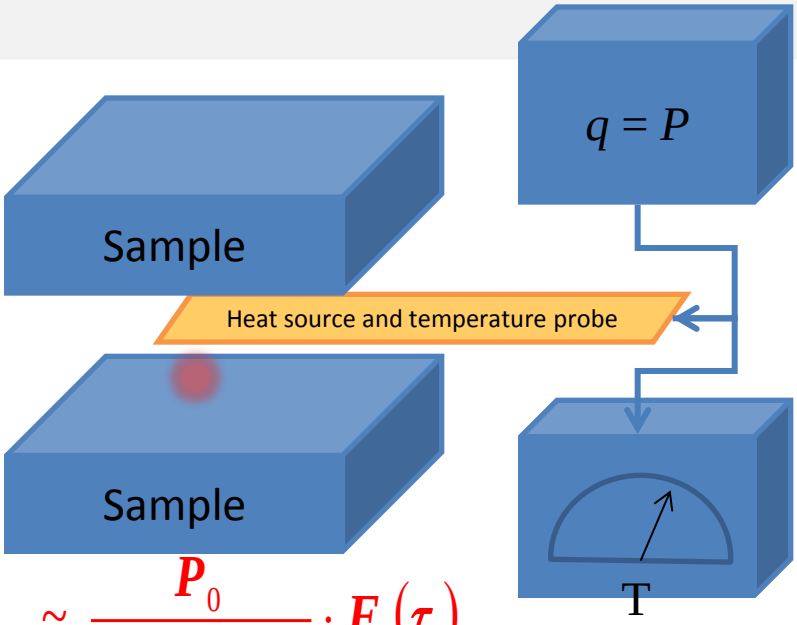
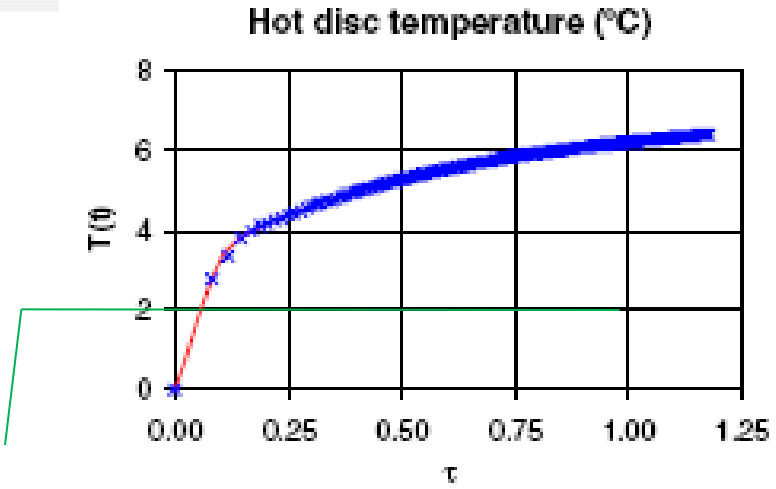
Transient state methods



$$\lambda_m \sim \frac{P_0}{L \cdot \Delta T(\tau)} \cdot F(\tau)$$



$$\tau = \sqrt{\frac{a \cdot t}{r_0^2}}$$

The value of the thermal conductivity λ is nearly inversely proportional to temperature rise.
Diffusivity **a** determines measurement duration, the needed time to reach the steady state.

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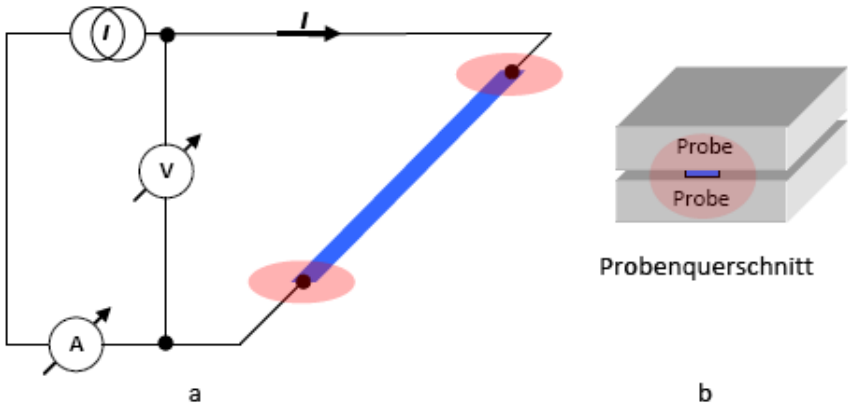
Hot strip

- -- end effect
- -- longer measuring time
- -- smaller strip resistance
- -- worse signal- noise ratio



Improvements for THS-method

- Plane design like electronic boards
- Film technology like heat foils fabrication
- Two part (tandem) strip with short part as “guard heater”
- Bridge circuit integrated
- Signal form with two well solved characteristic parameter for thermal conductivity und diffusivity

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Improvements for THS-method

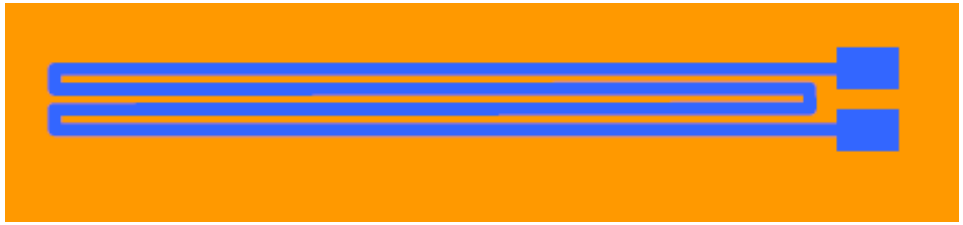
Improved Hot Strip

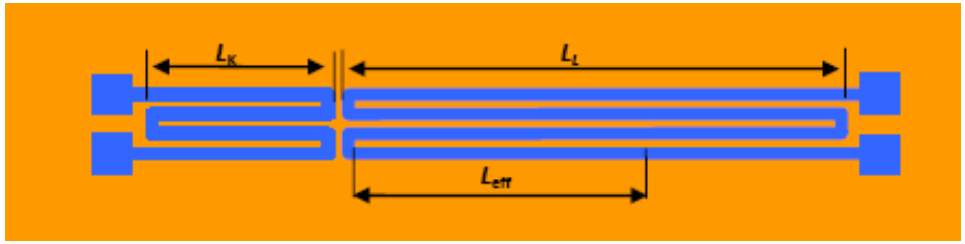
+ easy production

+ end-effect free

+ high electrical resistance

-- more electronic complexity





Tandem Strip

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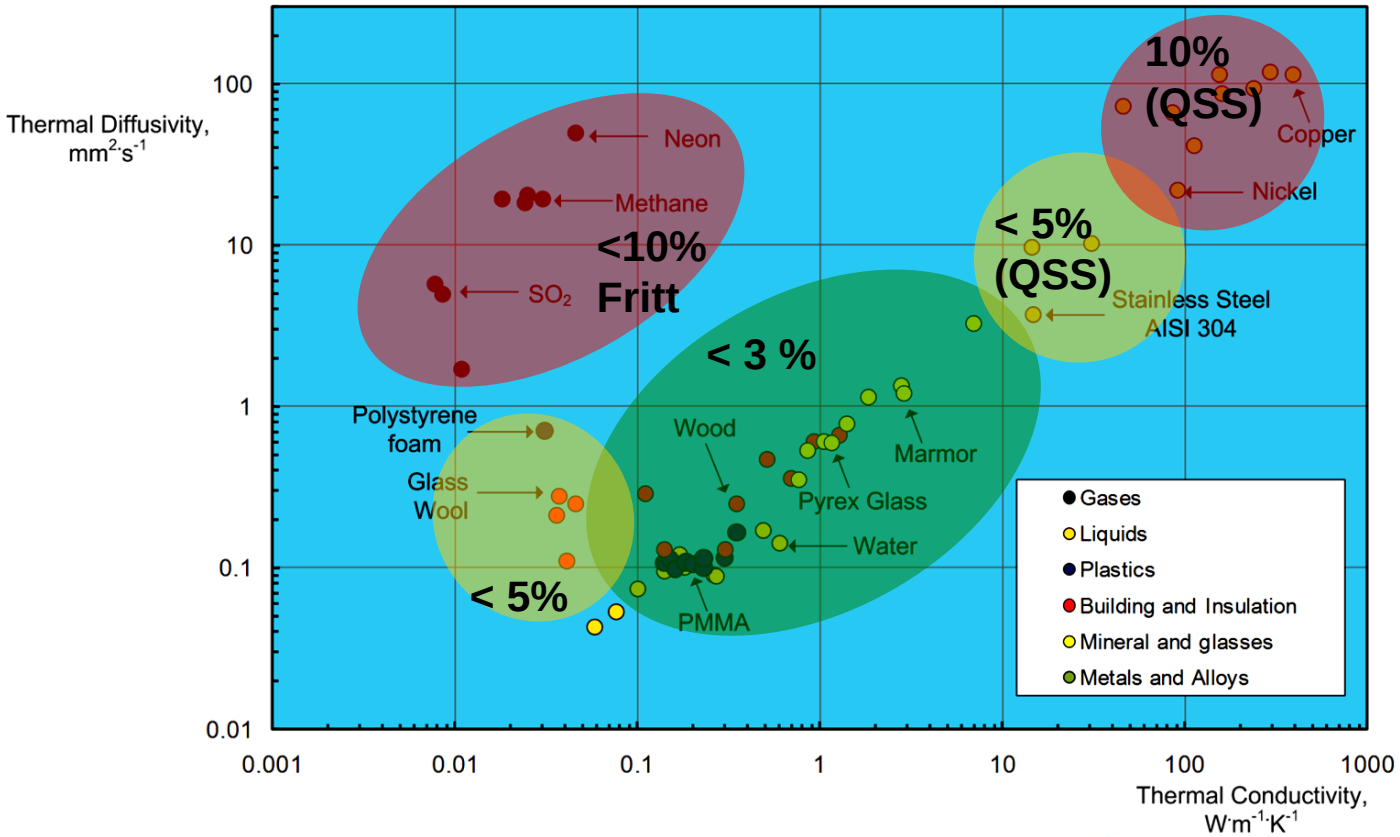
THB Specification



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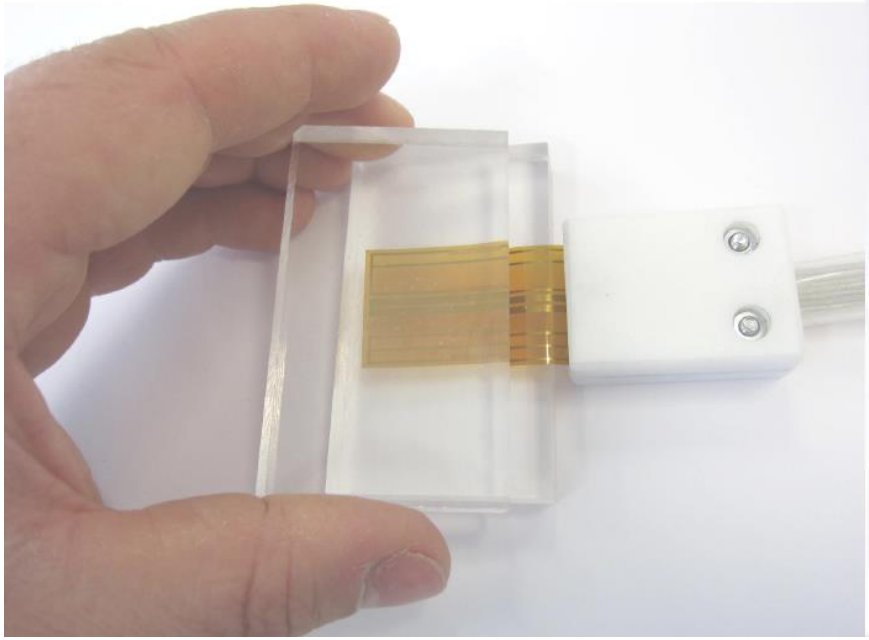
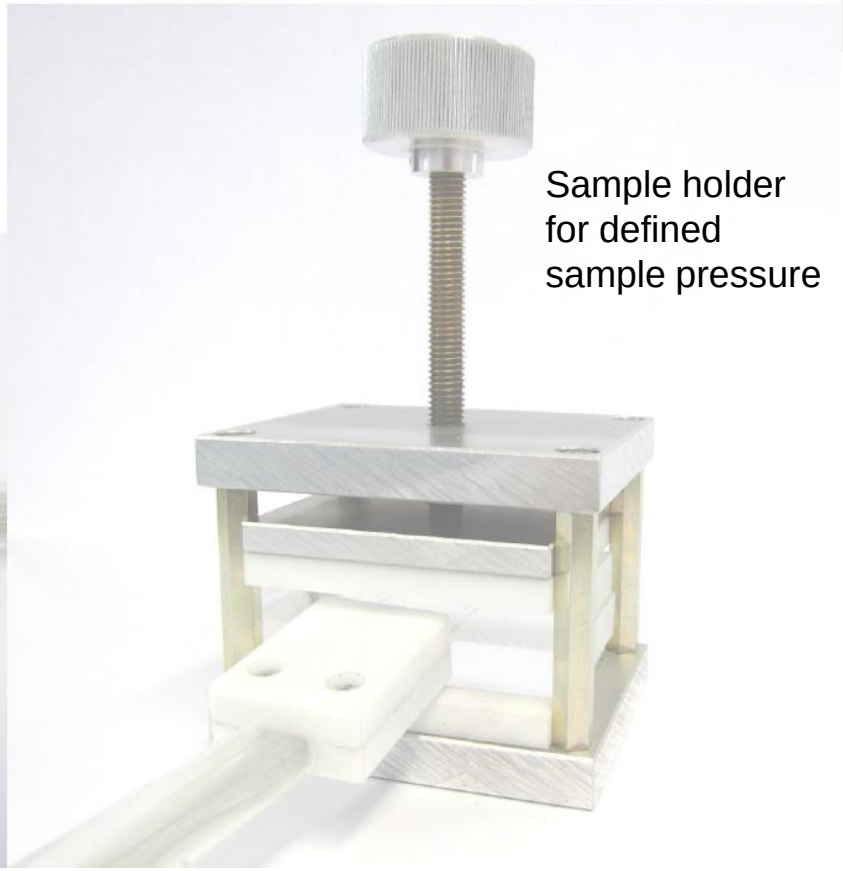
Sample Holder Solids

Sensor sandwiched between two PMMA samples





Sample holder for defined sample pressure

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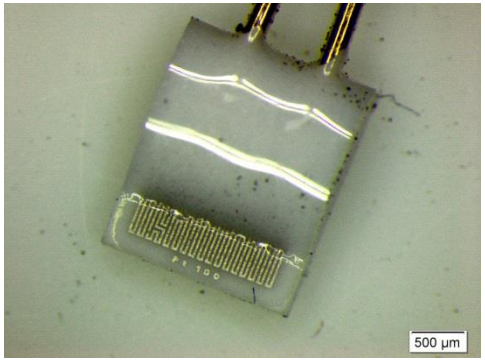
Hot Point Sensor



- 0.02 to 30 W/m*K
- -150 to 700 °C
- Small samples (3x3x3 mm)
- Reactive Samples (e.g. epoxy resins)
- Anisotropic Samples

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QSS- Sensor

- **Up to 500 W/m*K**
- **New Patented Methode**
- **Real Measurement of λ**

QSS Sensor

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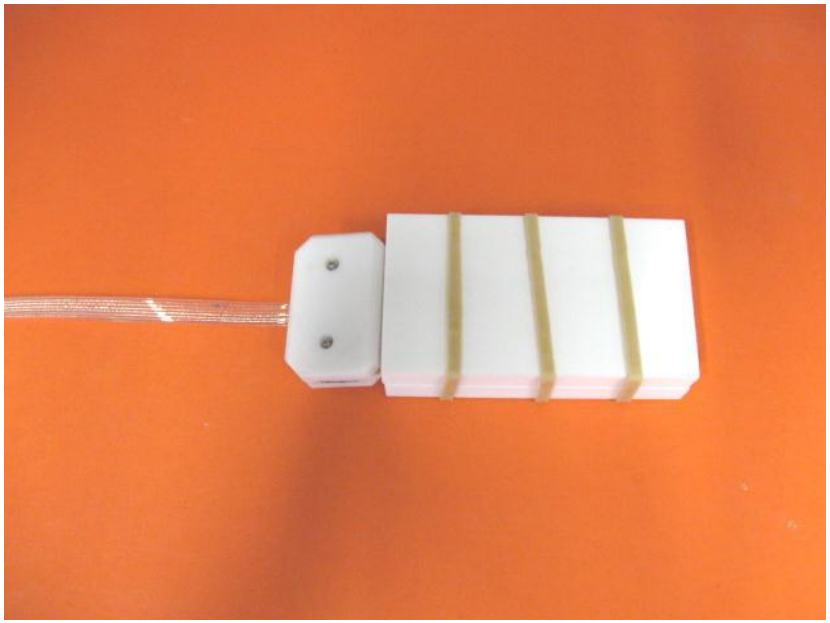
Fritt Sensor



- **Gases**
- **Liquids**

<u>Without Convection</u>

- **Calorimeter for Liquids with QSS- Sensor**

Fritt Sensor

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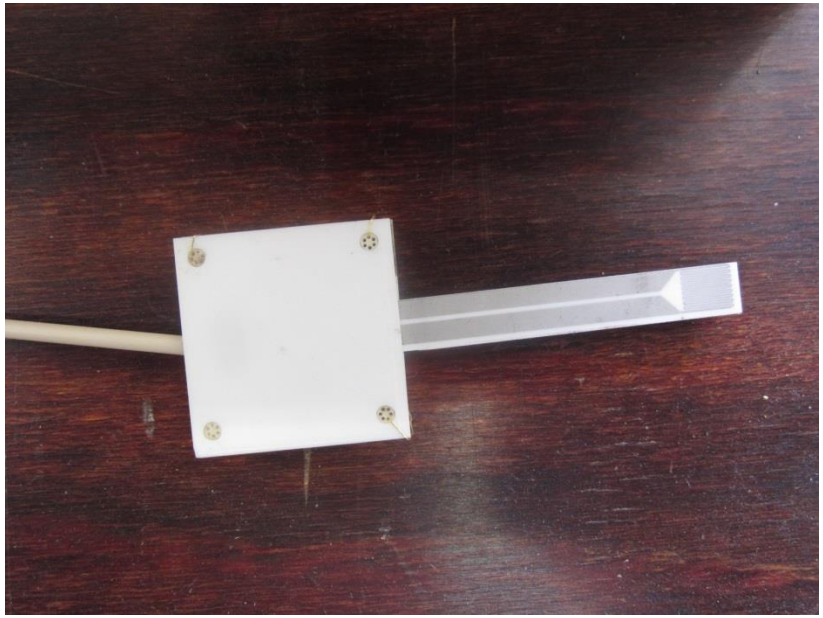
High Temperature Sensor



- **-150 to 700 °C**
- **0,01 to 30 W/m*K**
- **Minimum sample size: 3x3x1 mm**

High Temperature Hot Point Sensor

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Application PCM Materials

Problem:

- System must be able to measure solids, melts and liquids
- Temperature regulation must be possible with highest precision
- Special furnace is needed

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Linseis THB Furnace for PCM Materials

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Linseis THB Furnace for PCM Materials

- Temperature Range from -150°C to 700°C
- Temperature adjustment with high accuracy
- usable with all types of Sensors
- closed measurement chamber

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New THB Software

- Automatic Calibration
- Calculation of Thermal Penetration Depth
- Calculation of Effusivity and Specific heat Capacity
- Optimized Data Evaluation
- Data Base Link with Reference Materials
- Report Generator
- Data Export

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THB Main Benefits

- Measure simultaneously and precise both values:
  thermal conductivity and diffusivity
- Quick experimental runs from seconds to a few minutes.
- Typical uncertainty for most materials better than 3 % (k = 2).
- Solid, Liquid loose samples
- Anisotropic Samples can be measured
- Range for Thermal Conductivity: 0,01 to 500 W/m*K
- Self optimized measurements
- No special knowledge or skills needed
- Robust design suitable for many industrial applications.
- Automatically error detection of, e.g., poor thermal contact and temperature instability.

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Thank you for your attention !