

Measurement of thermal conductivity of phase change materials with Guarded Hot Plate / Heat Flow Meter

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11/11/2015 – Workshop: Thermal conductivity measurement of PCM

1. Stationary measurements

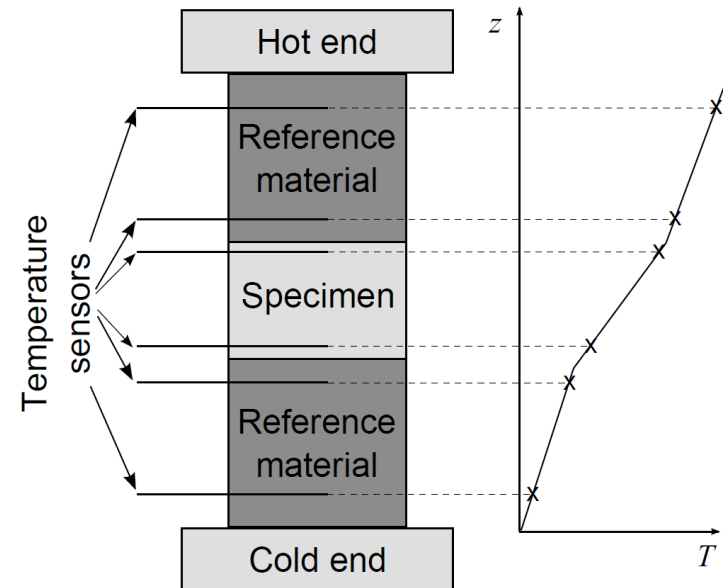
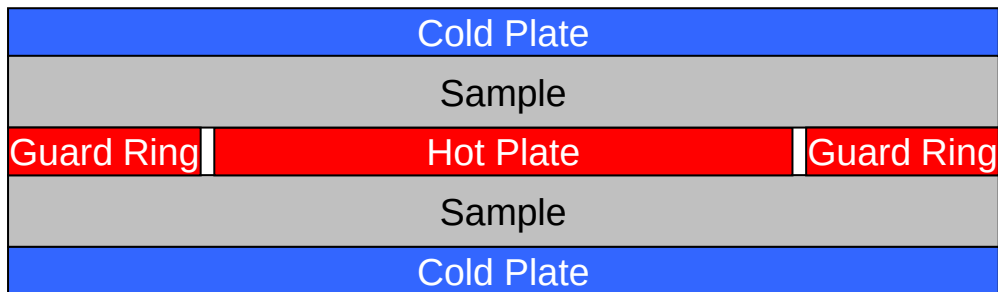
2. Problems

- Temperature Intervall
- Convection
- Contact Resistances
- Measurement time

Measurement of PCM

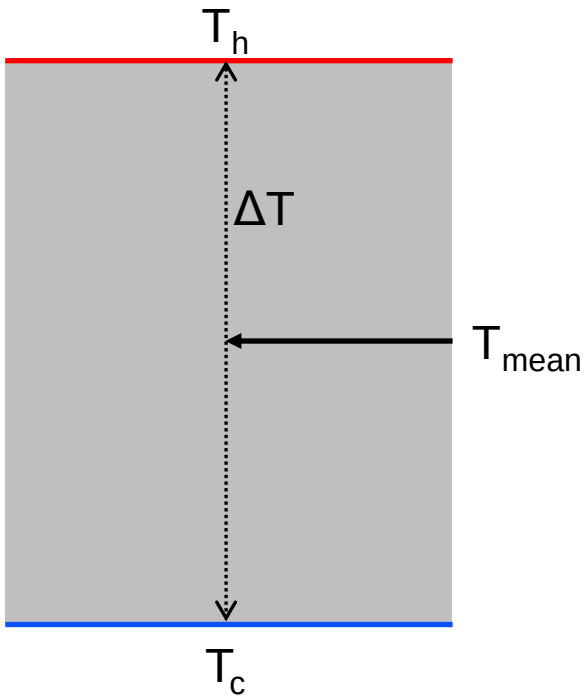
Stationary Measurements

Guarded Hot Plate, Heat Flow Meter, Cut-Bar Technique



Measurement of PCM

Stationary Measurements

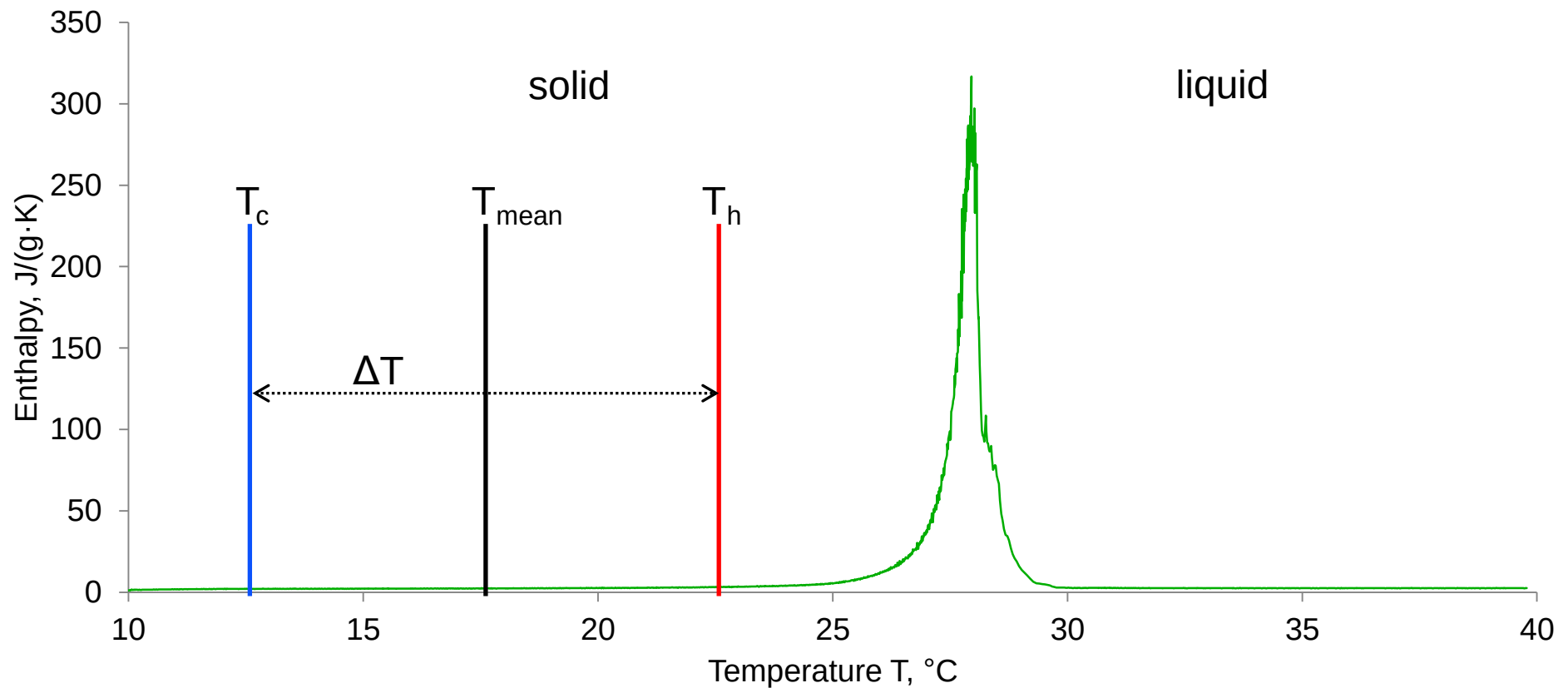


Thermal conductivity: $\lambda(T_{mean}) = \frac{P \cdot d}{A \cdot \Delta T}$

Thermal resistance: $R = \frac{d}{\lambda}$

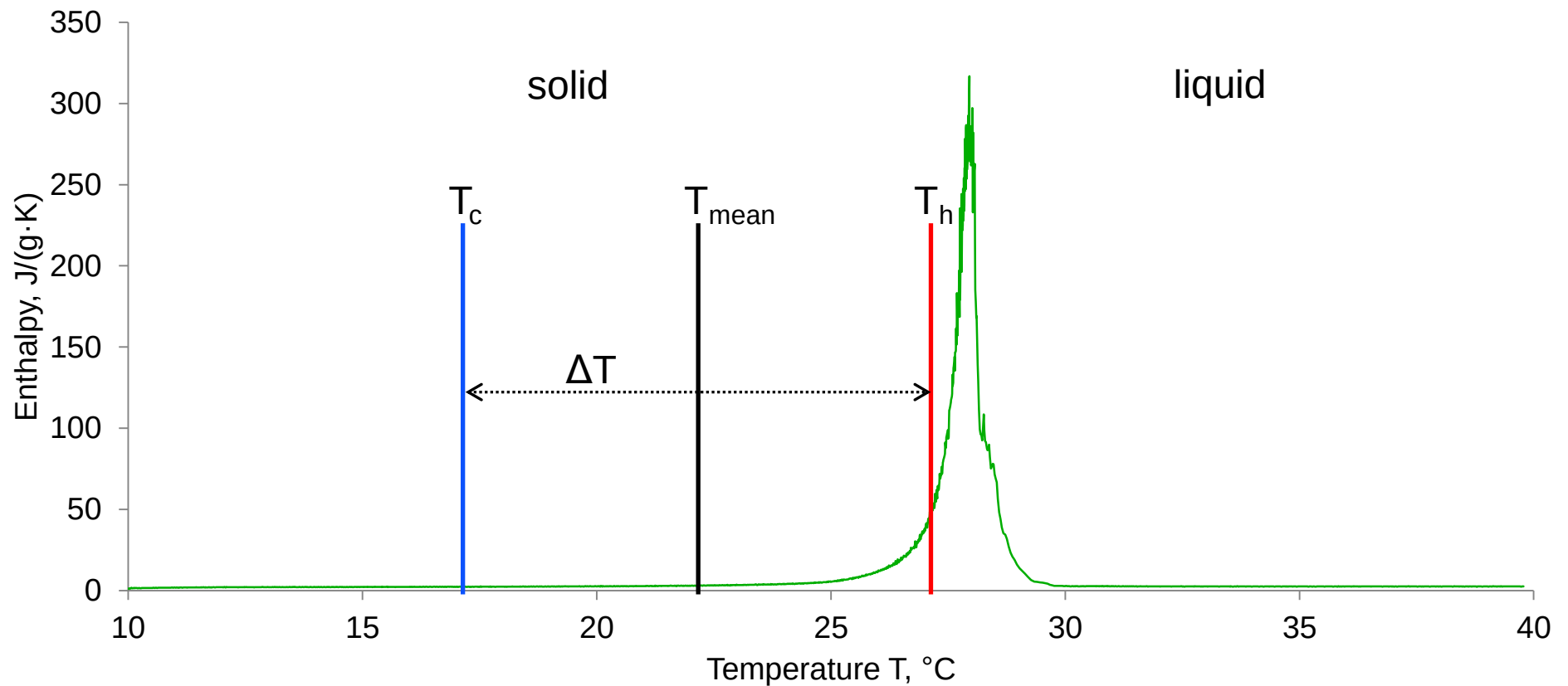
Measurement of PCM

Temperature intervall



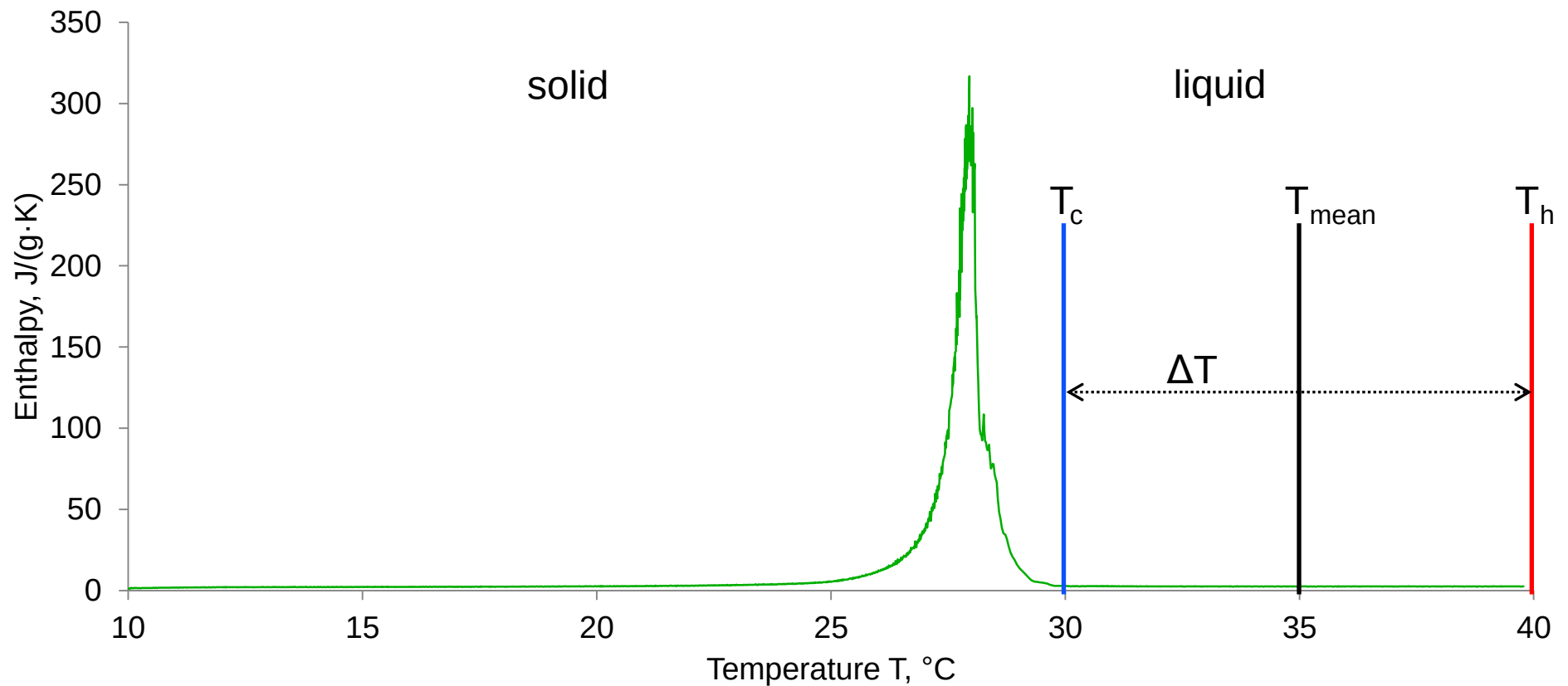
Measurement of PCM

Temperature intervall



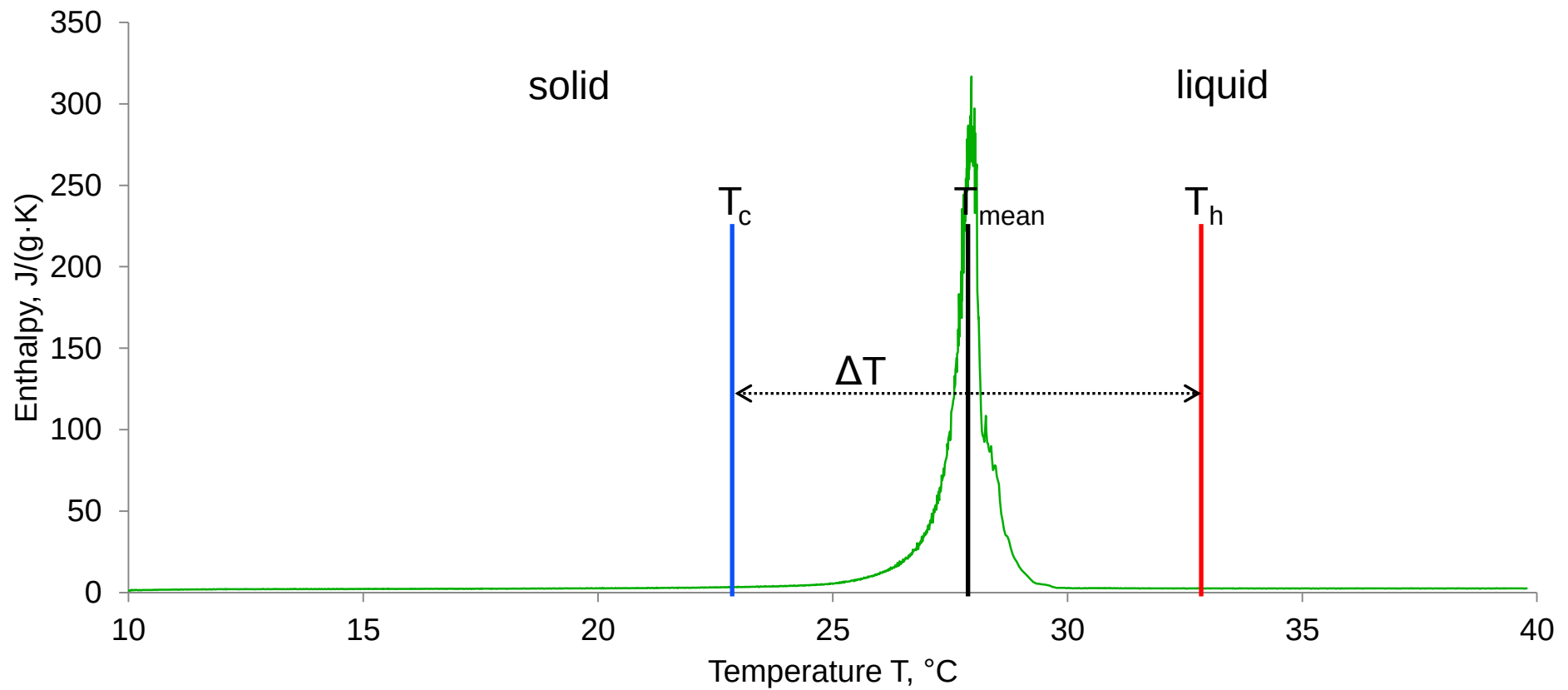
Measurement of PCM

Temperature intervall



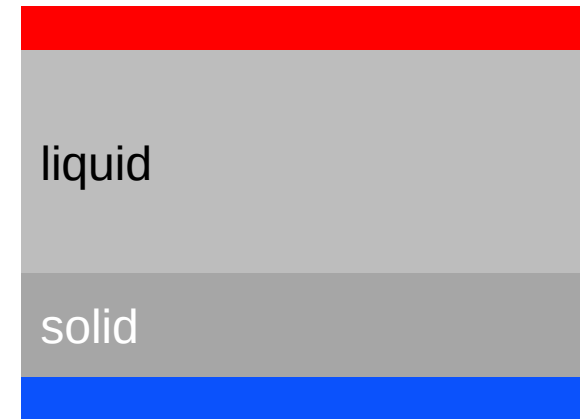
Measurement of PCM

Temperature intervall



Measurement of PCM

Both phases

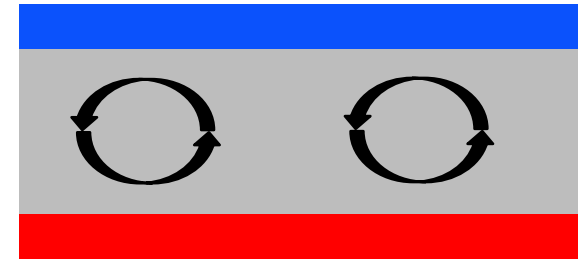
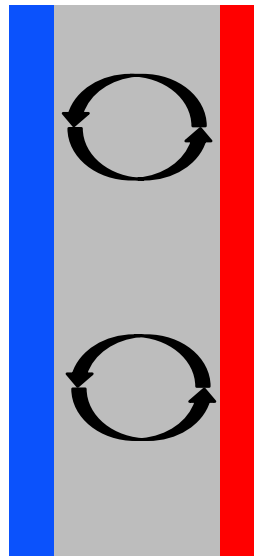
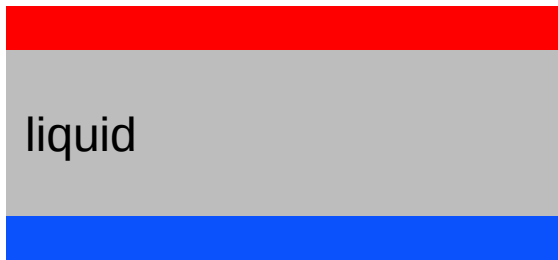


Effective thermal conductivity measured

$$R_{tot} = \frac{d_{liquid}}{\lambda_{liquid}} + \frac{d_{solid}}{\lambda_{solid}}$$

Measurement of PCM

Convection in the liquid phase



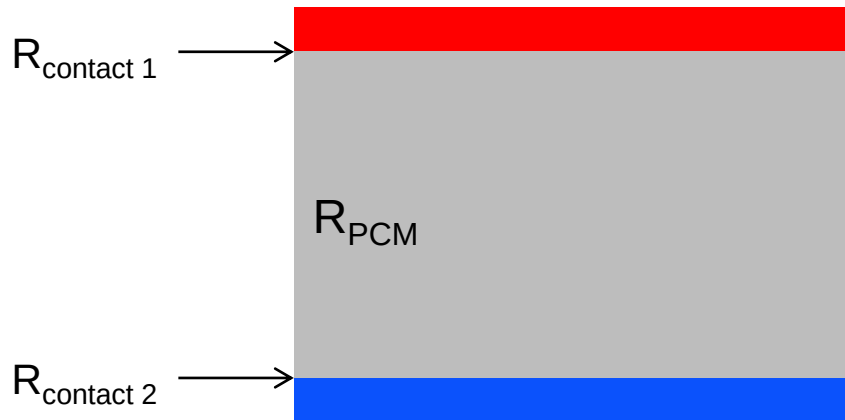
Convection changes the measured effective λ of the liquid phase.

Measurement of PCM

Thermal contact resistances

λ (PCM) typically around 0.1 to 0.6 W/(mK)

→ contact resistances between sample and apparatus' plates may have to be considered



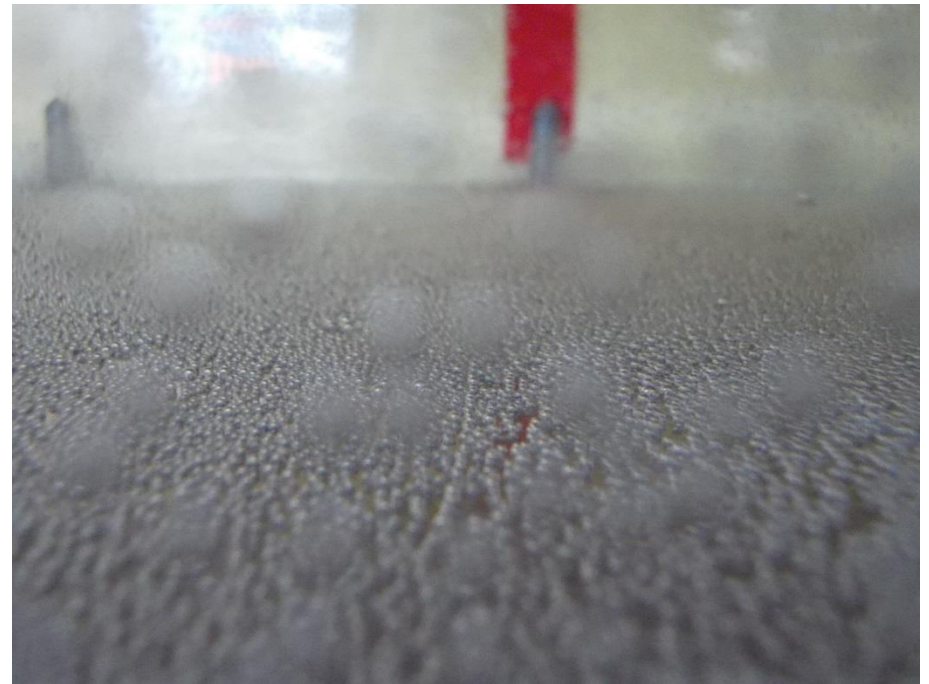
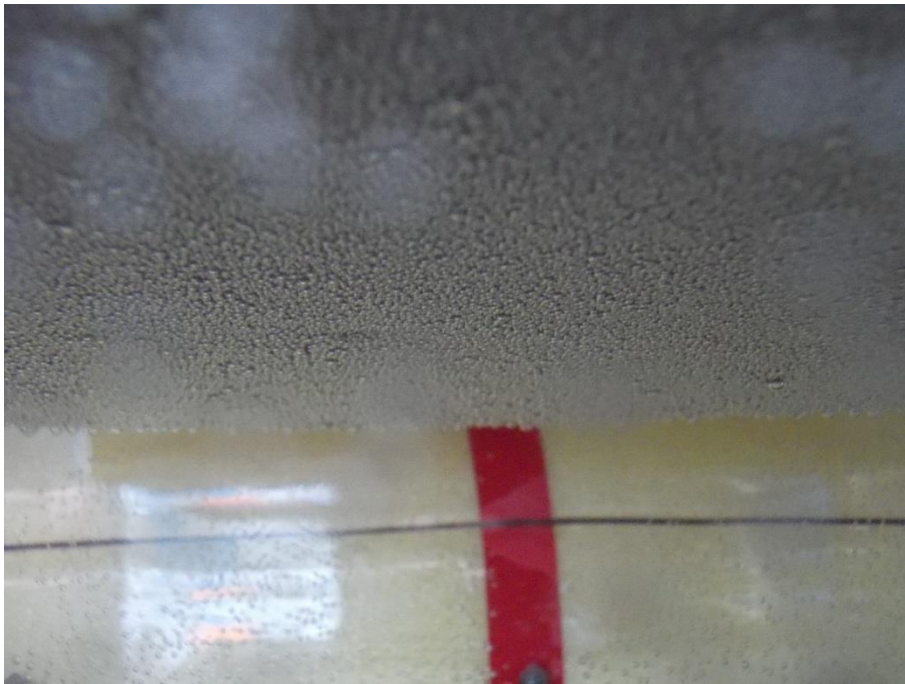
$$R_{tot} = R_{PCM} + R_{contact\ 1} + R_{contact\ 2}$$

$$R = \frac{d}{\lambda}$$

Measurement of PCM

Thermal contact resistances

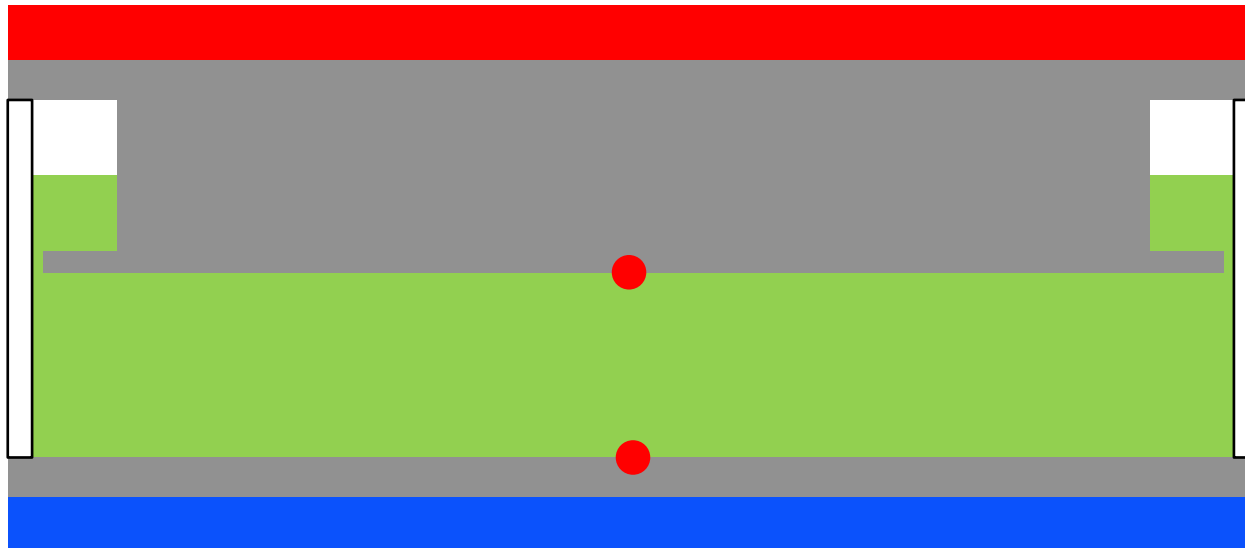
Gas bubbles at the top and bottom surface



Measurement of PCM

Sample holder

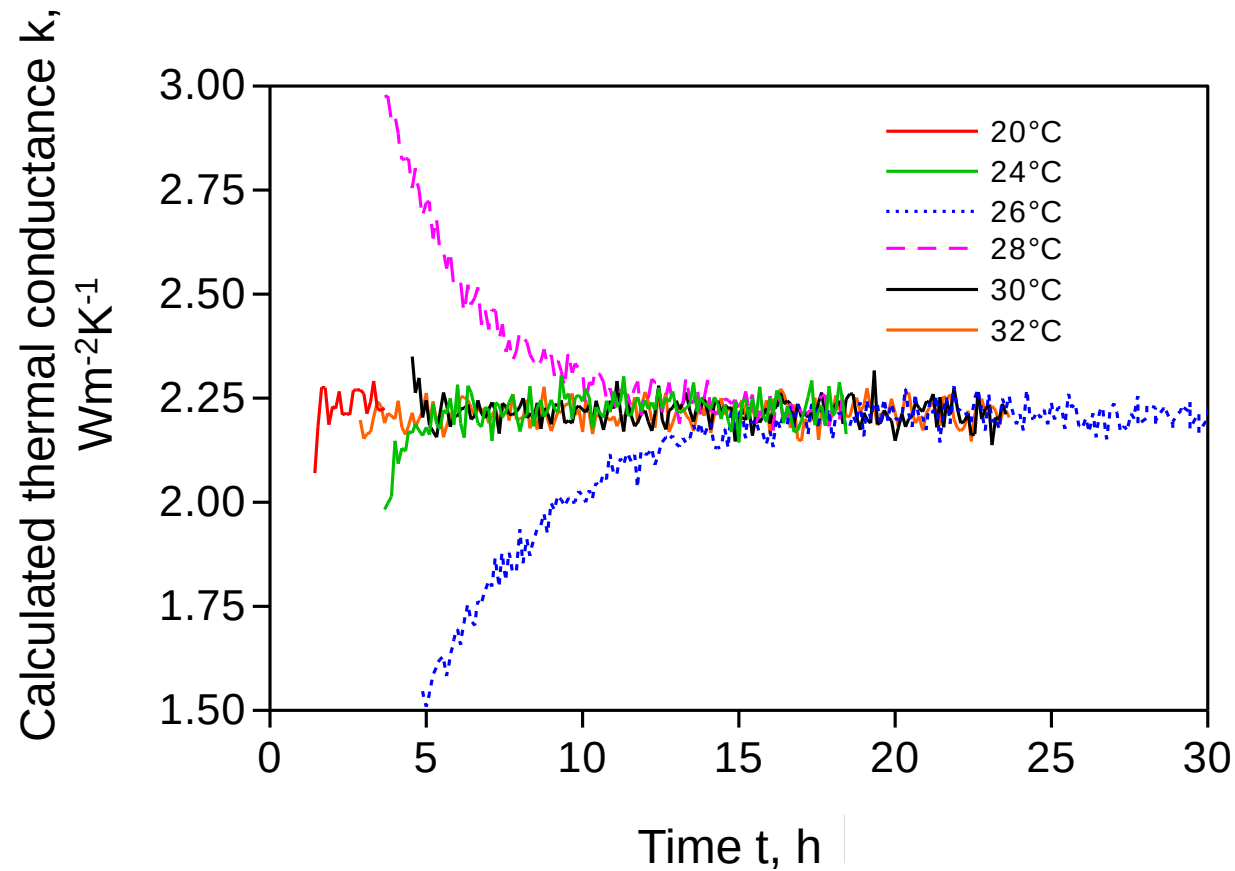
Sample holder with additional space for expansion



Measurement of PCM

Time of measurement

Measurement in the phase change region very time consuming (PCM ~ 27°C).



Measurement of PCM

Measurement of composites

Stationary methods (mostly) have the advantage of one directional heat flow over a larger area.

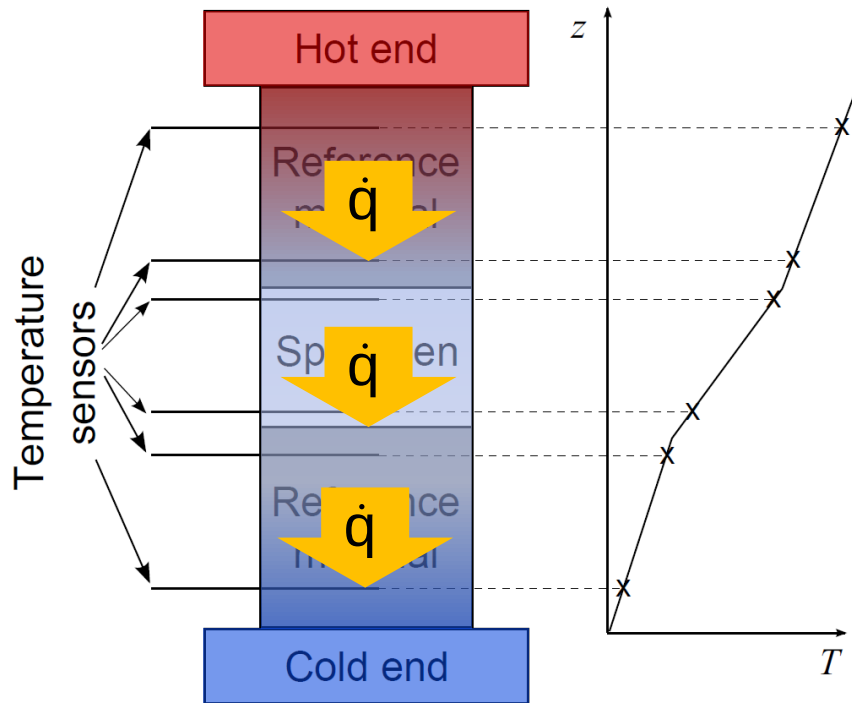
This allows for measurement of:

- Samples with anisotropic thermal conductivity
- Composites (where larger areas need to be measured)

Measurement of PCM

Compacted expanded graphite with RT80HC

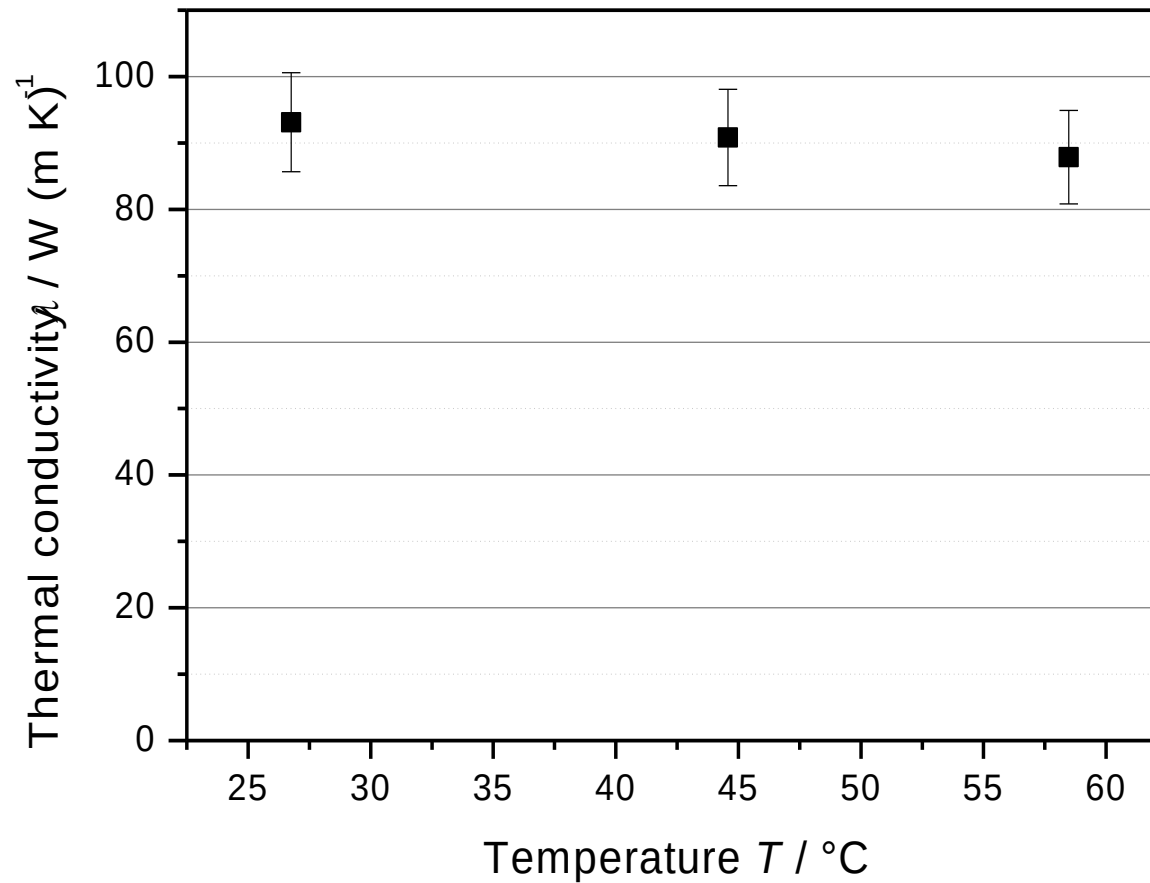
Measurement of thermal conductivity of
medium sized solid samples



Measurement of PCM

Compacted expanded graphite with RT80HC

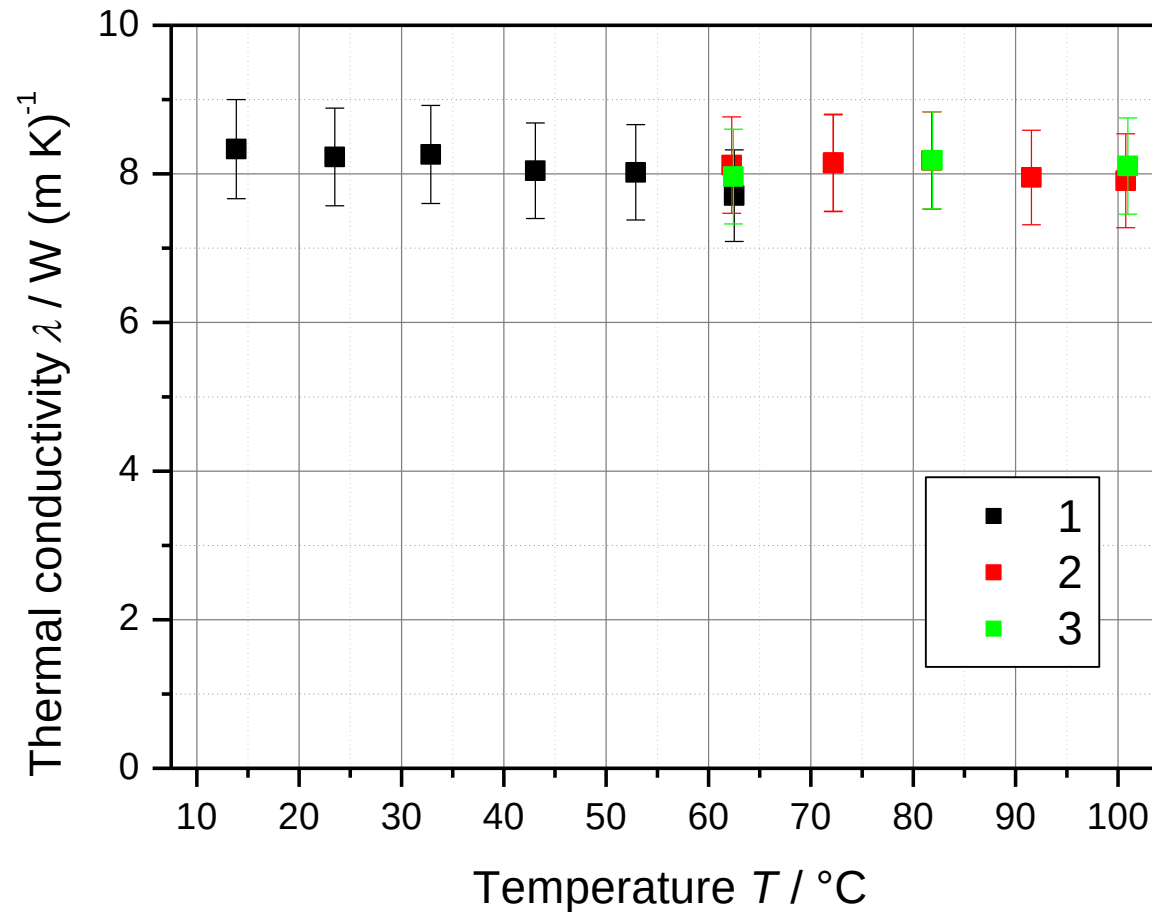
Measurement perpendicular to the direction of compression



Measurement of PCM

Compacted expanded graphite with RT80HC

In direction of compression



Thank you for your attention

MIT SONNE UND VERSTAND.

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