LaTIMA

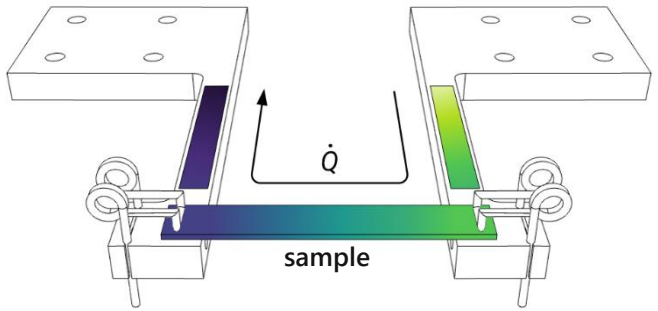
Lateral Thermal Interface Material Analyzer

NANOTEST

simply measured

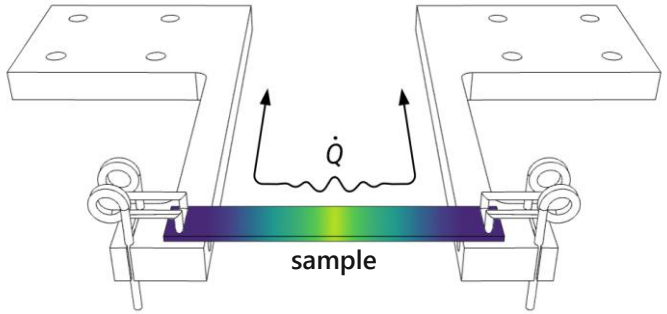
LaTIMA base

» Thermal conductivity



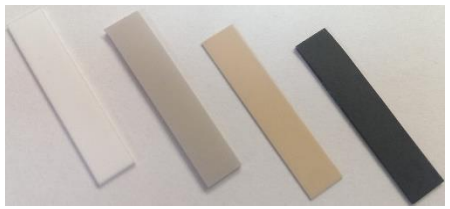
TIMAwave add-on

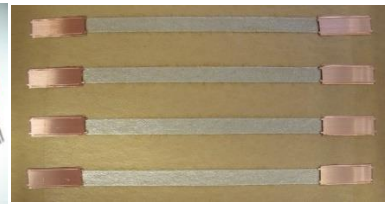
» Thermal diffusivity



For highly conductive materials

Feasible samples | Metals | Alloys | Substrates | Ceramics | | Solder | Sintered material | Semiconductors | FRP |



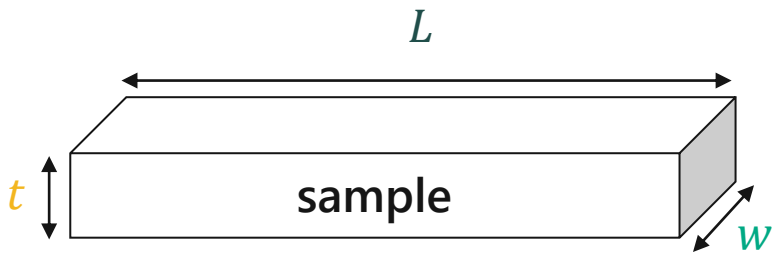


LaTIMA base

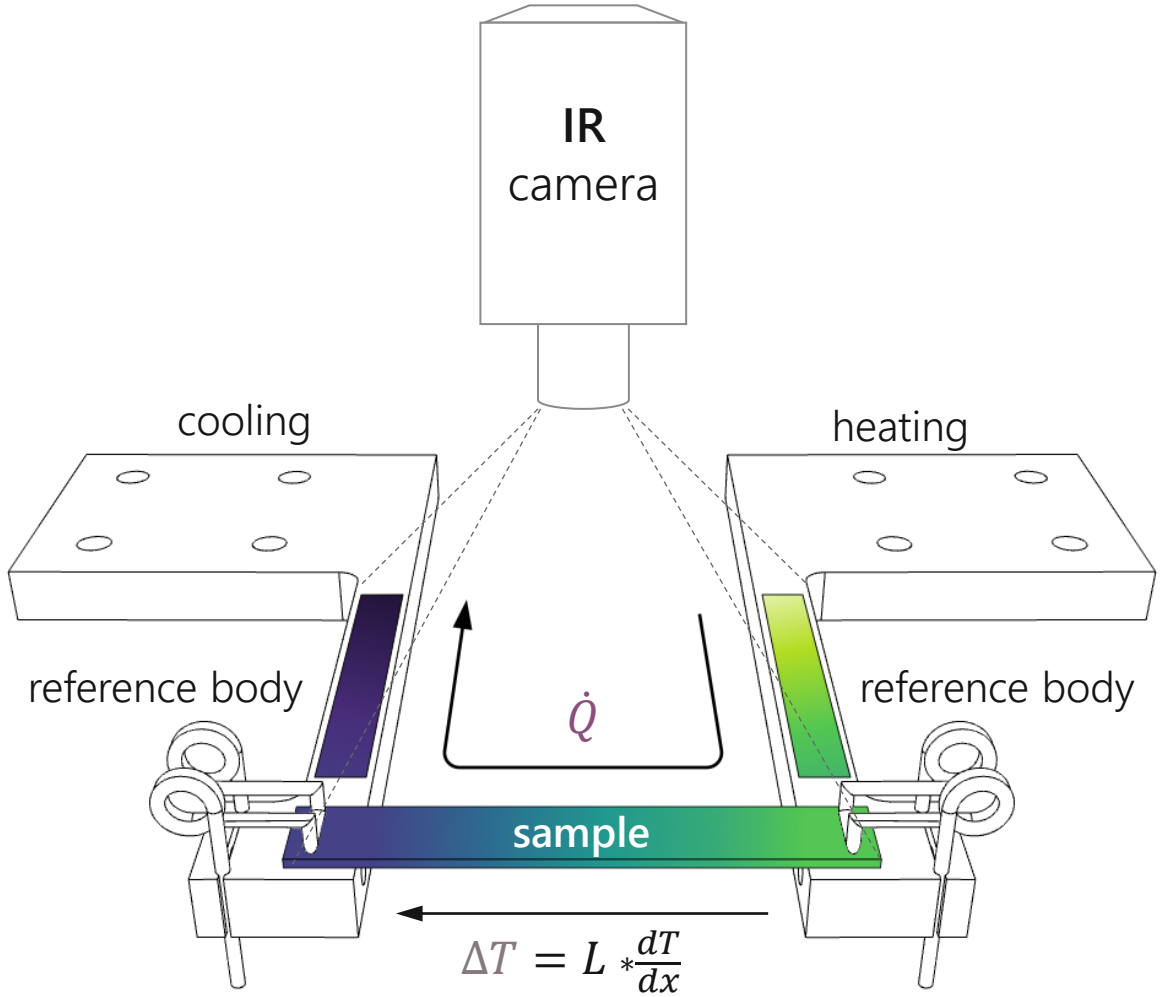
In-plane thermal conductivity measurements

LaTIMA measurement principle

- Steady-state heat flow
- Bar-shaped sample
- IR-camera based gradient measurement
- Heat flow calculation using reference bodies



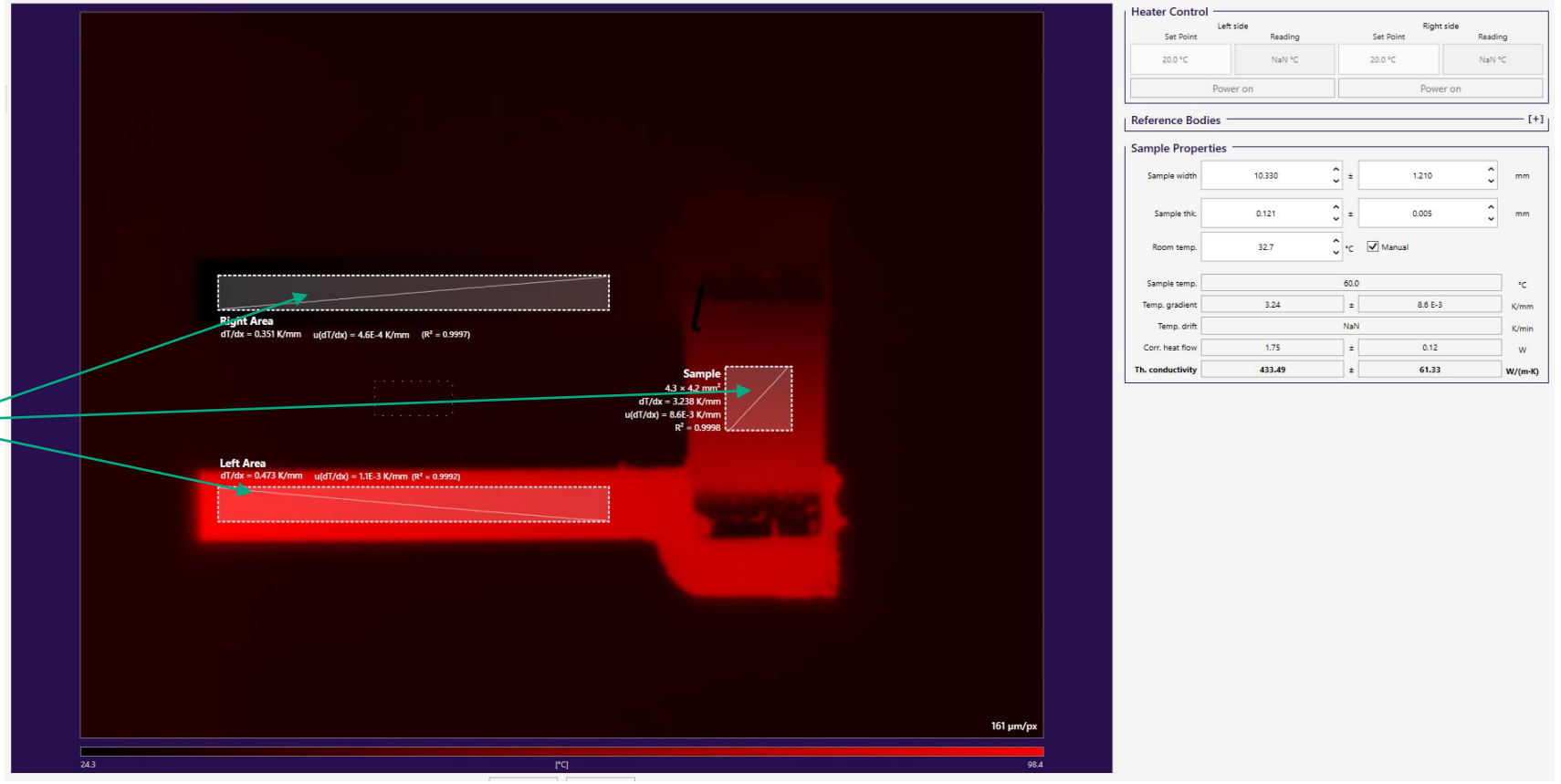
$$\lambda = \frac{L \cdot \dot{Q}}{w \cdot t \cdot \Delta T}$$



Exemplary measurement

» The curves of temperature vs location on the sample should be linear for a successful measurement

linear



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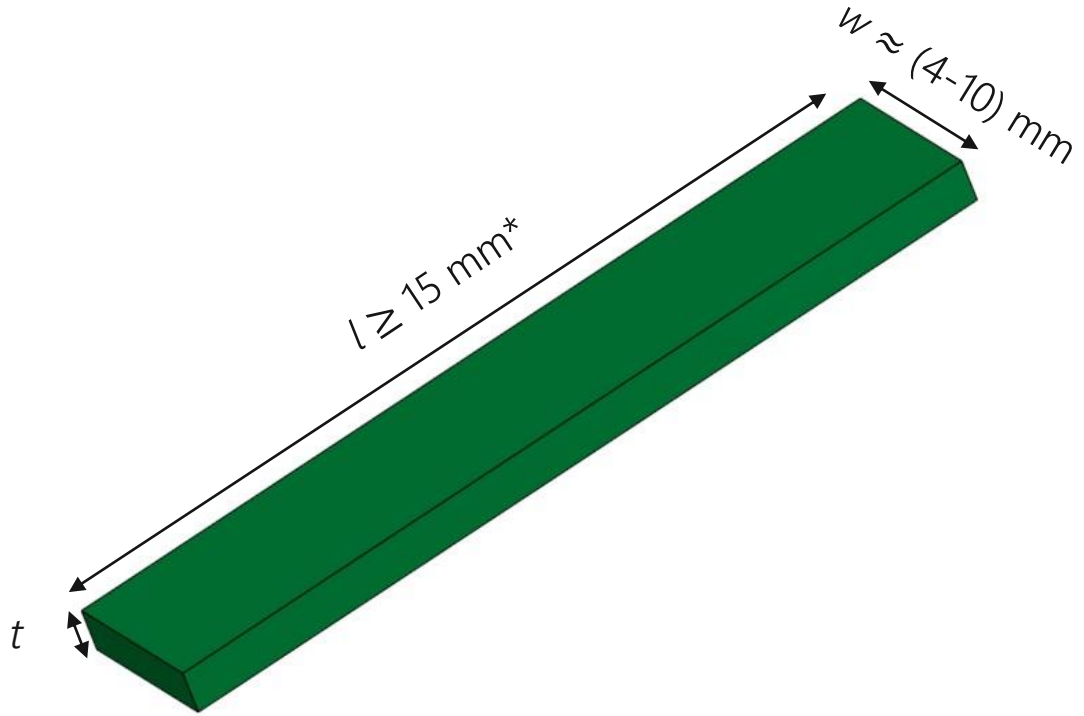
LaTIMA sample dimensions

Expected λ [W/(m·K)]	*Minimum thickness t* (mm) for *w* = 4 mm	*Minimum thickness t* (mm) for *w* = 10 mm
30	1.786	0.714
50	1.071	0.429
80	0.670	0.268
100	0.536	0.214
150	0.357	0.143
200	0.268	0.107
250	0.214	0.086
300	0.179	0.071
350	0.153	0.061
400	0.134	0.054
450	0.119	0.048
500	0.107	0.043
600	0.089	0.036
800	0.067	0.027
1000	0.054	0.021
1200	0.045	0.018
1400	0.038	0.015
1600	0.033	0.013
1800	0.030	0.012
2000	0.027	0.011



λ: Thermal conductivity of sample
t: Sample thickness
l: Sample length
w: Sample width

*longer samples are better, e.g. *l* = 25 mm

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LaTIMA examples

In-plane thermal conductivity measurements

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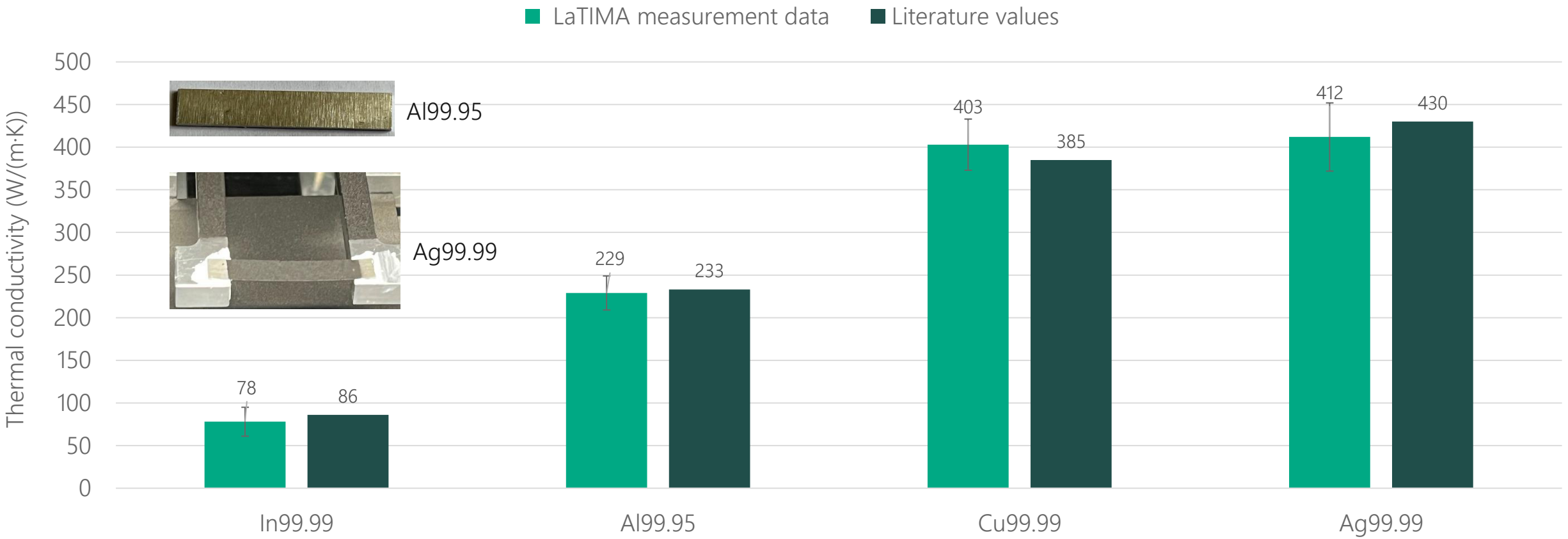
Verification and benchmark of LaTIMA®



→ With these reference measurements emissivity ε and thermal cond. of LaTIMA reference bodies λ_{RB} are optimized.

→ $\varepsilon = 0.1$ and

T (°C)	thermal cond. ref body λ_{RB} (W/(m·K))
0	185
100	195

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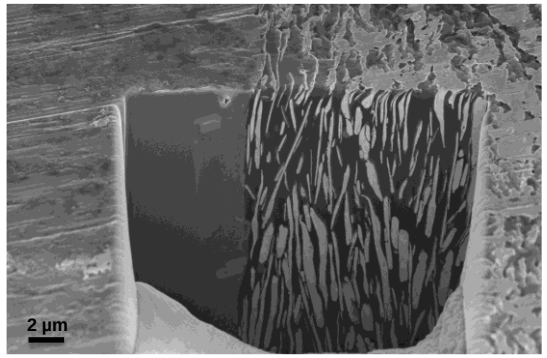
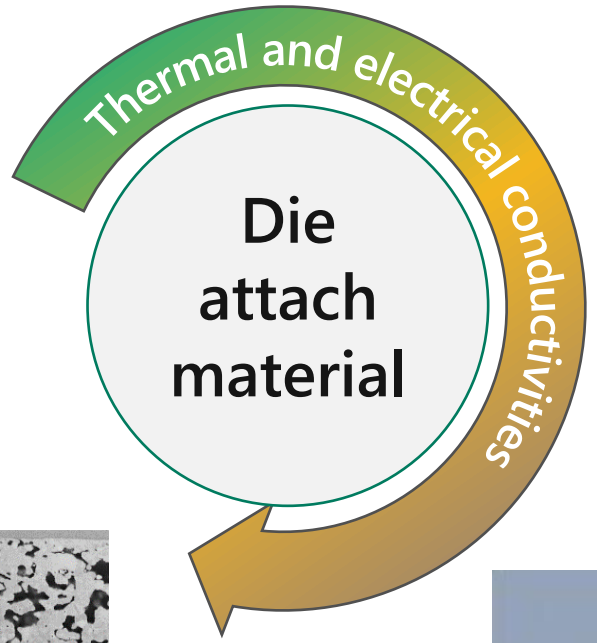
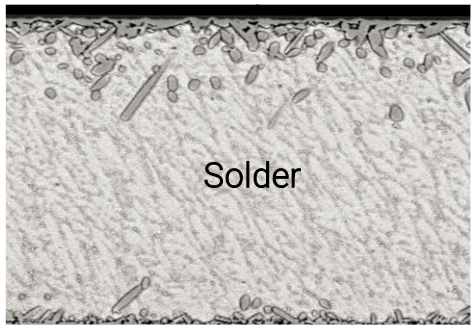
Die attach materials

Conductive adhesives

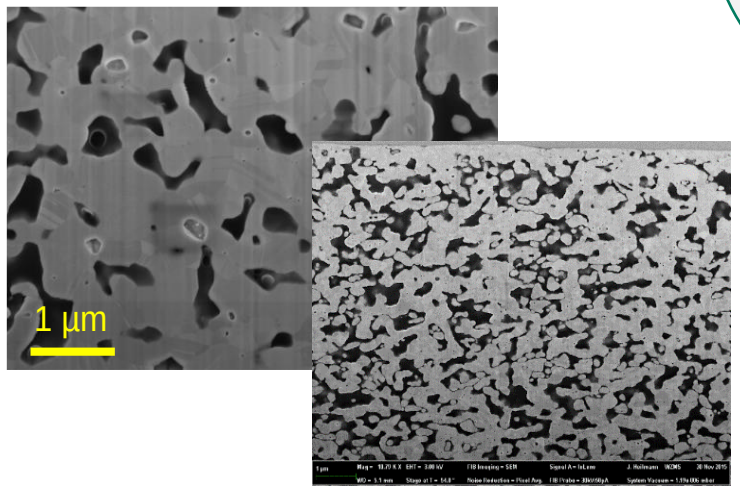


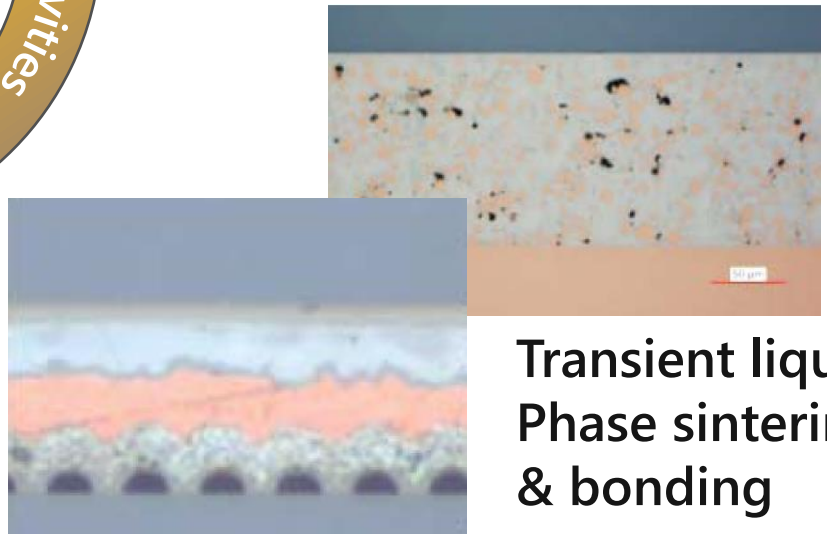




Soldering

Sintering

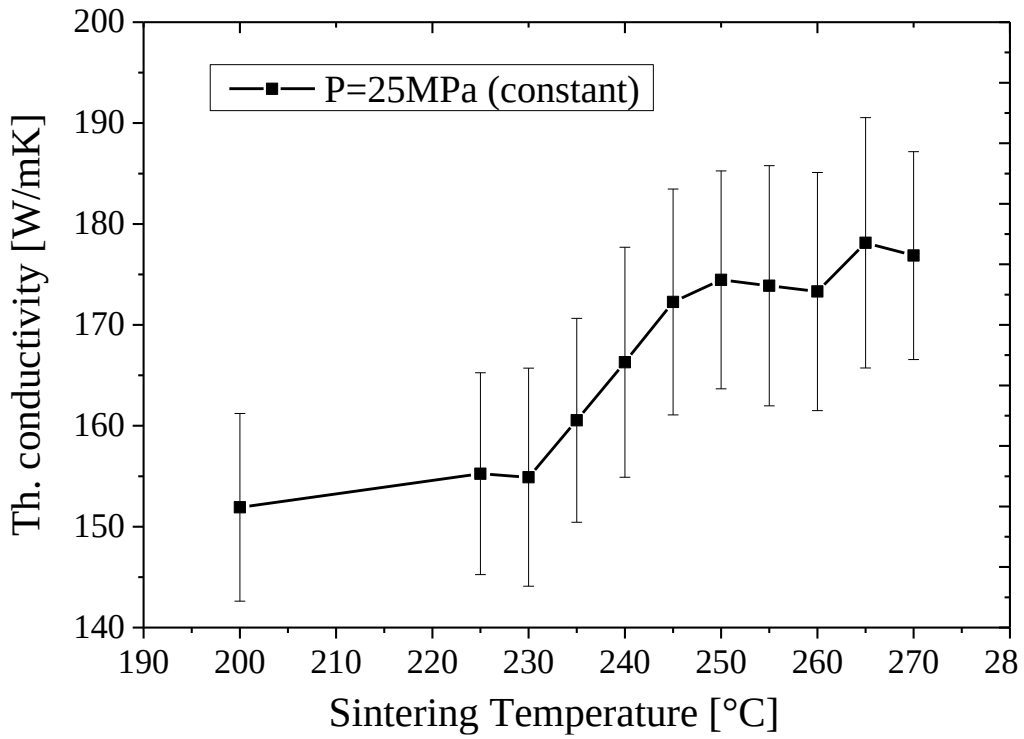


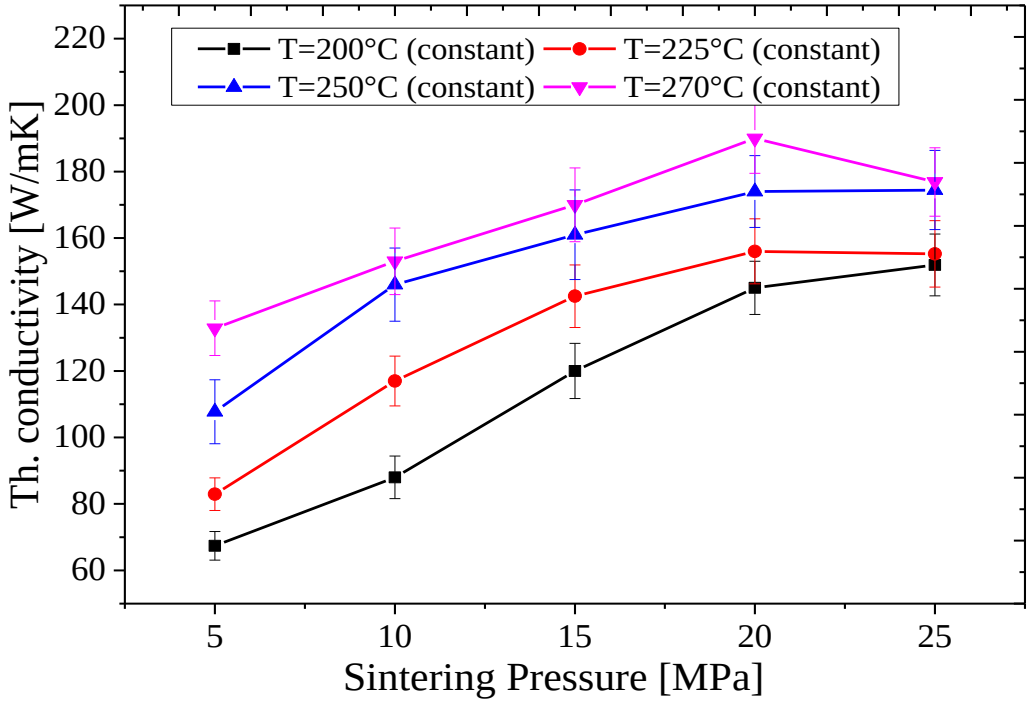


Transient liquid Phase sintering & bonding

Thermal conductivity of sintered silver

» Assessment of thermal conductivity





→ Up to 200% increase of thermal conductivity

65 W/mK @ (5 MPa and 200°C) → 190 W/mK @ (20 MPa and 270°C)

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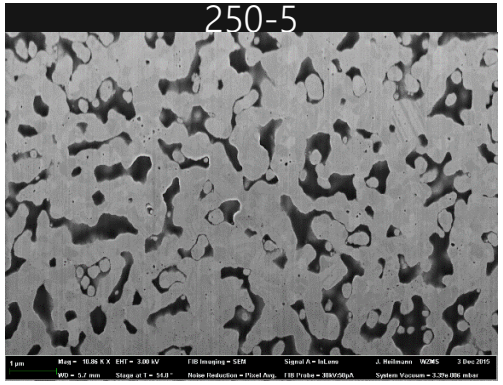
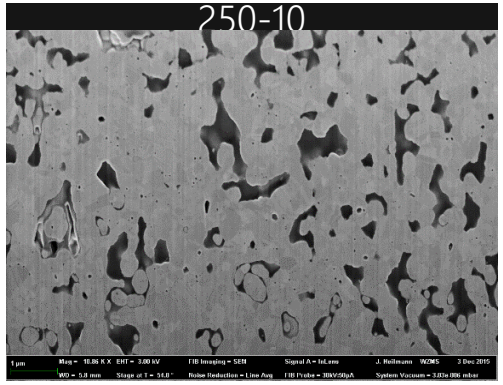
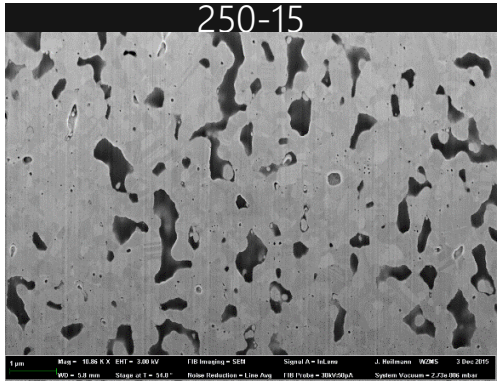
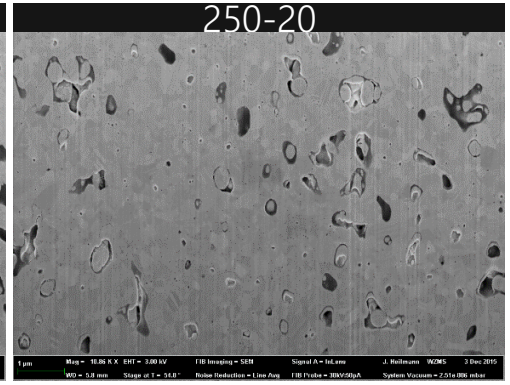
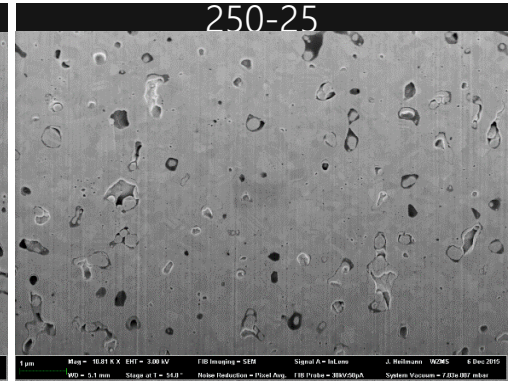
Sintered @ 250°C and diff. pressure





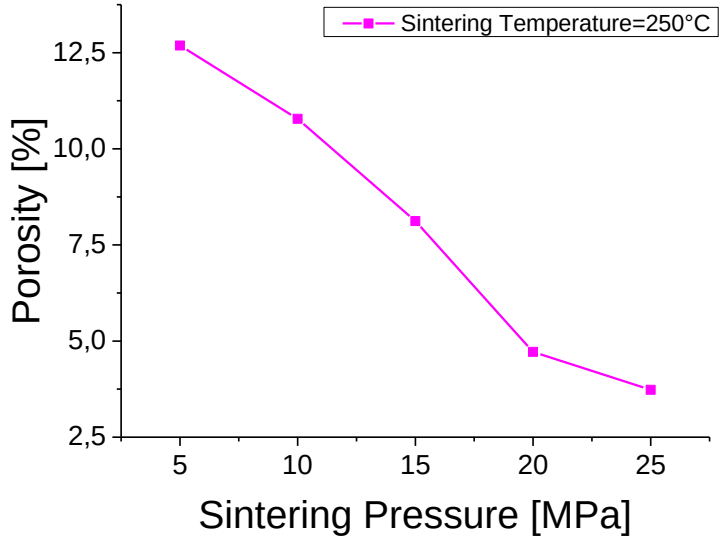


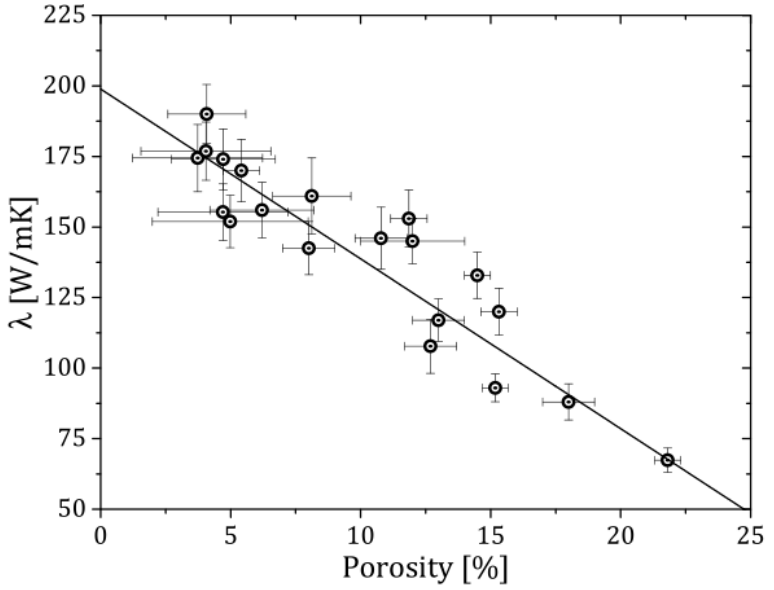




5 … 25 MPa

- Direct relationship between porosity ←→ sintering pressure
- Ca. 0.5% / MPa





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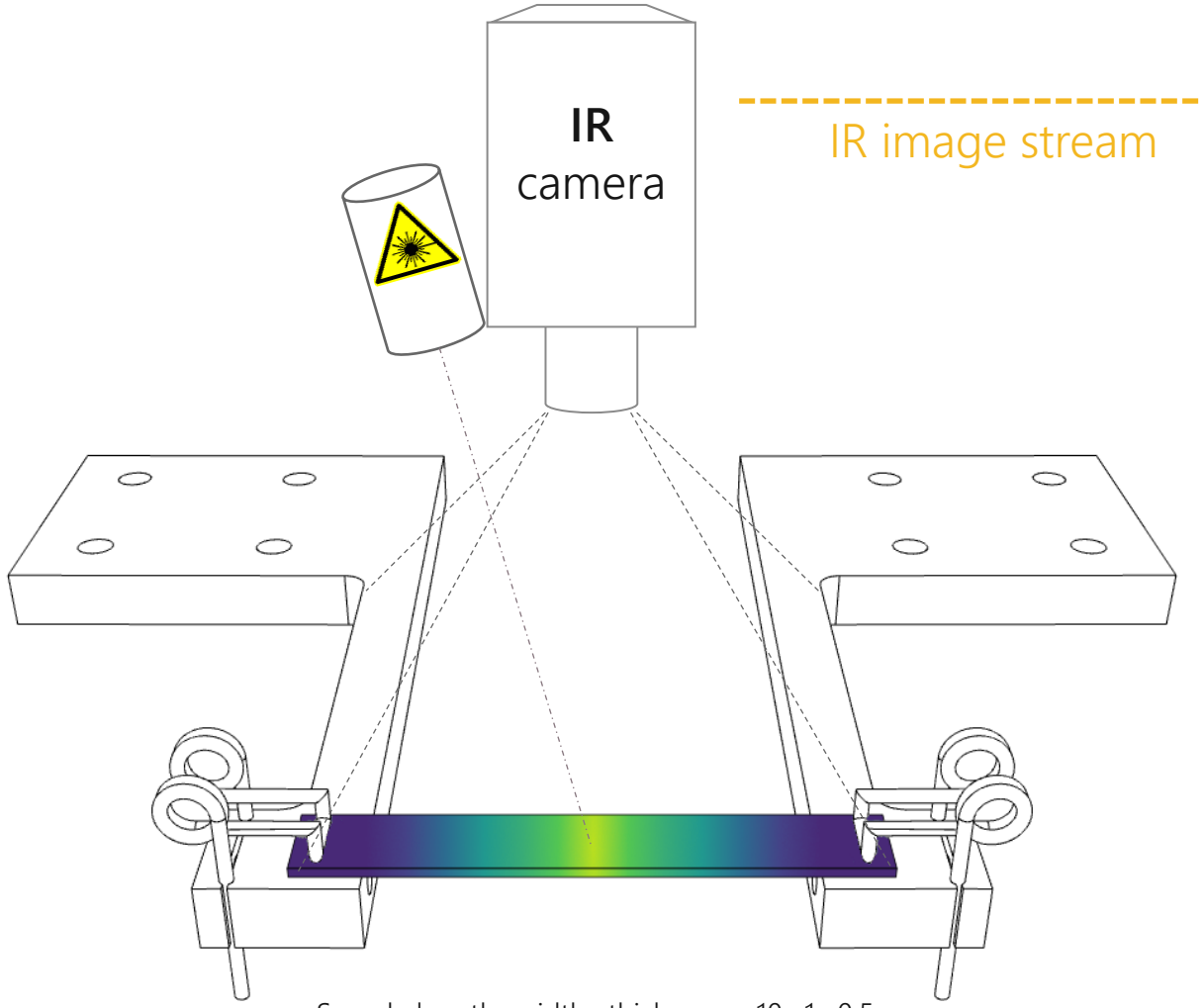
TIMA® *wave* measurement principle

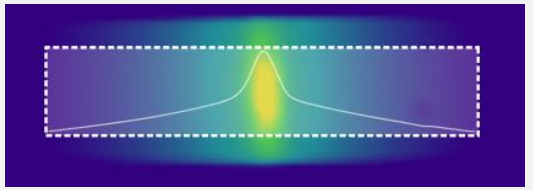
In-plane **thermal diffusivity** measurement of solid materials by **Angström**'s method



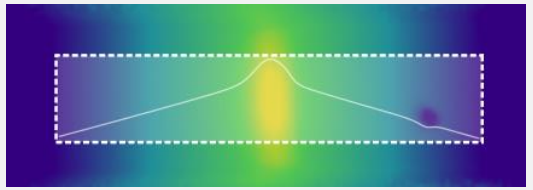
Sample length : width : thickness = 10 : 1 : 0.5

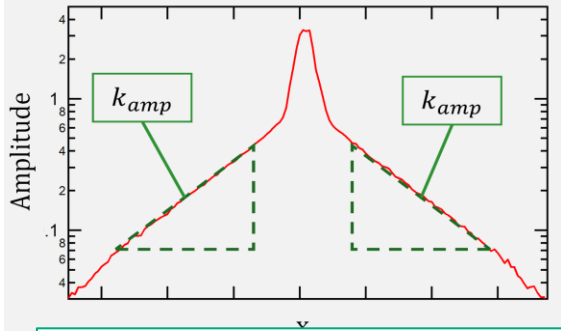
Lock-in processing

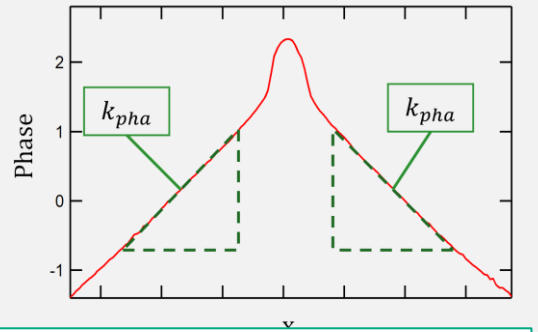
Amplitude image



Phase image







$$\lambda = \sqrt{\frac{\omega}{2 \cdot \alpha}} \Rightarrow \alpha = \frac{\omega}{2 \cdot k^2}$$

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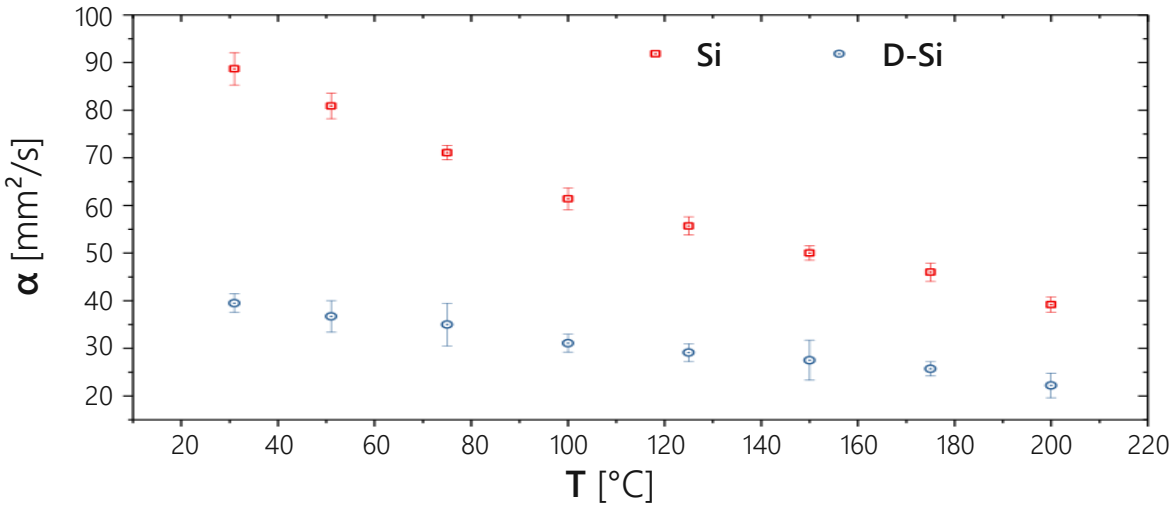
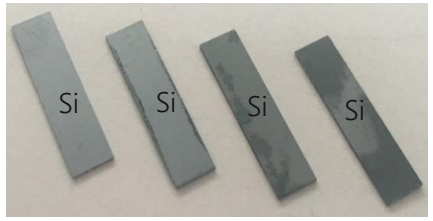
Results of thermal diffusivity measurement by TIMA*wave*

Pure and doped Silicon

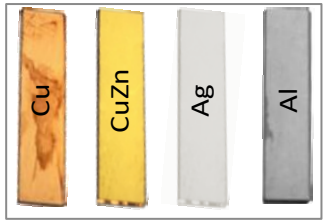
Temperature dependency



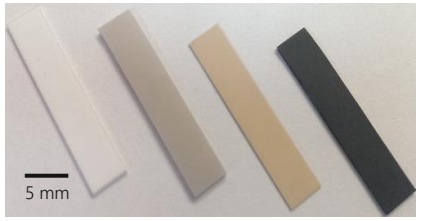
Semiconductors



Metals

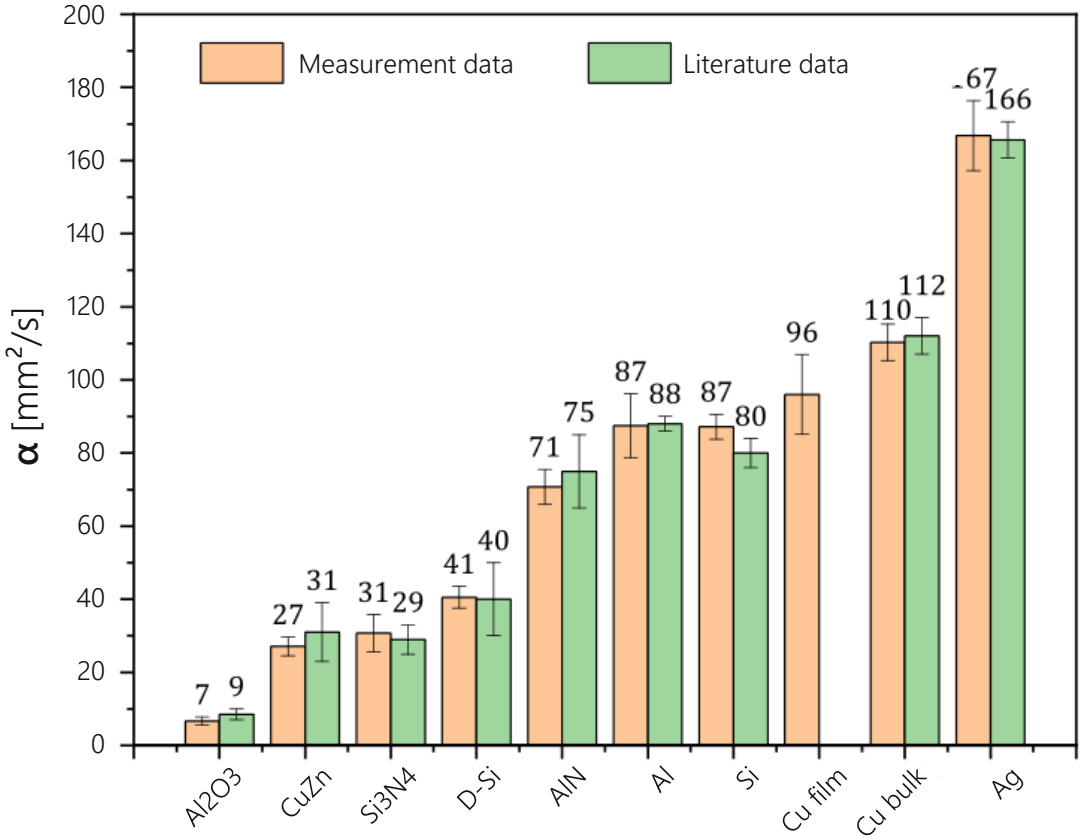


Ceramics



Various Ceramics and metals

Measurement vs. literature



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Features

- Straightforward approach
- Standard industry samples feasible
- Conductivity + diffusivity
- Temperature dependency (limited)
- No upper limits for thermal conductivity

Limits

- In-plane only
- Not well-suited for multi-layers
- Minimum heat flow required
  - Ca. $\lambda \geq 30$ W/mK
  - Ideally thickness ≥ 100 µm
- Samples need coating
- Not standardized

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simply measured

Thank you!

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