LINSEIS

THERMAL ANALYSIS

TRANSIENT HOT BRIDGE

THB Basic

THB Advanced

THB Ultimate

Since 1957 LINSEIS Corporation has been delivering outstanding service, know how and leading innovative products in the field of thermal analysis and thermo physical properties.

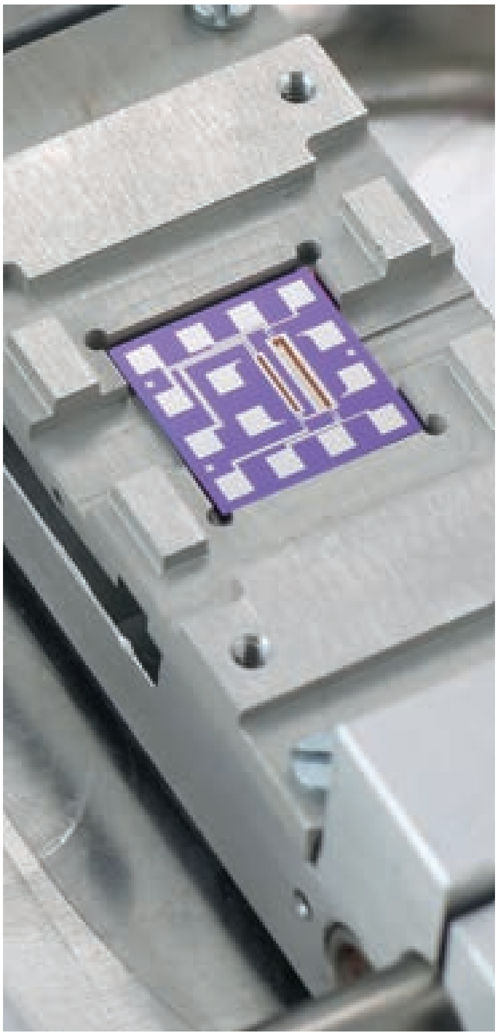
Customer satisfaction, innovation, flexibility and high quality are what LINSEIS represents. Thanks to these fundamentals, our company enjoys an exceptional reputation among the leading scientific and industrial organizations. LINSEIS has been offering highly innovative benchmark products for many years.

The LINSEIS business unit of thermal analysis is involved in the complete range of thermo analytical equipment for R&D as well as quality control. We support applications in sectors such as polymers, chemical industry, inorganic building materials and environmental analytics. In addition, thermo physical properties of solids, liquids and melts can be analyzed.

LINSEIS provides technological leadership. We develop and manufacture thermo analytic and thermo physical testing equipment to the highest standards and precision. Due to our innovative drive and precision, we are a leading manufacturer of thermal Analysis equipment.

The development of thermo analytical testing machines requires significant research and a high degree of precision. LINSEIS Corp. invests in this research to the benefit of our customers.

Claus Linseis
Managing Director



German engineering

The strive for the best due diligence and accountability is part of our DNA. Our history is affected by German engineering and strict quality control.

Innovation

We want to deliver the latest and best technology for our customers. LINSEIS continues to innovate and enhance our existing thermal analyzers. Our goal is constantly develop new technologies to enable continued discovery in science.

THB

TRANSIENT HOT BRIDGE

Heat management is becoming very important in the building industries due to exploding energy costs (isolation) or in the semiconducting industries if we think of power electronics and highly integrated circuits. Thus, the knowledge of heat transport properties is a crucial parameter for research and development.

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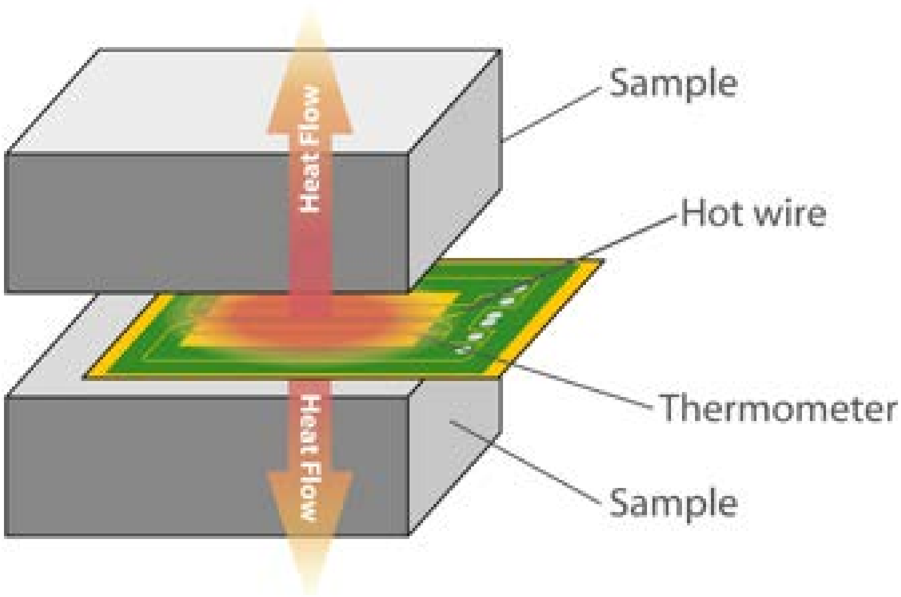


The method:

The THB measurement method, initially developed by the National Metrology Institute of Germany, is an optimized transient or quasi- steady-state hot wire to measure all relevant thermal transport properties (thermal conductivity, thermal diffusivity and volumetric specific heat) with the highest possible accuracy.

Developed in cooperation with PTB Physikalisch-Technische Bundesanstalt

Complies to the following norms:
ASTM D 5930-01, DIN ISO 22007-2, ASTM D 5334.

PTB
Physikalisch-Technische Bundesanstalt
Nationales Metrologieinstitut

Advantages of improved technology

- smallest footprint
- light in weight
- optimized electronics for highest efficiency
- fastest data acquisition
- highest measurement accuracy
- lowest signal-to-noise ratio
- user-friendly software - easy to use and powerful in operation
- with EPROMs
- Linseis Intelligence software for fully automated operation
- no user settings required
- limits operational errors
- faster measurements

Temperature range from 150 to 700°C

Easy set-up and sample preparation

Broad thermal conductivity range from 0.01 to 1800 W/mK

THB models

for beginnders and advanced users

The THB - available in Basic, Advanced and Ultimate models - is an intelligent series of measuring instruments. The sensor is initialized at the push of a button and the measurement parameters are automatically set and recorded in the software. In a few seconds, the THB automatically provides measurement results (0.005 to 1800 W/mK and 0.05 to 1200 mm²/s) in the temperature range from -150°C to 700°C.

THB Basic

- Suitable for low thermal conductivity materials (insulation and building materials)
- Easy installation - basic installation of the meter is done remotely
- THB/B sensor included (THB/A sensor on request)

THB Advanced

- Universal instrument with the widest thermal conductivity range
- Suitable for solids, liquids, pastes and powders
- Suitable for laboratory service providers, institutes and universities
- Easy installation - basic installation is done remotely
- QSS sensor included (THB/A, THB/B or Hotpoint sensor on request)

THB Ultimate

- High-end instrument for every need
- Suitable for almost all materials: from insulators to to copper, from solids to liquids
- Easy installation and training by qualified personnel
- Two sensors of your choice included

Different Sensors

Transient Hot Bridge (THB) sensor

The THB method was developed from the hot wire and hot strip method.
During the measurement, the sensor emits a constant heating current and also heats itself. The temperature rise is recorded by the bridge voltage and is a measure of the thermal properties of the sample.

- patented sensor
- suitable for fast and high accuracy measurements
- Thermal Conductivity, Thermal Diffusivity and Specific Heat Capacity
- uncertainty < 3%
- most accurate sensor for low conductivity materials

	Min. sample size*	Temperature range**	Measuring range	Suitable for***
THB/A	20 x 40 x 5 mm	-150 up to 300°C	0.01 up to 5 W/mK	S
THB/A/Metal	20 x 40 x 5 mm	-150 up to 300°C	0.01 up to 5 W/mK	S, P, L
THB/B	10 x 20 x 3 mm	-150 up to 300°C	0.01 up to 2 W/mK	S
THB/B/Metal	10 x 20 x 3 mm	-150 up to 300°C	0.01 up to 2 W/mK	S, P, L
THB/A/HT	20 x 40 x 5 mm	up to 700°C		S

* The exact min. sample size depends on the material properties.
** The maximum temperature for a performance under air is +200 °C. The temperature range can be exceeded up to +300 °C in inert gas atmosphere.
*** Solid (S), Powder (P), Liquid (L)

Different Sensors

Quasi Steady State (QSS) Sensor

For highly conductive materials, heat transfer can be so fast that it cannot be detected with transient hot-wire methods. The solution for such samples is the QSS sensor, a quasi-steady-state technique that eliminates the time constant of instruments. It combines the characteristic advantages of steady-state and transient techniques.

The QSS sensors contain a heater and two temperature sensors. The difference in temperature between the two sensors is measured.

After a short set-up time during which all transients die out, the instrument operates under quasi-steady-state conditions. Guard heaters are not required because the outer boundaries are free to change over time.

- Suitable for samples with high thermal ductivity
- Uncertainty < 5%.
- Bridge circuit integrated in sensor
- Very broad measuring range

	Min. sample size*	Temperature range**	Measuring range	Suitable for***
QSS	25 x 55 x 3 mm	-150 up to 300°C	0.005 up to 1800 W/mK	S, (P.L)
QSS HT	25 x 55 x 3 mm	RT up to 700°C	0.2 up to 100 W/mK	S

* The exact min. sample size depends on the material properties.
** The maximum temperature for a performance under air is +200 °C. The temperature range can be exceeded up to +300 °C in inert gas atmosphere.
*** Solid (S), Powder (P), Liquid (L)

Different Sensors

Hotpoint sensor

The Hotpoint sensors are suitable for very small volume samples down to 3x3x2 mm.
Due to its very low thermal mass, the sensor responds to sudden temperature changes in a few milliseconds. The sensor acts as both a thermometer and a heat source, making it ideal as a thermal transport property sensor. The thermal conductivity of the samples can be calculated from the temperature rise over time using established heat flow equations.

- Suited for measuring small or anisotropic samples
- Uncertainty about 5 % –10 %
- Sensor is heated by a heating current
- Temperature rise as function of time is measured

	Min. sample size*	Temperature range**	Measuring range	Suitable for***
Hot Point	3 x 3 x 2 mm	-150 up to 200°C	0.01 up to 30 W/mK RT	S, P, L
Hot Point HT/L	1 ml	up to 700°C	0.01 up to 5 W/mK	L, P

* The exact min. sample size depends on the material properties.
** The maximum temperature for a performance under air is +200 °C. The temperature range can be exceeded up to +300 °C in inert gas atmosphere.
*** Solid (S), Powder (P), Liquid (L)

Different Sensors

Single-side sensor (QSS sensor)

The single-sided sensor allows the direct measurement of thermal conductivity without the requirement to clamp a sensor between two sample parts.

Thus, the single-sided sensor is especially suited for testing large samples which cannot or should not be modified, i.e. cut into two parts. Thus, non-destructive measurements can be realized.

The single-side sensor uses the QSS sensor design together with an insulation material on one side of the sensor. This results in a more directed heat flow to the sample, thus, the sensor is especially suited for high conductive materials.

In practice, the sigle-sided sensor just needs to be placed on top of the surface of the material or vice versa. Additionally, the contact can be improved by compressing the configuration - similar to the two sample preparation procedure.

- especially suited for high conductive materials
- for large samples which cannot or should not be modified
- non-destructive measurements

Specifications

	THB Basic	THB Advanced	THB Ultimate
Measuring range			
Thermal Conductivity	0.01 up to 5 W/mK	0.005 up to 500 W/mK	0.005 up to 1800 W/mK
Thermal Diffusivity	0.05 up to 50 mm^2/s	0.05 up to 300 mm^2/s	0.05 up to 1200 mm^2/s
Specific Heat Capacity	100 up to 5000 $kJ/(m^3K)$	100 up to 5000 $kJ/(m^3K)$	100 up to 5000 $kJ/(m^3K)$
Measuring precision			
Thermal Conductivity**	better than 1 %	better than 1 %	better than 1 %
Thermal Diffusivity**	better than 4 %	better than 4 %	better than 4 %
Thermal Capacity**	better than 4 %	better than 4 %	better than 4 %
Measuring duration			
Solids	approx. 1 up to 10 min	approx. 1 up to 10 min	approx. 1 up to 10 min
Liquids	approx. 1 up to 120 s	approx. 1 up to 120 s	approx. 1 up to 120 s
Operating temperature			
Sensor	-150 up to 700°C	-150 up to 700°C	-150 up to 700°C
Sensor type	Kapton, Ceramics	Kapton, Ceramics	Kapton, Ceramics
Sample size			
Smallest sample size*	3 x 3 x 2 mm	3 x 3 x 2 mm	3 x 3 x 2 mm
Max. sample size	unlimited	unlimited	unlimited

* depends on sensor, material and furnace
** depends on sample sensor and sample preparation

	THB Basic	THB Advanced	THB Ultimate
Thermal Conductivity range	0.01 to 5 W/mK	0.005 to 500 W/mK	0.005 to 1800 W/mK
Thermal Diffusivity range	0.05 up to 50 mm^2/s	0.05 up to 300 mm^2/s	0.05 up to 1200 mm^2/s
Specific Heat Range	100 to 5000 $kJ/(m^3K)$	100 to 5000 $kJ/(m^3K)$	100 to 5000 $kJ/(m^3K)$
THB-Sensors	✓	✓	✓
QSS-Sensors	✗	✓	✓
Hotpoint-Sensors	✗	✓	✓

Measured parameters	Thermal Conductivity, Thermal Diffusivity, Specific Heat, Effusivity
Measuring method	Transient Hot Bridge and Quasi Steady State Method
Temperature range	From -150°C up to 700°C
Sample size	Smallest sample size: 1.5 x 1.5 mm Largest sample size: unlimited
Sensor Types	Kapton, Ceramic
Reproducibility	Better than 1%
Accuracy	Better than 3% for most samples
Instrument dimensions	200 mm x 200 mm x 65 mm
Power requirements	36 Watt, 100 to 240 V (AC), 50/60 Hz (US/EU socket included)
Software	Advanced THB Windows® based software interface. Allows fastest measurement times on the market. No room for user errors thanks to optimized, software-controlled measurement algorithms. This allows for most accurate and time saving measurements available. One button solution. Easy data export to Microsoft Excel®

Complies to the following Norms:

- ASTM D 5930-01
- ISO 22007-2
- ASTM D 5334

Accessories

furnace programm

Standard THB furnace – Peltier cooling

THB furnace suited for phase change materials

Furnaces and climate chambers	Temperature range
Standard THB furnace HT - Peltier ccoling	-20 up to 50°C
Standard THB furnace HT - with heating	RT up to 200°C
High temperature furnace	RT up to 700°C
Low temperature furnace for lage samples max. 60 x 100 x30 cm	-125 up to 500°C
Furnace for controlled humidity	-20 up to 80°C
Furnace for liquids, powders and pastes	150 up to 500°C

calibration materials

PMMA

BK7

Titanium

Tinn

Zinc

Accessories

further accessories

- Press for defined pressure on the specimen (test stand, handwheel operated up to 500 N, digital force gauge up to 250 N)
- Specimen holder for liquids
- Specimen holder for powder
- Transport case for the THB

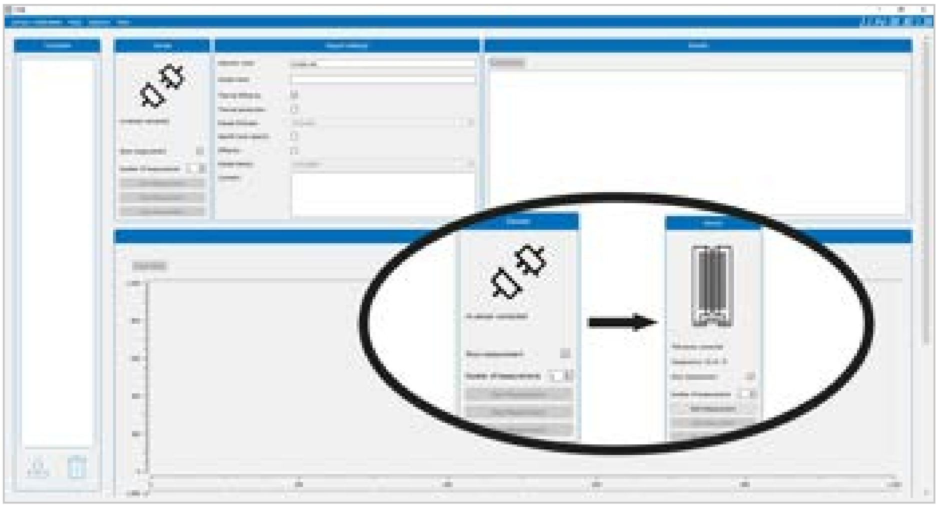

Press for defined pressure


Basic press with manual stage

New automatic Software

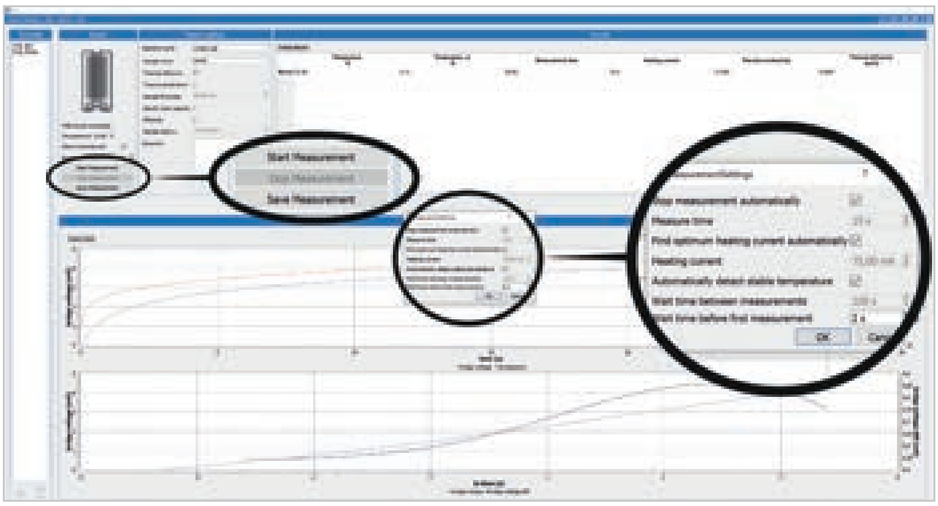
3 steps to results

1 Automatic detection of the connected sensor



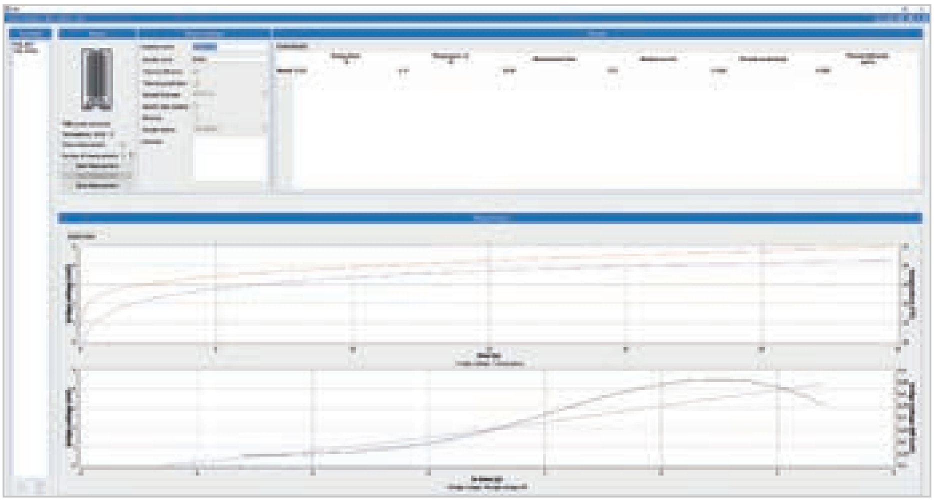
The THB software automatically checks the sensor connection and identifies the type of sensor that is actually connected to the instrument. In the field "sensor" the actual status can be seen, including an image of the sensor type and the actual temperature read. This allows the user to easily check the system configuration anytime.

2 Intuitive user interface for the operation of the instrument and data analysis



The intuitive new software package allows easy measurement setup with only a few clicks. In the field "sensor", the actual configuration is automatically displayed. No need to manually select a sensor or setup. One click on start measurement opens a short dialogue where all necessary input can be made within seconds. The automatic iterative mode that can be selected instead of using defined settings, leading to an automated optimization of measurement time and current to obtain proper measurement results.

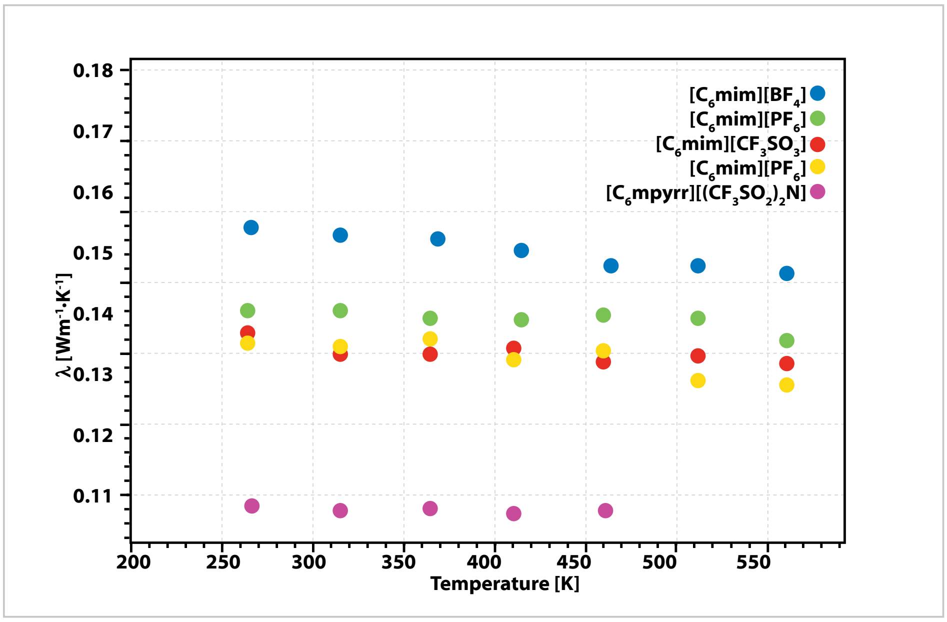
3 Linear and logarithmic real time plots and automatic calculation of the results



In the lower section of the screen, the live measurement data can be observed as curves during the measurements. The bridge voltage between the resistance wires is displayed as well as the temperature and derivative of the bridge voltage over time. Out of this curve, the software automatically calculates the thermal conductivity using the in-built software model. The displayed curves can act as a visual tool to verify the results as well as a possibility to identify errors or unexpected effects.

Applications

Thermal Conductivity of Ionic Liquids (THB Advanced)

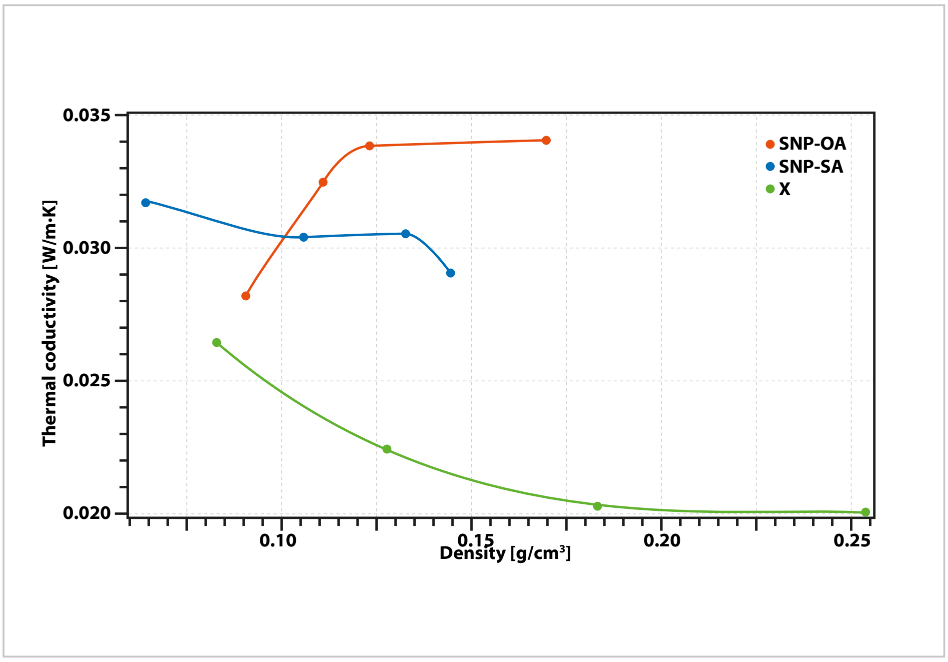


The LINSEIS Transient Hot Bridge Analyzer (THB) is the most accurate method on the market to measure the thermal conductivity of Ionic Liquids form -150 to 700 °C.

With this optimized Hot Wire technique, measurements can be performed in the liquid as well in the solid state at low temperatures. The measurement time is below one minute.

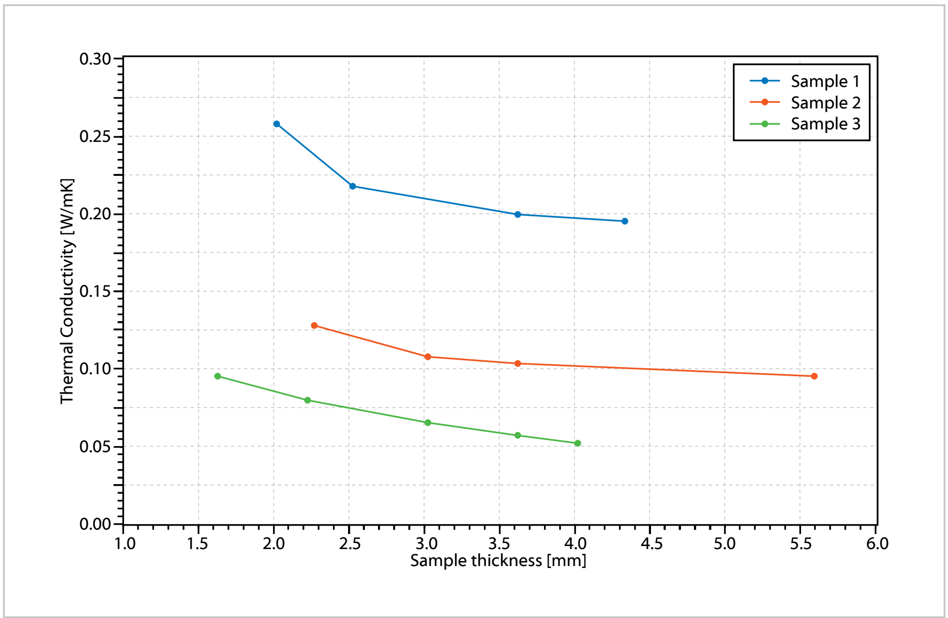
The figure shows the thermal conductivity of various Ionic Liquids as a function of the temperature.

Aerogel powders (THB Advanced)



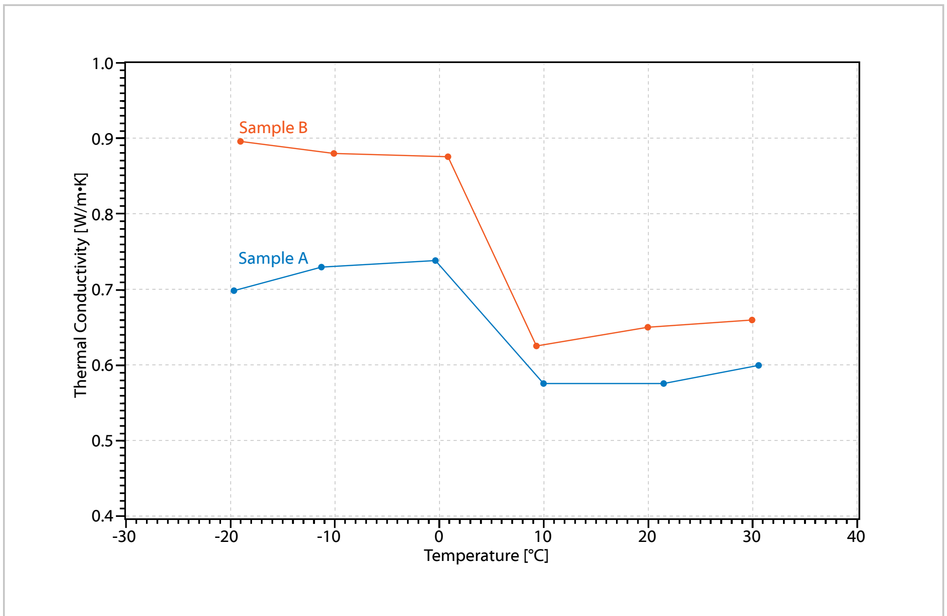
Thermal conductivity of Aerogel powders at different densities. The measurements have been performed with a powder sample holder with which the volume and therefore the density can be varied.

Insulation material – Thermal conductivity (THB Advanced)



The thermal conductivity of three different insulation materials was investigated in dependence on the thickness of the material, thus, the compression of the material. The insulation material consisted of a glass wool in between a fabric. The measurement was performed with a THB Advance. The given thicknesses, starting with the highest one, were set and at each thickness the thermal conductivity was determined four times in a row. The average of those is plotted in the graph. Here, one can see that for each material the thermal conductivity increases when the pressure onto the sample increases, i.e. the thickness decreases.

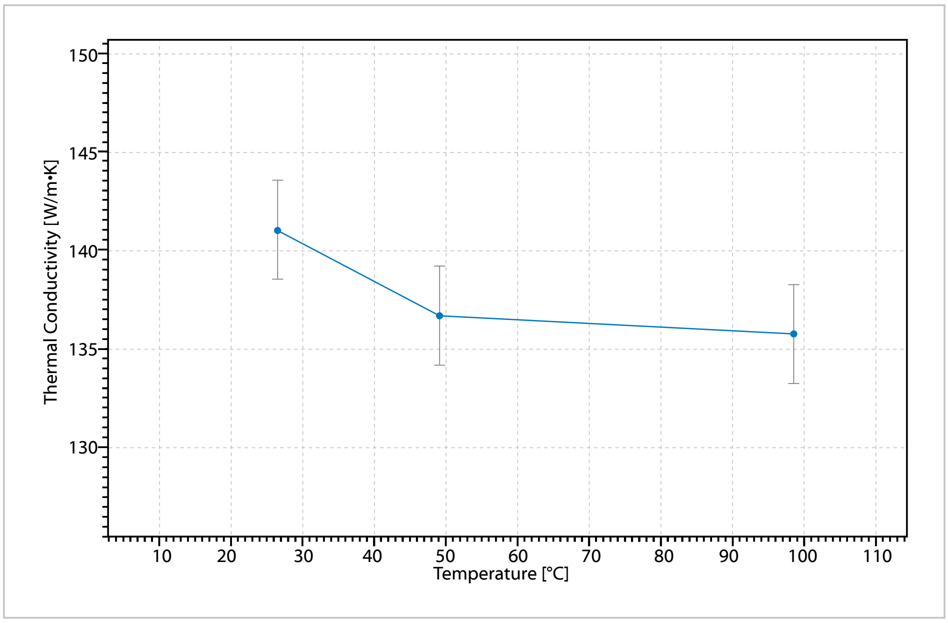
Phase Change Material –Thermal Conductivity (THB Basic/Advanced)



The example shows the analysis of the thermal conductivity of two hydrated salts. At room temperature both samples were liquid. For the measurement the sensorTHB/B/Metal was hung into the sample. Three measurement points were recorded at each temperature level and averaged.

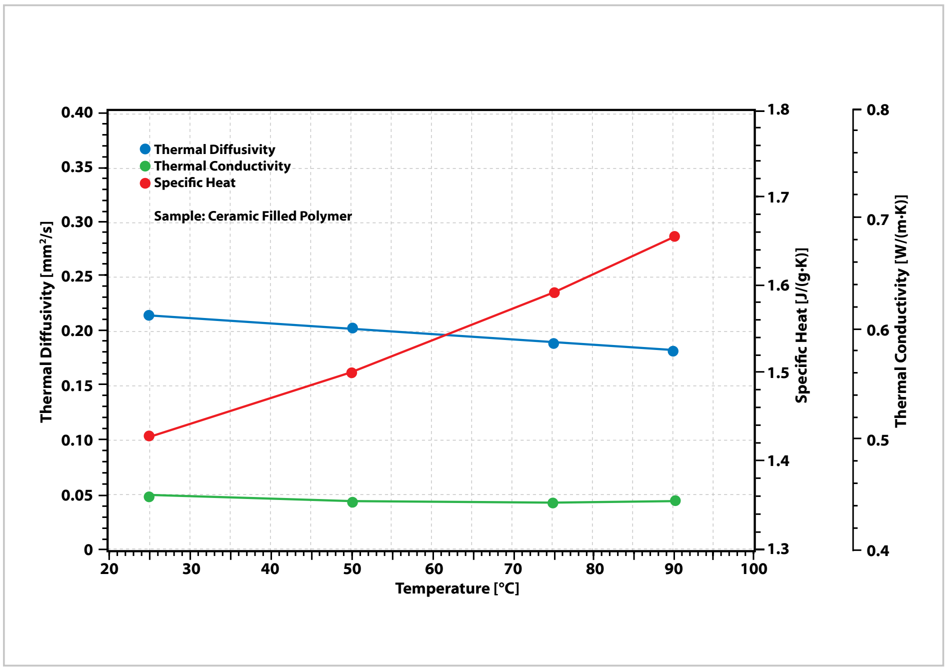
The thermal conductivity of Sample A slightly increases with heating up to 0 °C, whereas Sample B shows slightly decreasing values. Both samples change from the solid to the liquid state in the temperature range from 0 °C to 10 °C which can also be clearly seen in the thermal conductivity drop. With increasing temperature, the thermal conductivity of both samples increases slightly.

Aluminium Alloy – Thermalconductivity (THB Advanced/Ultimate)



The thermal conductivity of an aluminiumalloy was investigated from room temperatureto 100 °C using the THB. For the measurementthe QSS sensor was placed between twosample pieces and pressed together for animproved thermal contact. The configurationwas placed in a furnace and the temperaturesteps were room temperature, 50 °C and 100°C. At each step the measurement wasrepeated three times and the results wereaveraged. In the diagram one can see that thethermal conductivity is slightly decreasingwith temperature. The error bars show anuncertainty of 2 %.

Ceramic filled polymer (THB Advanced)



To optimize material properties a big variety of additives are known and used in material technologies and composite materials are of big interest, too. Even more important is the exact examination of the real properties of these materials, which can vary widely due to production conditions and mixture. Composite materials are widely used from electronic to building materials industries.

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Services: Service Lab, Calibration Service

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