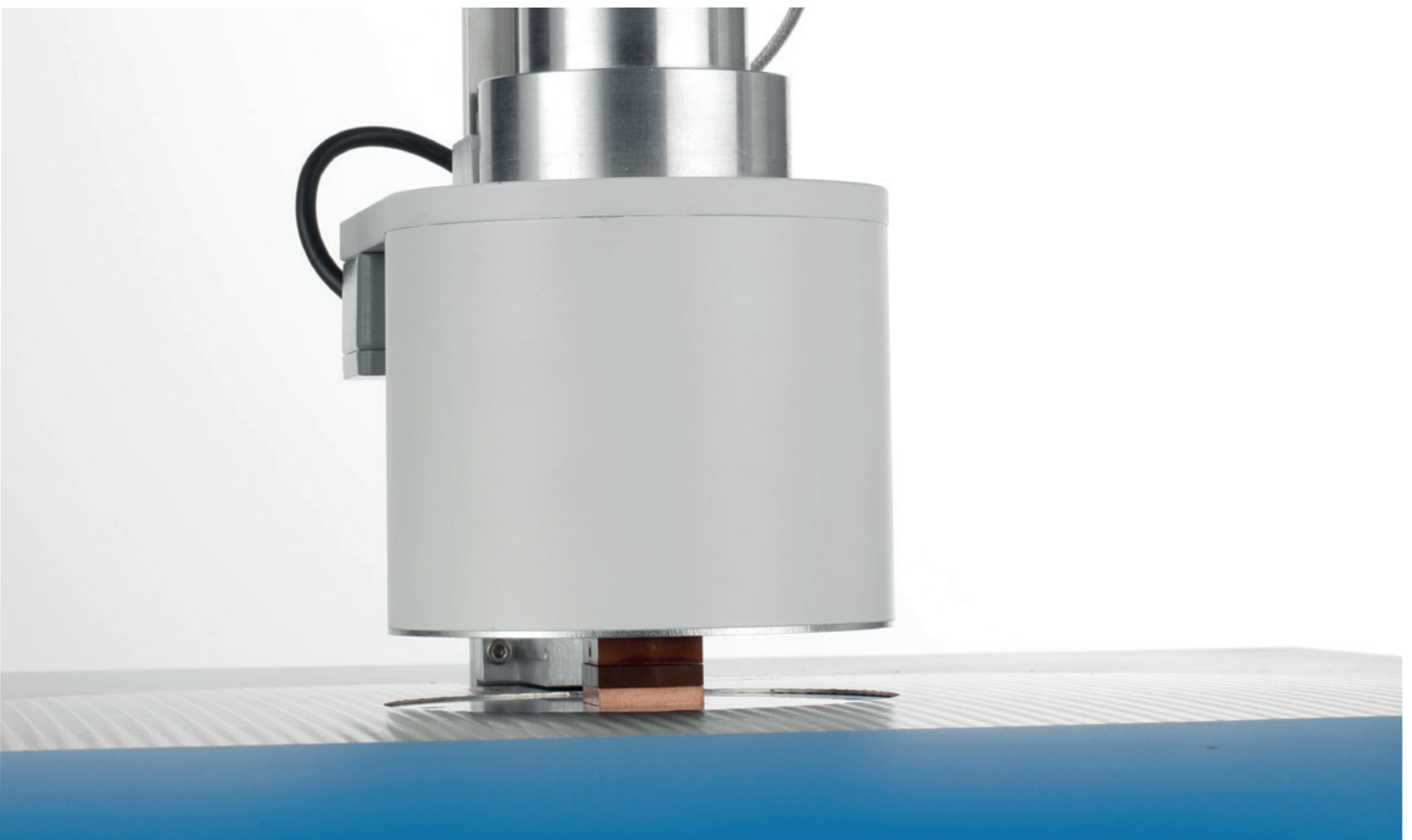


LINSEIS

T H E R M A L A N A L Y S I S

TIM-Tester

Characterization of Thermal Interface Materials and Phase Change Materials under variable load and temperatures



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.

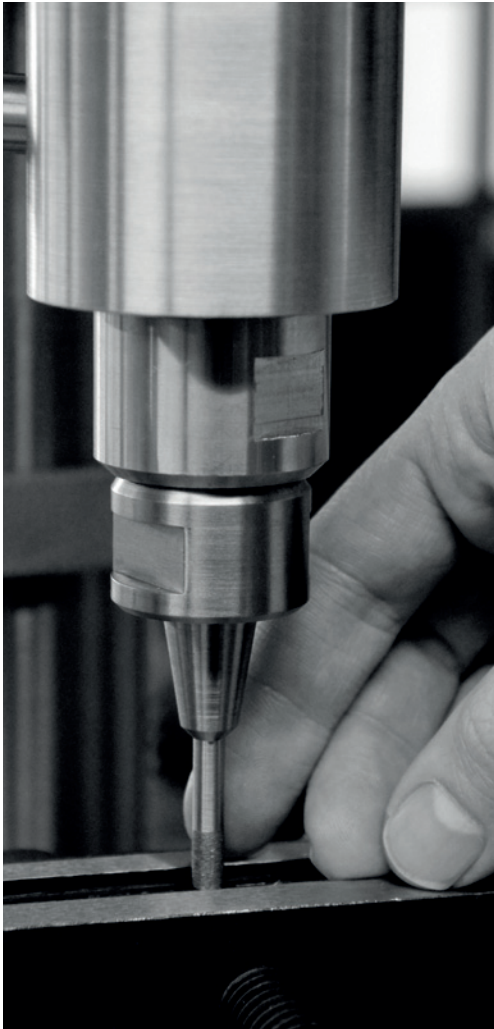
The LINSEIS business unit of thermal analysis is involved in the complete range of thermo analytical equipment for R&D as well as quality control. We support applications in sectors such as polymers, chemical industry, inorganic building materials and environmental analytics. In addition, thermo physical 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 invests in this research to the benefit of our customers.

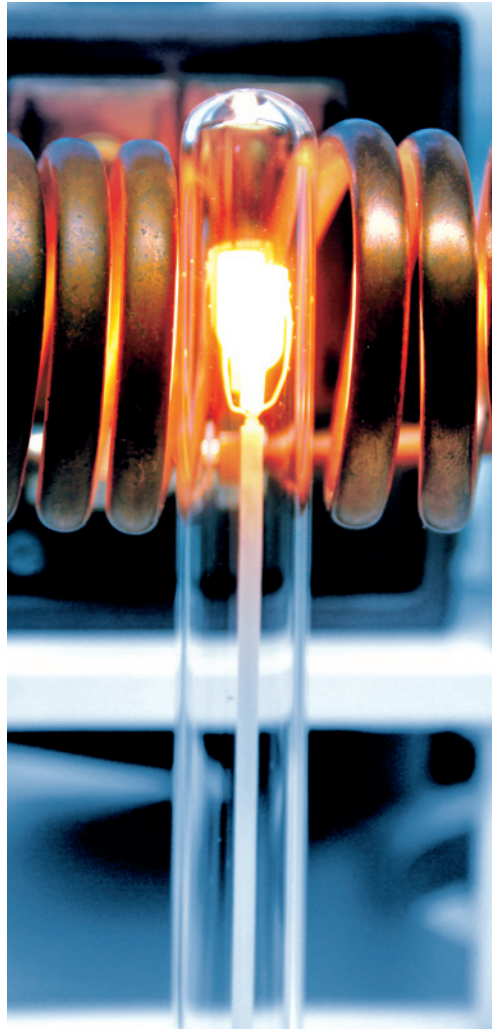


Claus Linseis
Managing Director



German engineering

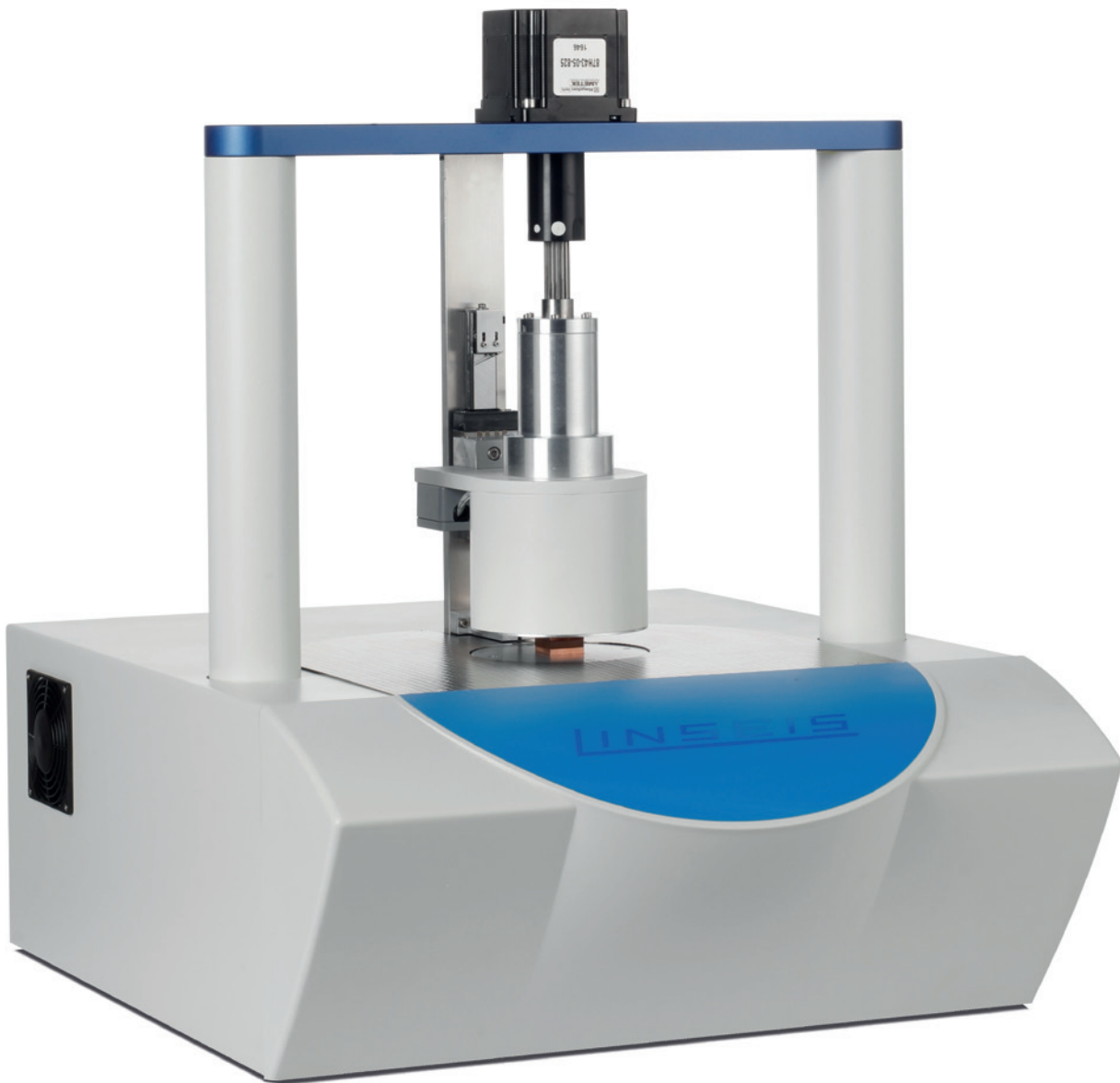
The strive for the best due diligence and accountability is part of our DNA. Our history is affected by German engineering and strict quality control.



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.

GENERAL



Automatic pressure adjustment using electric actor (up to 8 MPa)

Automatic thickness determination using high resolution LVDT

Instruments working according to ASTM D5470

Full integrated, software controlled device

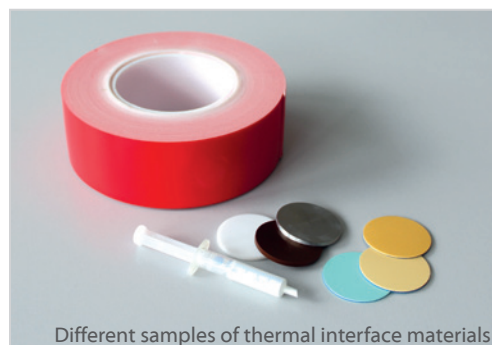
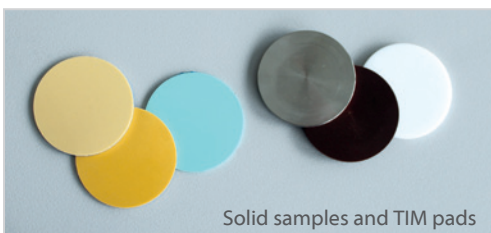
Waste heat management, thermal runaway protection in batteries and electronic packaging is becoming more and more important as power densities of these devices increase. Thermal management of these complex systems is not trivial and requires a fundamental understanding of how components and interface materials work together to shed heat.

Our LINSEIS Thermal Interface Material Tester (TIM-Tester) is the perfect solution for thermal management optimization of these complex systems.

The TIM Tester measures thermal impedance and identifies an apparent thermal conductivity for a wide range of materials from liquid compounds to hard solid materials. The approach is consistent with the ASTM D5470 - standard.

Thermal interface materials such as thermal fluids, thermal pastes (greases), phase change materials (PCM), solders or resilient thermal conductors are tested automatically by applying pressure up to 8 mPa (for \varnothing 20mm sample) and heat up to 300°C.

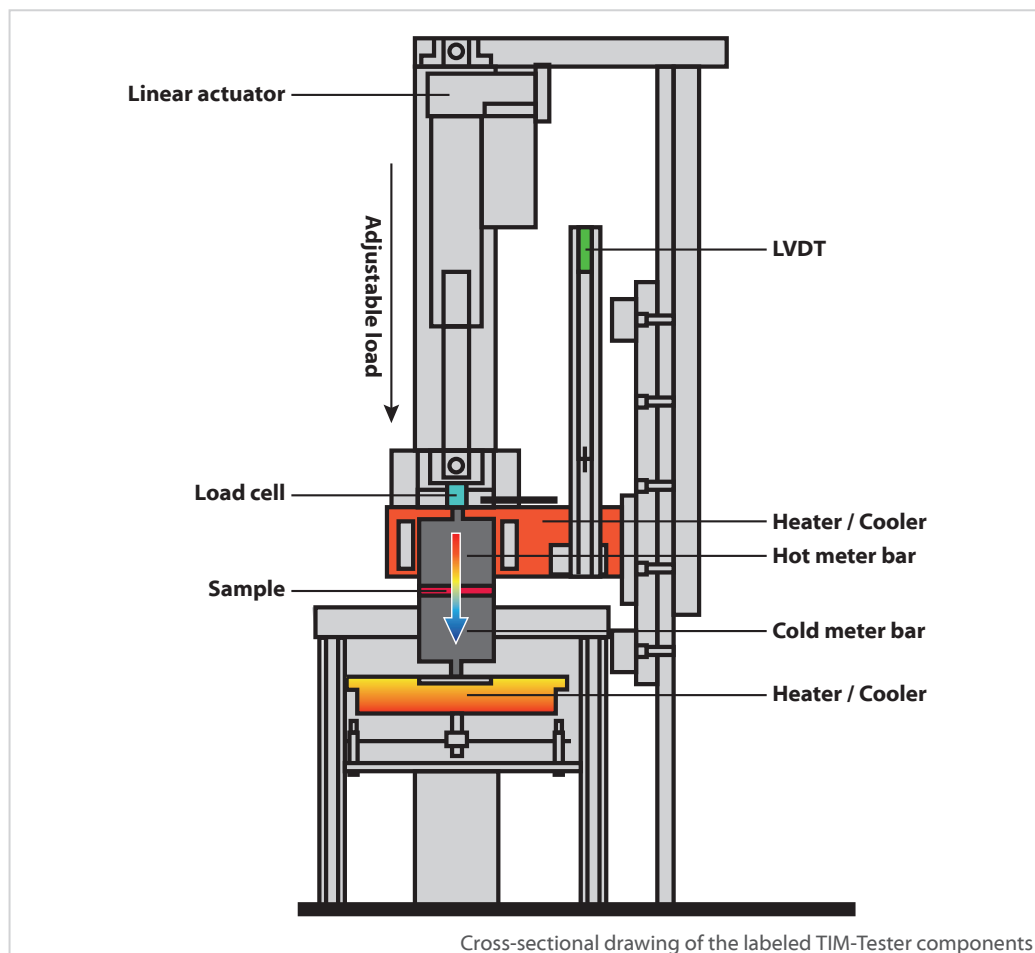
The software platform allows the instrument to be operated over a wide temperature and pressure range while recording all test parameters in real time. This allows the user the freedom to fully explore an experimental design space for materials optimization. The sample holder is designed with sample size and shape flexibility in mind to accommodate actual size parts.

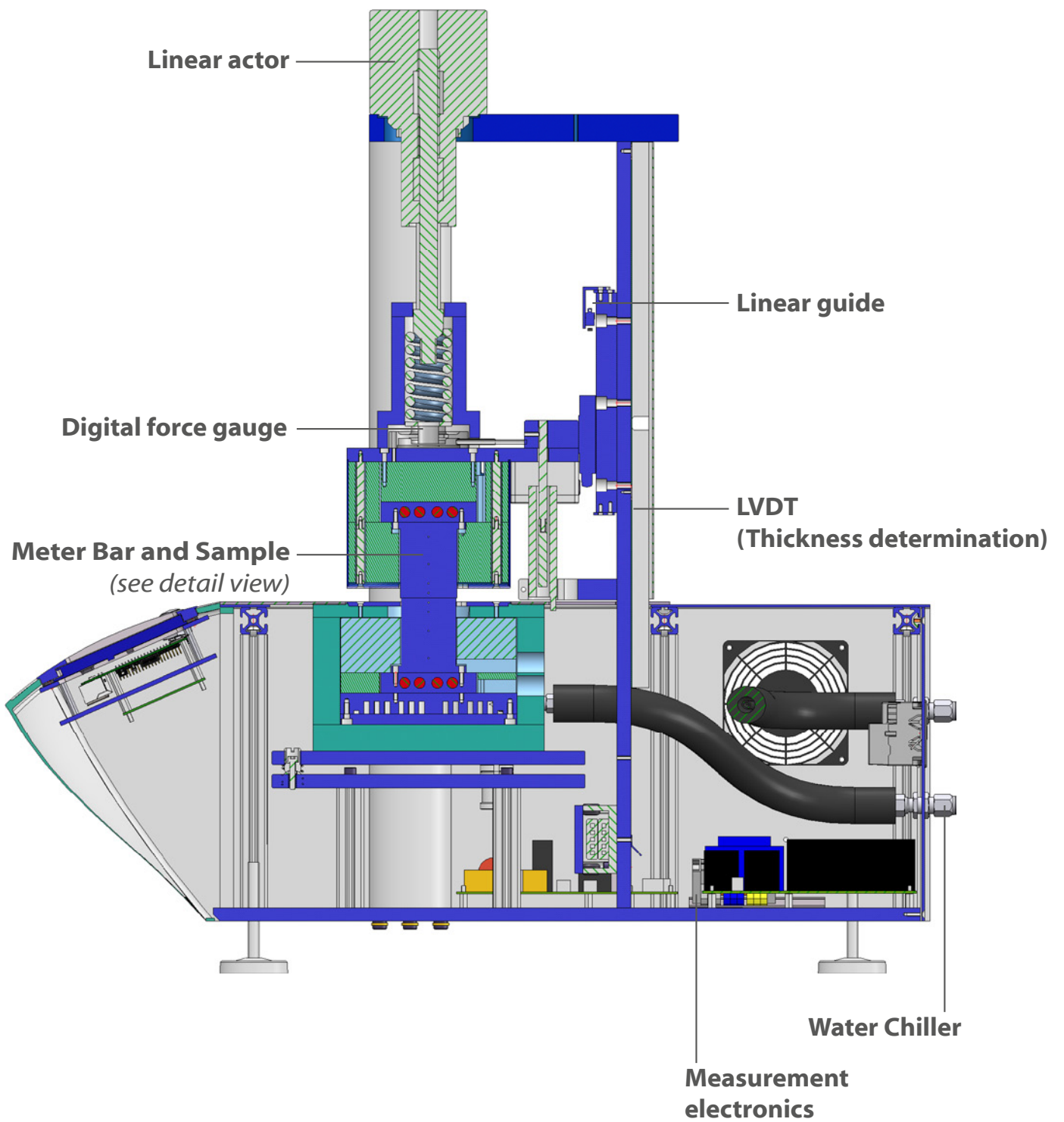


PRINCIPLE

A sample is positioned between a hot and a cold meter bar, where the hot meter bar is connected to a regulated heating stage and the cold meter bar is connected to a thermostatically controlled, liquid cooled heat sink. The contact pressure on the sample can be automatically adjusted with an integrated electric actor (in terms of pressure stability over temperature). The sample dimension (thickness) can either be entered manually or can be measured (and controlled) using an integrated sensor.

The heat flux through the sample is measured using several temperature sensors which are located in a known distance inside of each of the meter bars. The thermal impedance can be obtained from the temperature drop caused by the sample material using its geometry for the calculation. For obtaining the apparent thermal conductivity, the thermal impedance for a single and a multiple layered specimen can be plotted against the thickness of the respective specimen.





SOFTWARE

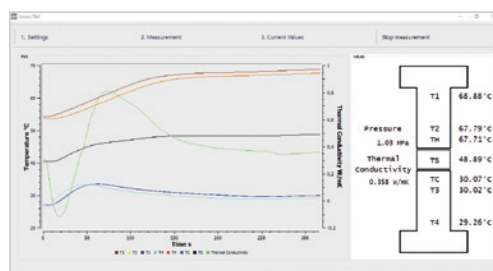
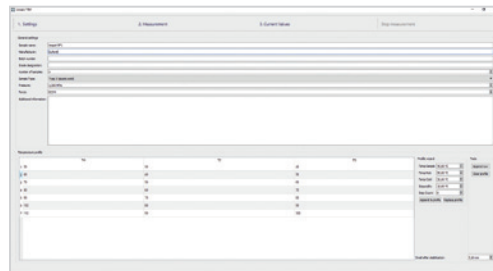
Smart Software Solutions from LINSEIS

The all new Rhodium Software greatly enhances your workflow as the intuitive data handling only requires minimum parameter input.

AutoEval offers a valuable guidance for the user when evaluating standard processes such as thermal impedance or thermal conductivity determination.



- Software packages are compatible with latest Windows operating system
- Set up menu entries
- Software controlled heating, cooling or dwell time segments
- Software controlled thickness determination, force/pressure adjustment
- Easy data export (measurement report)
- All specific measuring parameters (User, Lab, Sample, Company, etc.)
- Optional password and user levels
- multiple language versions such as English, German, French, Spanish, Chinese, Japanese, Russian, etc. (user selectable)

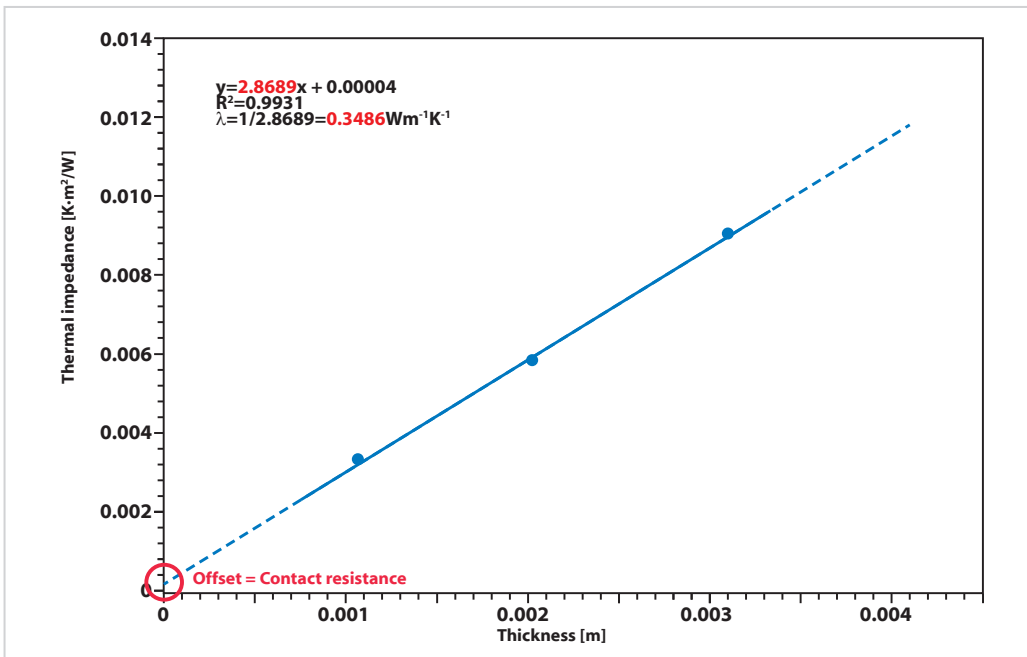


SPECIFICATIONS

	TIM-Tester
Sample size	Round: from \varnothing 20mm to \varnothing 40 mm Rectangular: from 20mm x 20mm to 40mm x 40mm Other sizes on request. Thickness: 0.01mm up to 15mm (extendable to 50 mm)
Sample types	solids, powders, pastes, foils, liquids, adhesives
Sample thickness measurement accuracy	+/- 0.10 % at 50% stroke +/- 0.25 % at 100% stroke
Sample resistance range	0.01 K/W – 8 K/W
Sample temperature range	RT up to 150°C RT up to 300°C (on request)
Temperature measurement accuracy	0.1°C
Thermal conductivity range	0.1 up to 50 W/m·K Extended range on request
Contact pressure range	0 up to 8 MPa (depending on sample size and shape) From round \varnothing 20mm (up to 8 MPa) to \varnothing 40 mm (up to 2 MPa) and rectangular 20mm x 20mm (up to 6.2 MPa) to 40mm x 40mm (up to 1.5 MPa)
Contact pressure accuracysystems	+/- 1%
Dimensions	675 mm H x 550mm W x 680 mm D
Cooling system	external chiller (in combination with a additional heater)
Heating system	Resistance heater

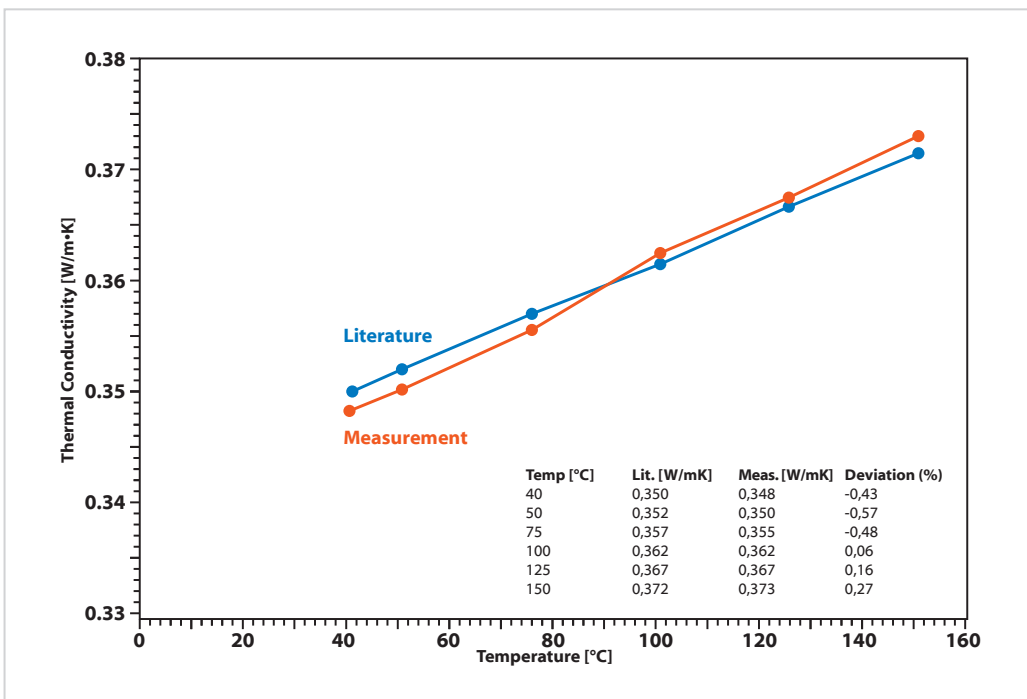
APPLICATIONS

Measurement of Vespel™ (at 50°C, 1MPa)



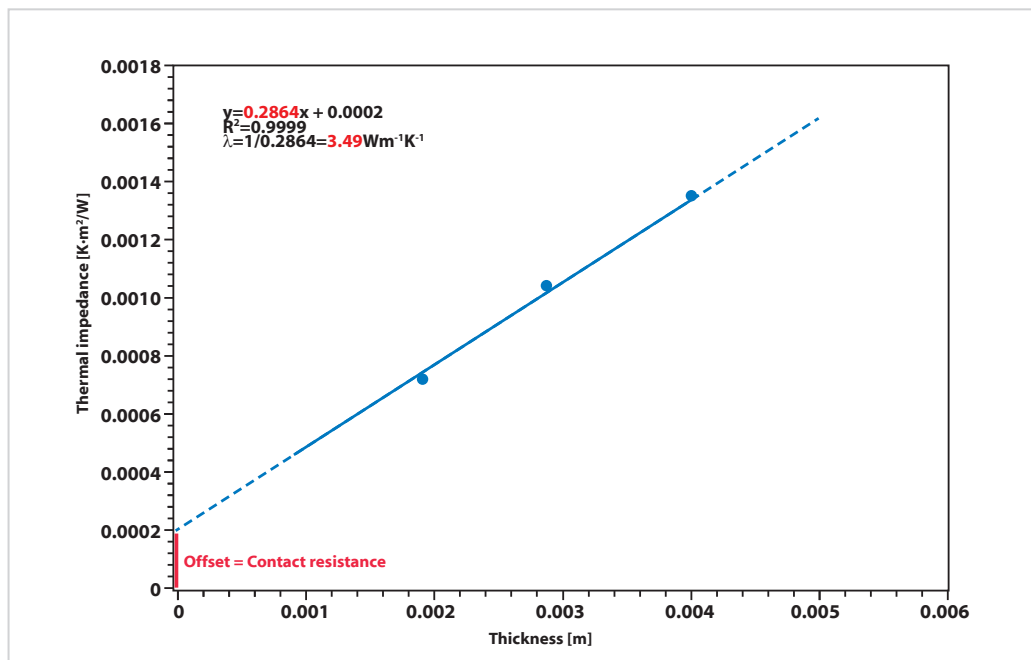
Measurement of the thermal impedance (thermal conductivity) of a 25mm x 25mm Vespel™ sample at 50°C ($T_H=70^\circ\text{C}$, $T_C=30^\circ\text{C}$) and a contact pressure of 1 MPa. Three different samples with a thickness between 1,1 mm and 3,08 mm have been measured in order to determine the apparent thermal conductivity and thermal contact resistance (using linear regression).

Temperature dependent measurement of Vespel™



Plot of the temperature dependent apparent thermal conductivity of a 25mm x 25mm Vespel™ sample between 40°C and 150°C and a constant contact pressure of 1 MPa.

Measurement of type 2 thermal pad (at 50°C)



Measurement of the thermal impedance (thermal conductivity) of a 25mm x 25mm thermal conductive pad (sample type 2) at 50°C ($T_H=70^\circ\text{C}$, $T_C=30^\circ\text{C}$). Three different samples with a thickness between 2.01 mm and 3.02 mm have been measured in order to determine the thermal contact resistance (using linear regression).

Possible sample types

Type I

Viscous liquids that exhibit unlimited deformation when a stress is applied. These include liquid compounds such as greases, pastes, and phase change materials. These materials exhibit no evidence of elastic behavior or the tendency to return to initial shape after deflection stresses are removed.

Type II

Viscoelastic solids where stresses of deformati-

on are ultimately balanced by internal material stresses thus limiting further deformation. Examples include gels, soft, and hard rubbers. These materials exhibit linear elastic properties with significant deflection relative to material thickness.

Type III

Elastic solids which exhibit negligible deflection. Examples include ceramics, metals, and some types of plastics.

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