LINSEIS

pushing boundaries

LFA L52

Laser Flash Analysis

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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 thermoanalytical 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, thermophysical properties of solids, liquids, and melts can be analyzed.

Rooted in a strong family tradition, LINSEIS is proudly steered into its third generation, maintaining its core values and commitment to excellence, which have been passed down through the family leadership. This generational continuity strengthens our dedication to innovation and quality, embodying the essence of a true family-run business.

LINSEIS provides technological leadership. We develop and manufacture thermoanalytic and thermophysical 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 thermoanalytical 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

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Engineering & Innovation

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

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 to constantly develop new technologies to enable continued discovery in Science.





Linseis **Service**

Customized Solutions - The Linseis Advantage

At Linseis, we believe that every measurement challenge is unique — and so should be your instrument.
While many suppliers rely on standardized configurations, Linseis distinguishes itself through exceptional flexibility and the capability to deliver customer-specific adaptations in record time.

Our experienced engineering teams work hand in hand with you to design and implement fully customized solutions that meet your precise application requirements — whether that means a unique sensor configuration, an extended temperature range, or a specialized software integration.

With decades of experience and a modular product architecture, we turn customization into a standard service — fast, efficient, and reliable.
Choose Linseis and experience what true flexibility in thermal analysis and material characterization means.

Contact form

Service & Support

Redefining Ownership

When investing in analytical instrumentation, long-term value matters just as much as precision. That's why Linseis systems are engineered to deliver the lowest **Total Cost of Ownership** in their class — combining reliability, efficiency, and flexibility in every detail.

Our instruments are built with robust, high-quality components designed for longevity and minimal maintenance. This means fewer service interventions, shorter downtimes, and reduced operating costs over the entire product lifetime. Intelligent software updates and remote support further ensure that your system remains state-of-the-art, even years after installation.

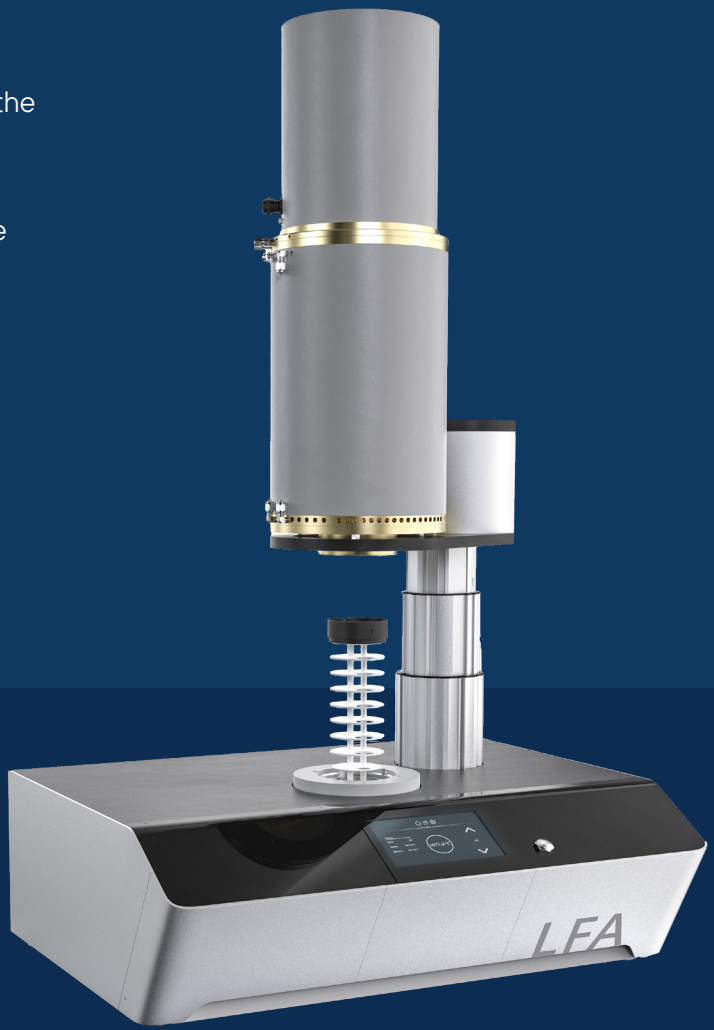




Laser Flash **Analysis**

Information about the thermophysical properties of materials and heat transfer optimization of final products is becoming more and more vital for industrial applications. Over the past few decades, the flash method has developed into a commonly used technique for the measurement of the thermal diffusivity and thermal conductivity of various kinds of solids, powders, pastes and liquids. Application areas are electronic packaging, heat sinks, brackets, reactor cooling, heat exchangers, thermal insulators and many others. Trouble-free sample preparation, small required sample dimensions, fast measurement times and high accuracy are only a few of the advantages of this non-contact and non-destructive measurement technique.

LINSEIS offers a variety of instruments to measure the Thermal Diffusivity/Conductivity.
The LFA L52 Laser Flash series provides the best possible technological solution for the temperature range from **-100 °C up to 2800°C.**



Absolute Method

The method used is an absolute measurement technique for thermal diffusivity, hence there is no need to calibrate the system.

The **LFA L52** Laser Flash operates in agreement with national and international standards, such as **ASTM E 1461, DIN EN ISO 22004-4 an ISO 22007-4**

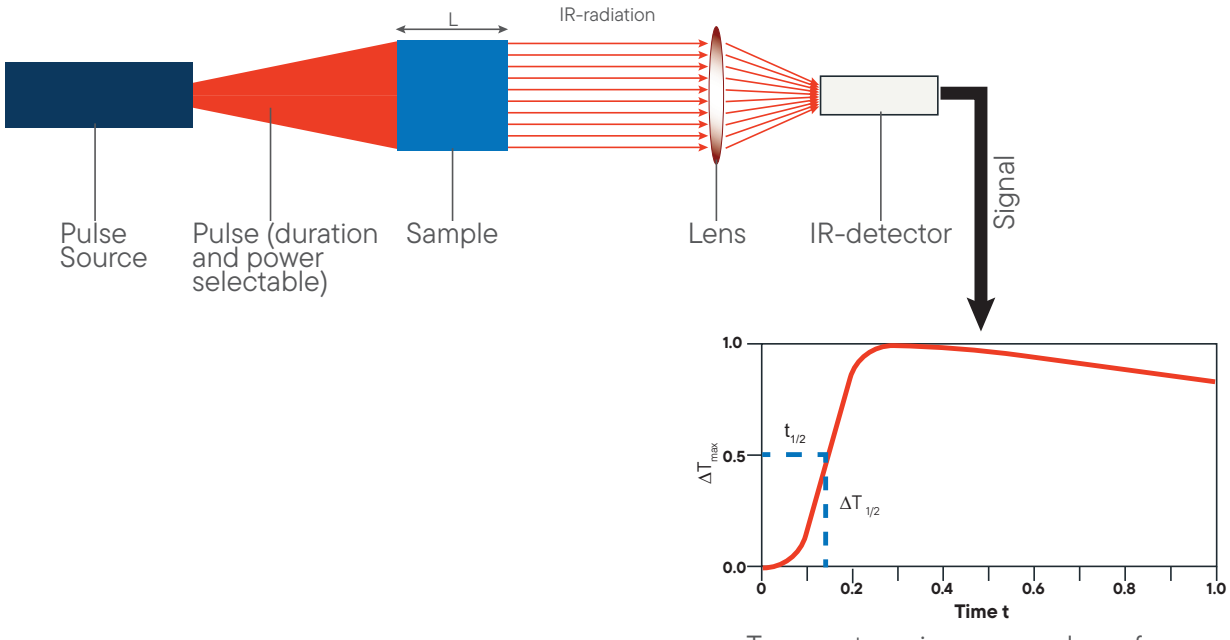
Measurement Concept

The sample is positioned on a sample robot, which is surrounded by a furnace. For the measurement, the furnace is held at a predetermined temperature and a programmable energy pulse irradiates the rear side of the sample, resulting in a temperature rise at the sample surface. This resulting temperature rise of the surface of the sample is measured by a very sensitive high speed infrared (IR) detector . Both, thermal diffusiviy and specific heat can be determined from the temperature vs. time data. If the density (ρ) is identified, the thermal conductivity can be calculated via:

$$\lambda(T)=\alpha(T)\cdot Cp(T)\cdot\rho(T)$$

λ=Thermal Conductivity [W/m·K]
α=Thermal Diffusivity [mm²/s]
Cp=Specific Heat [J/g·K]
ρ=Density [g/cm³]
T=Temperature

Principle of LFA L52 measurement



Temperature rise on sample surface

Calculation of thermal diffusivity

- Determine the baseline and maximum rise to give the temperature difference, ΔTmax
- Determine the time required from the initiation of the pulse for the rear face temperature to reach ΔT½ . This is the half time, t½.
- Calculate the thermal diffusivity, α, from the specimen thickness L and the half-time t½, as follows:

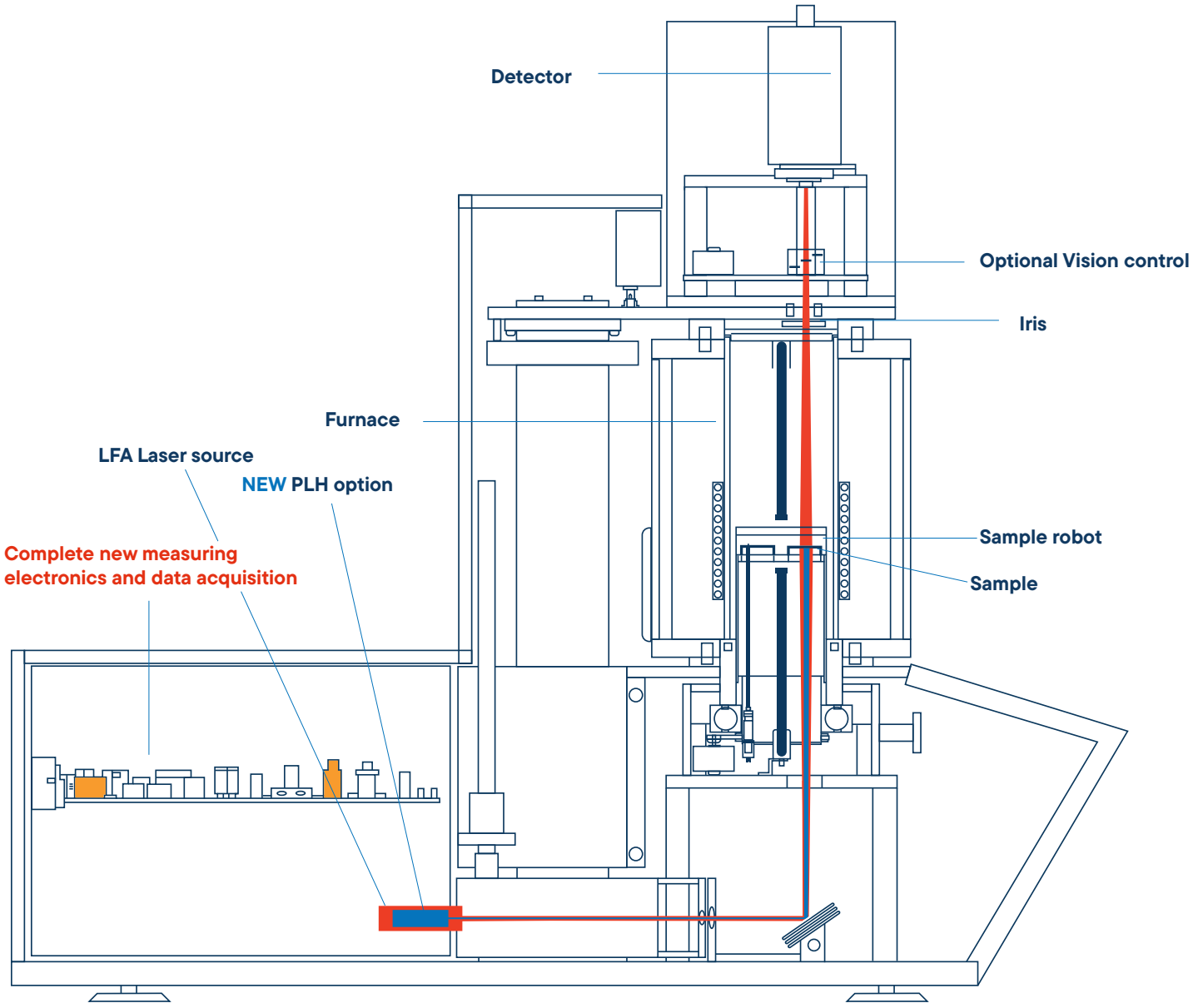
$$\alpha = 0.13879 \cdot \frac{L^2}{t_{1/2}}$$

L=Sample height [mm]
t½=Half time rise [s]
α=Thermal Diffusivity [mm²/s]

* The software section contains further details on evaluation

System Design

The vertical arrangement with sensor on top, sample in the middle and Laser Flash source on the bottom ensure easy handling and best possible measurement results. The pulse energy is adjustable in the range of 0.05 to 25 J/pulse. In addition, the pulse duration can be adjusted. Due to this flexibility all kinds of demanding samples (from thin film to bulk and from low to high thermal conductivity) can be analyzed.



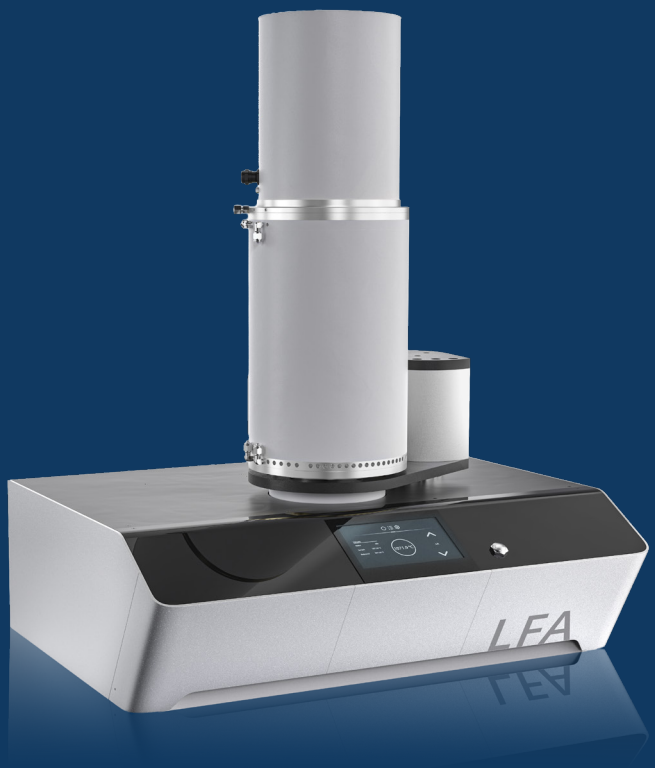
LFA L52

LFA L52 1250/1600

The standard model is designed for metals and ceramics and is ideal for applications with high sample throughput. It enables the simultaneous measurement of 3, 6 or 18 samples and supports sample diameters up to 25.4 mm, allowing precise analysis of thermal conductivity, thermal diffusivity and specific heat capacity.

LFA L52 2000/2400/2800

The high-temperature LFA version enables measurements up to 2000/2400/2800 °C and is equipped with a sample robot for up to three samples with a diameter of 12.7 mm.



LFA L52 2400

Provides accurate measurements at temperatures up to 2400 °C in our tungsten furnace, enabling graphite-free analysis across a broad temperature range. Equipped with a sample robot for up to three samples with a diameter of 12.7 mm, the model ensures high sample throughput and precise Cp measurements.

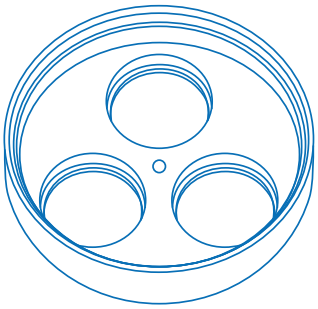
LFA L52 LT

The low temperature version delivers precise measurements from -125 °C/-100 °C to 500 °C for various applications..
Laser power in the low temperature range can be the decisive factor in obtaining precise measurement
results.

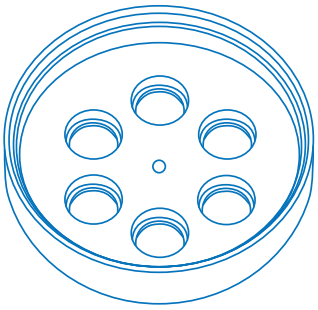
Unmatched sample throughput

Various sample holder types allow the measurement of a broad range of sample dimensions from 3 to 25.4 mm in solid, liquid, powder, or paste form. In addition, sample carriers for phase change materials are available.
The Linseis sample robot can measure up to 6 samples simultaneously, with options for up to 18 samples on request. Sample holder materials include graphite, SiC, alumina or various metals.

Sample carriers

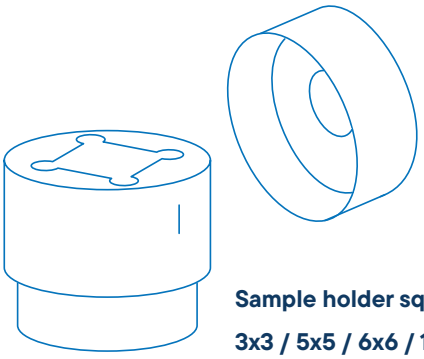


3 round (25.4 mm) or square (20 mm x 20 mm) samples

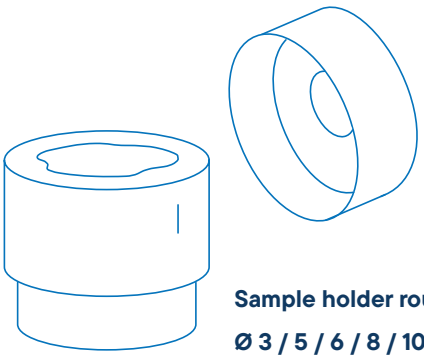


6 round (3, 5, 6, 8, 10, 12.7 mm) or square (3, 5, 6, 10 mm) samples

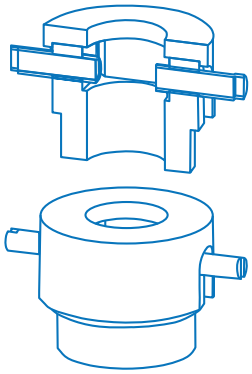
Sample holder



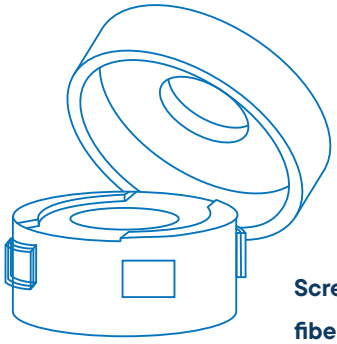
Sample holder square samples
3x3 / 5x5 / 6x6 / 10x10 / 20x20 mm²



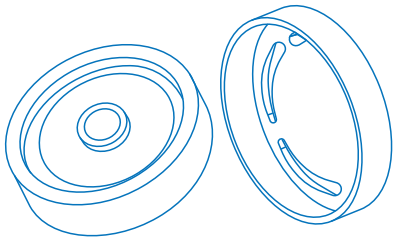
Sample holder round samples
Ø 3 / 5 / 6 / 8 / 10 / 12.7 / 25.4 mm



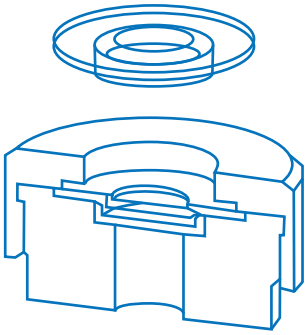
Sample holder for lamellas
Ø 10 mm x 10 mm,



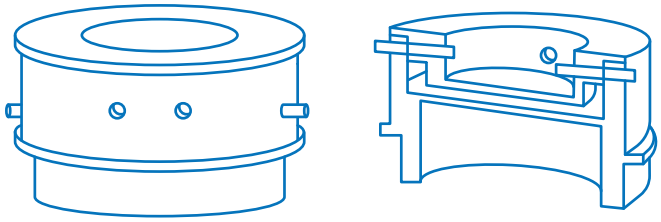
Screwable sample holder for
fibers and foils



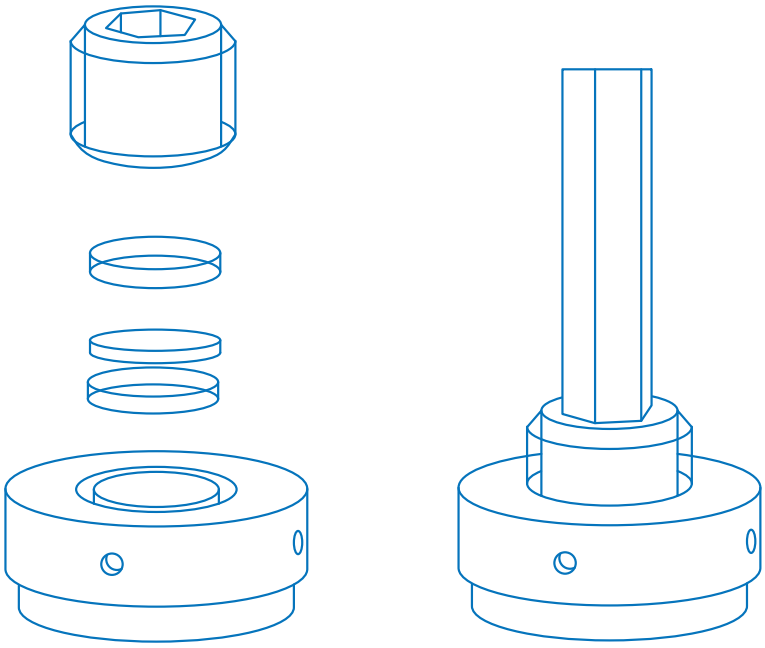
In-plane e.g. thin films or
anistropy
Ø 12.7/ 25.4mm



Sample holder with sapphire
crucible
e.g. metal melt, molten salts
Ø 12.7/ 25.4mm



Sample holder for liquids, powders,
pastes and molten salts
Ø 12.7/25.4mm



Torque pressure container
e.g. compressible samples
Torque: 0.3 up to 3 Nm
Sample: Ø 12.7 / 25.4 mm


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New features

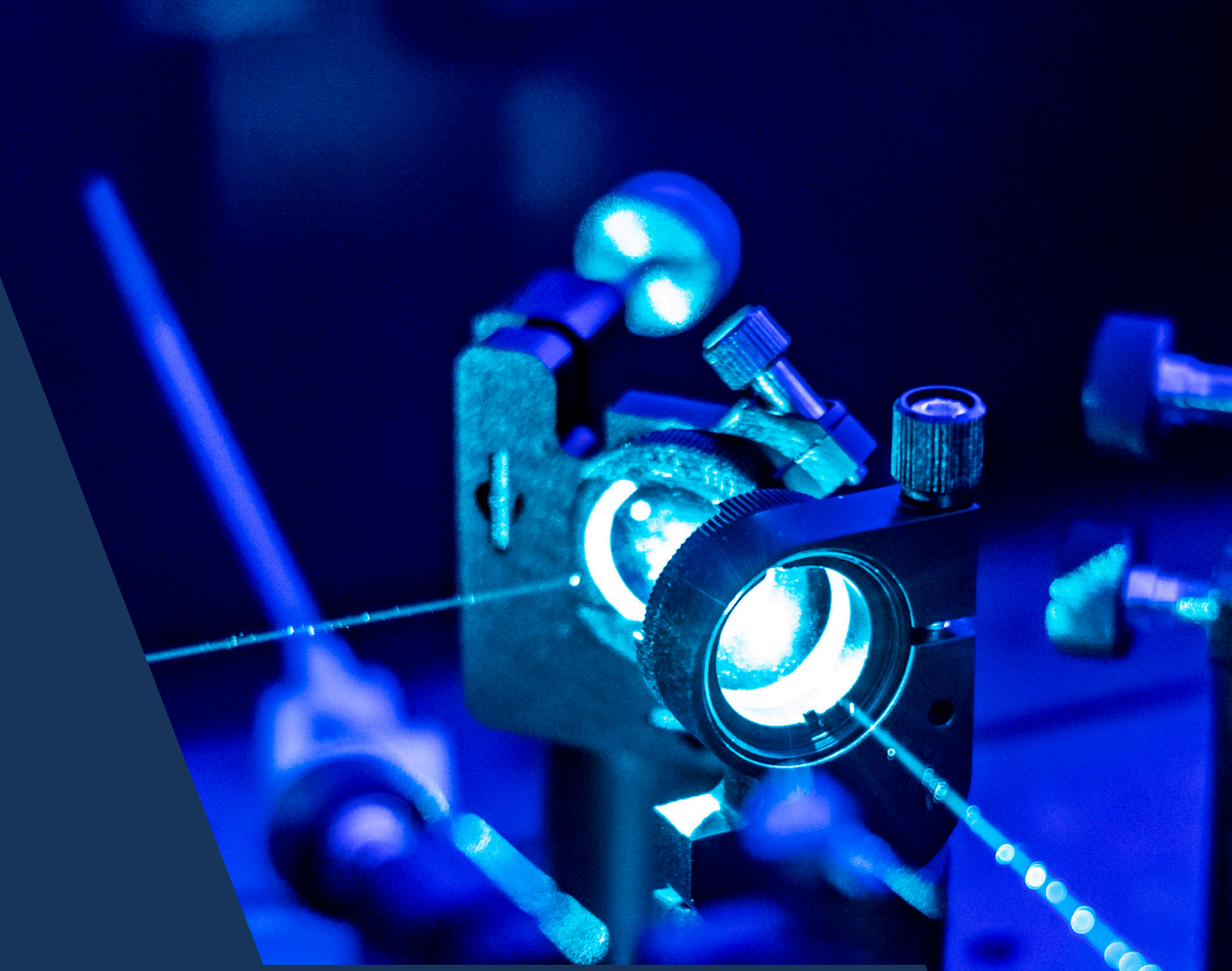


Software Improvements

- **LINSEIS LiEAP software:** Our software platform is now even more focused on the needs of our customers to ensure that you are always informed of the latest status and receive support whenever it is needed.
- **Automatic updates and new features:** Our software receives regular automatic updates that not only improve security, but also continuously provide new features.
- **Lex Bus Plug & Play:** Our latest hardware interface Lex Bus revolutionizes the way data communicates within our systems. Lex Bus enables seamless and efficient integration of new hardware and software tools.
- **Improved furnace control:** Our new and further improved furnace control offers more precise temperature control, which leads to better measurement results and higher throughput through better temperature sequencing according to your wishes and requirements.
- **Preventive maintenance and problem detection:** Using intelligent components and accessories, our preventive maintenance approach detects problems and wear and tear before they can cause damage and keeps your device in top shape.

Our high-performance Laser

- High Energie Nd:Yag Laser up to 25 J/Pulse (Free adjustable)
- Pulselength from 0.05 ms up to 5 ms (Free adjustable)
- Charge Voltage from 200 V up to 400 V (Free adjustable)
- Pulsemonitoring included
- Beam divergence smaller then 4 mrad
- Perfect beam homogeneity
- Laser spot variable between 6 mm and 25 mm depending on configuration
- Can be used as free space or with an optical fiber
- Very easy to maintain and service thanks to modular design
- All important components are monitored by a safety system to ensure the best possible protection for the laser system



Linseis Lab Link

With Linseis Lab Link, we offer an integrated solution to address uncertainties in measurement results. With direct access to our application experts via the software, you can get advice on the correct measurement procedure and evaluation of results. This direct communication ensures optimal results and maximizes the efficiency of your measurements for precise analysis and research as well as a smooth process flow.

Design Improvements

The new device design is characterized by an elegant aluminum casing that is both robust and aesthetically pleasing. The LED status bar provides a user-friendly visualization of important information. A touch panel enables intuitive operation and contributes to a modern user experience that combines comfort and functionality. The new device design focuses on ergonomic operation.

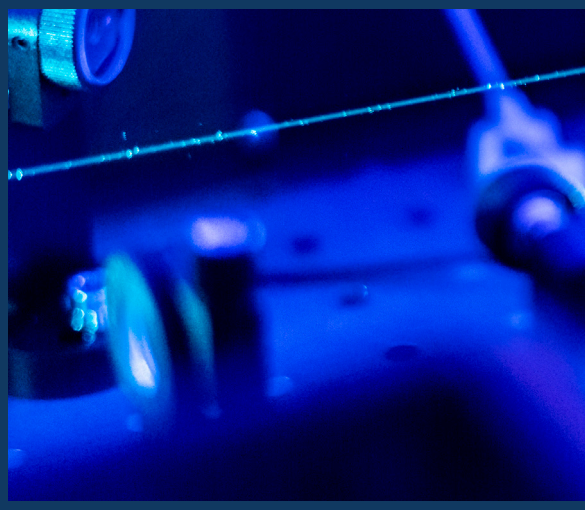
New Hardware Features

PLH Upgrade: The LFA systems can be equipped with the PLH hardware, extending the measurement range to thin films down to tens of µm range.

Unique Features

New Electronics

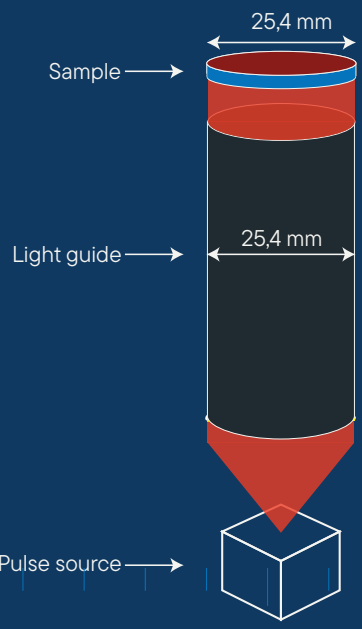
- **Enhanced Amplifier Electronics:** Upgraded electronics improve the signal-to-noise ratio (SNR), delivering a clearer separation between the measured signal and background noise and provide 16-bit resolution, ensuring accurate and reproducible measurements for thin or conductive samples.
- **Higher Data Acquisition Rate:** A 2.5 MHz acquisition rate enables precise analysis of fast-conducting and thin materials, capturing detailed data in short timeframes.
- **Improved communication:** Either USB or Ethernet can be used to opereate the LINSEIS equipment as stand a one or in a bigger network
- **Sample Robot:** LINSEIS LFA L52 allows up to six samples (Option for up to 18 samples available) to be measured in a single run. This means that the reference and sample can be tested under exactly the same conditions, ensuring maximum precision and comparability in Cp measurements for temperatures as high as 2800 °C



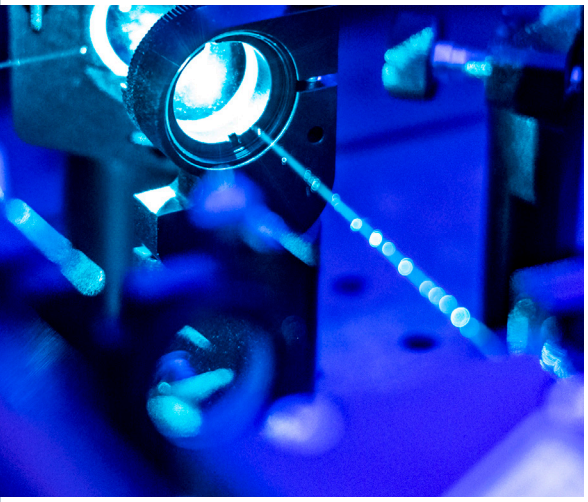


Complete Sample Illumination

The LFA L52 ensures full illumination of samples up to **25.4 mm** in diameter avoiding a radial temperature gradient in the sample. This results in improved reproducibility and more consistent results across a wide range of sample sizes.





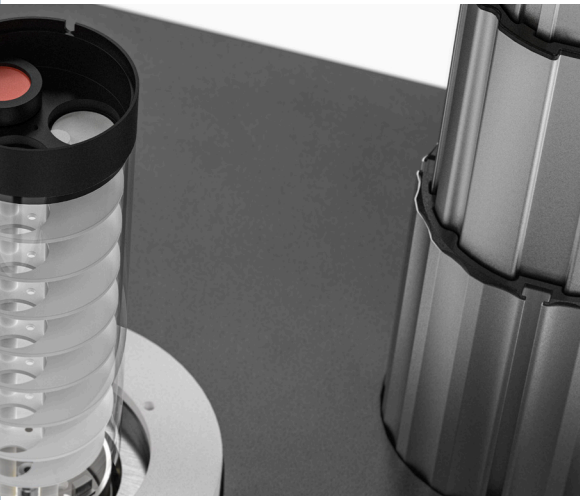


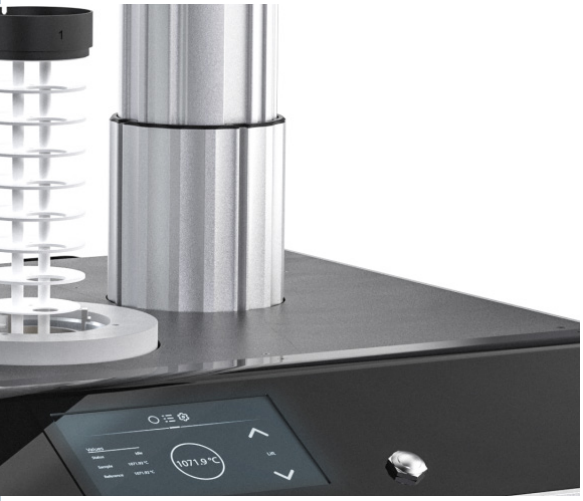
Optimized Low-Temperature Furnace

The newly introduced signal-optimized low-temperature furnace ensures gradient-free, high-accuracy measurements at lower temperatures.

Gradient-Free Hot Zone

The temperature control of the furnace is optimized with a gradient-free hot zone. This design ensures that the entire sample is subjected to uniform heating, leading to enhanced measurement reproducibility which is critical for accurate thermal conductivity results.





Software

LiEAP Software

The LiEAP software includes AI-based assistance that minimizes operator errors and reduces measurement uncertainties. Additionally, the software supports various unique models, including the Dusza model, which can handle transparent, porous, liquid, powder samples and multilayer systems.

- Fully compatible MS®Windows™ software
- Data security in case of power failure
- Safety Features (Thermocouple break protection, power failure, etc.)
- Online and offline Evaluation of current measurement
- Curve comparison
- Storage and export of evaluations
- Export and import of data in ASCII format
- Data export to MS Excel
- Multi - method analysis (DIL, STA, DSC, HCS, LSR, LZT, LFA)
- Programmable gas control
- NEW workflow

Evaluation Software

- Automatic or manual input of related measurement data: such as density and specific heat
- Universal combined evaluation model for data evaluation
- Special models for translucent or porous samples

Evaluation Models

- Dusza combined model
- McMasters model (for porous samples)
- Parker
- Cowan 5 and 10
- Azumi
- Clark-Taylor
- Degiovanni
- Finite pulse correction
- Heat loss correction
- Baseline correction
- Multilayer model
- Determination of contact resistance
- Correction for translucent samples
- and many more features

Measurement Software

- Easy and user-friendly data input for temperature segments, gases etc.
- Controllable sample robot
- Software automatically displays corrected measurements after the energy pulse
- Fully automated measurement procedure for multi sample measurements
- Costumer support
- Easy mode for efficent and fast measurements
- Expert mode for maximum individualisation
- Service model monitors the device mode and provides feedback

Cp (Specific Heat) determination by comparative method

To calculate the specific heat capacity, the maximum of the temperature rise in the sample is compared to the maximum of the temperature raise of a reference sample. Both, the unknown and the reference sample are measured under the same conditions in a single run, using the sample robot.
So, the energy of the laser pulse and the sensitivity of the infrared detector are the same for both measurements. The temperature rise in the sample can be calculated according the following equation:

$$\Delta T = \frac{E}{m \cdot Cp}$$

ΔT = Rise in temperature [K]
E = Pulse energy [J]
m = Sample mass [g]
Cp = Heat capacity [J/g·K]

Since the energy is the same for sample and reference, the Cp of the sample can be calculated according the following equation:

$$Cp_{sample} = Cp_{Reference} \frac{\Delta T_{reference} \cdot m_{reference} \cdot Loss_{sample}}{\Delta T_{sample} \cdot m_{sample} \cdot Loss_{reference}}$$

To achieve a good accuracy, the absorbability and emissivity of sample and reference must be the same (same coating), and the absolute heat capacity (Cp * sample mass) of sample and reference must be similar.

Pulse detection

In order to enhance the precision of the Cp meaurement, it is essential to measure the energy of the pulse and the sensivity of the detector, rather than assuming these to be constant.
Therefore, the updated LFA L52 offers the possibilitiey to record the plus shape and detects the pulse shape and perform an energy correction in the fully automated measurement cycle. This results in a highly accurate determination of the specific heat capacity in the comparative measurement mode with a known reference material.

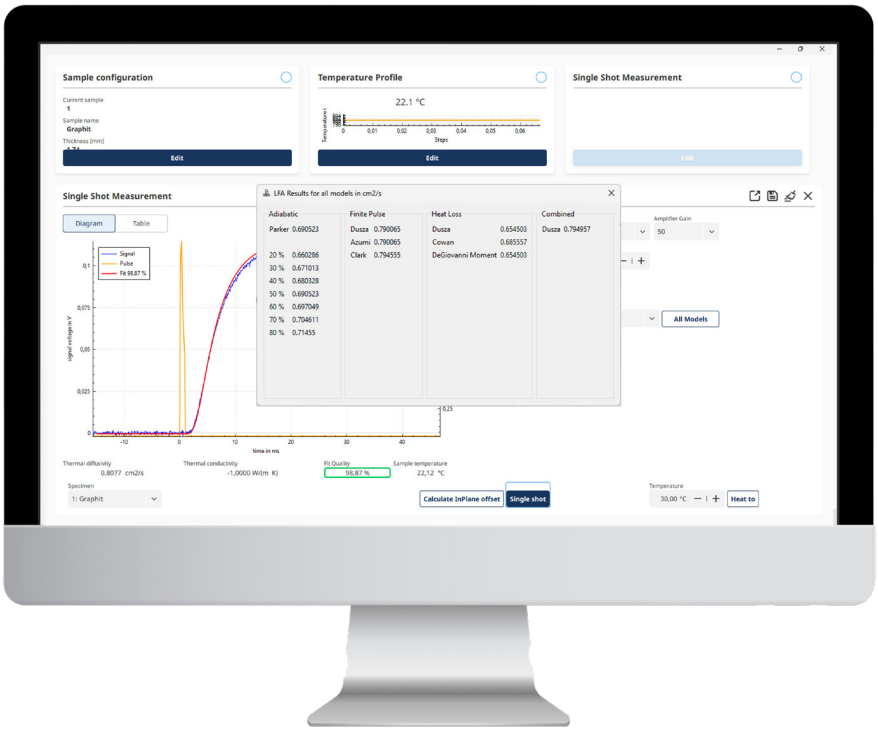


Model selection

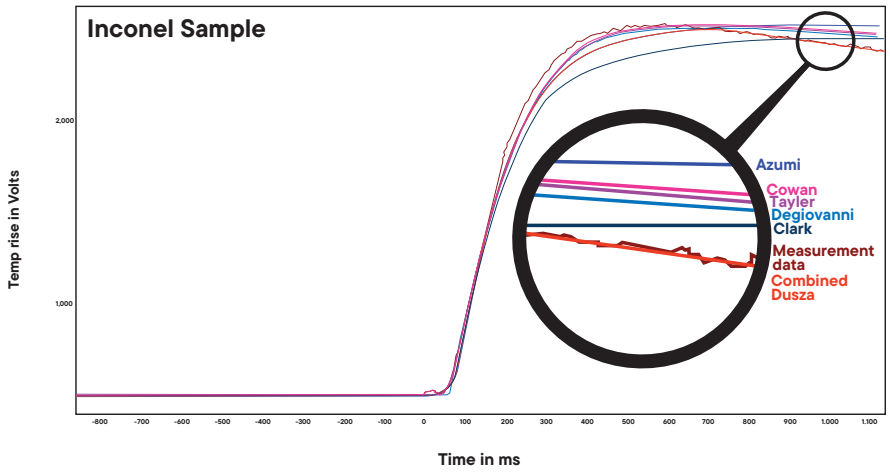
While the basic calculation presented in the Measurement Concept section describes an idealized case, real experiments require the consideration of practical measurement conditions such as heat losses, finite pulse duration and specific sample characteristics including transparency or multilayer structures to obtain accurate results.

Supported model selection

The software allows the selection of various evaluation models. To support the user with the selection, the fit quality of all models can be easily displayed to guarantee an easy handling as well as maximum accuracy.
Empirical data from customers and Linseis application labs worldwide show that the combined Dusza model is the most universally applicable, typically providing the best fit between measurement data and model across a wide range of materials.



Combined Dusza-Model - Universal combined solution of the simultaneous heat loss and finite pulse corrections with the laser flash method

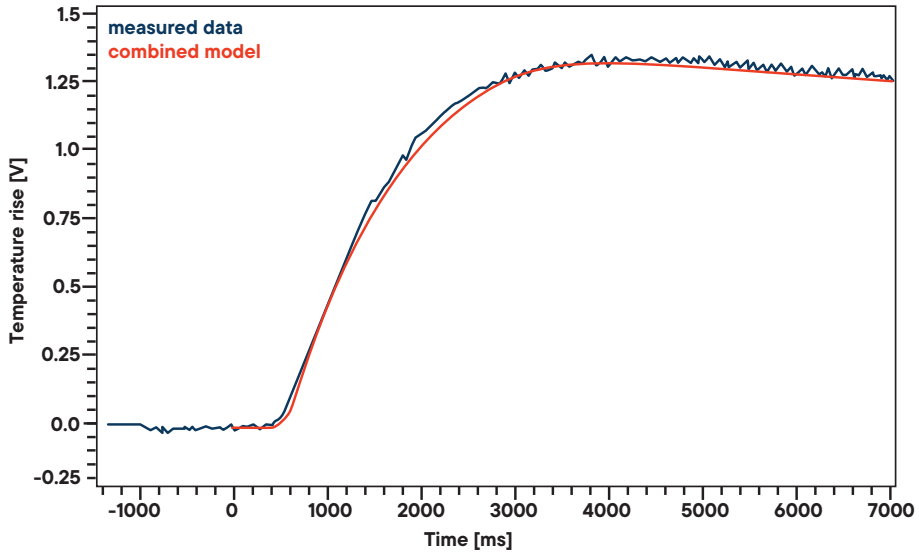


** Dusza, Laszlo. "Combined solution of the simultaneous heat loss and finite pulse corrections with the laser flash method." High Temperatures-high Pressures (1995): 467-473.*

The universal combined model, based on Dusza's proven method, enables reliable evaluation of laser flash data by simultaneously correcting for heat losses, finite pulse effects, and non-adiabatic conditions. Thanks to non-linear parameter estimation, no manual model selection is needed—saving time and avoiding user error. Tested on over 100 samples, the method consistently delivers accurate results. The example with an Inconel sample clearly shows: the combined model provides the best fit and highest precision compared to conventional approaches.

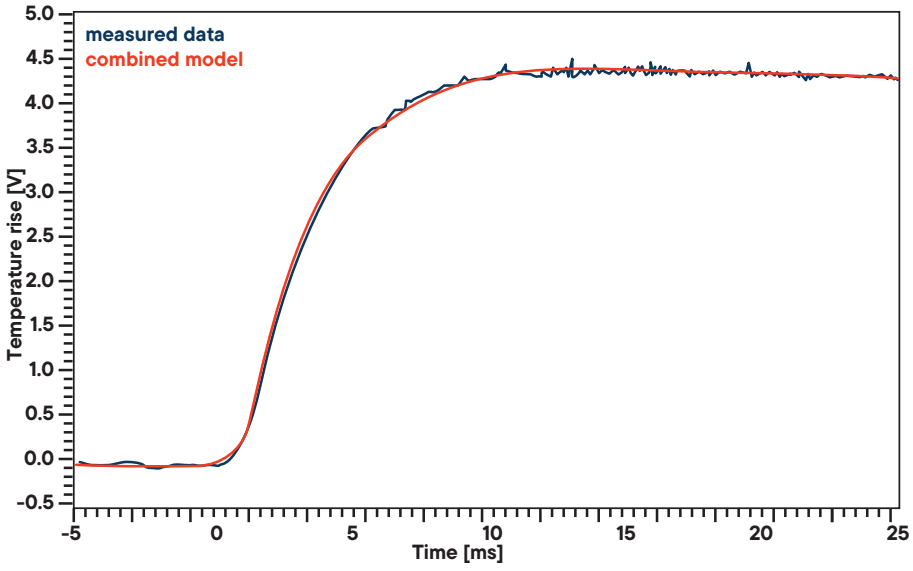
LFA Overview

Low Thermal Conductive PMMA



Temperature rise of the PMMA sample (length 1.01 mm, half time rise 1218.75 ms). The combined model illustrates a perfect fit to the data points

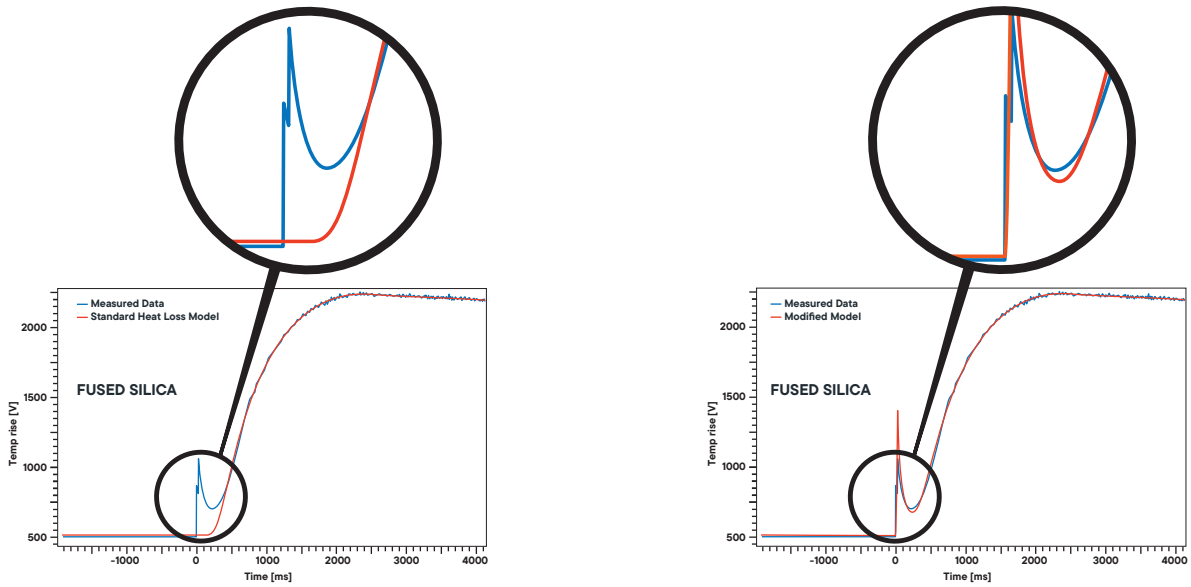
High Thermal Conductive Graphite



Temperature rise of a graphite sample (length 1.11 mm, half time rise 4.37 ms). The combined model curve is fitted to the data points.

Modified combined model / special model for translucent samples

Standard Heat Loss Model vs. Modified Model



As illustrated in the graph, the temperature rise for translucent samples, generated by the induced energy pulse, results in an immediate signal increase of the detector. This initial signal has to be considered and corrected, as it distorts the measurement result to a seemingly higher thermal diffusivity.
Up to now, existing models could not provide a sufficiently good fit for this immediate temperature rise phenomenon. Our unique combined model enables the correction of the sample data and provides an adjusted fit, leading to significantly improved measurement results.

McMasters Model for porous samples

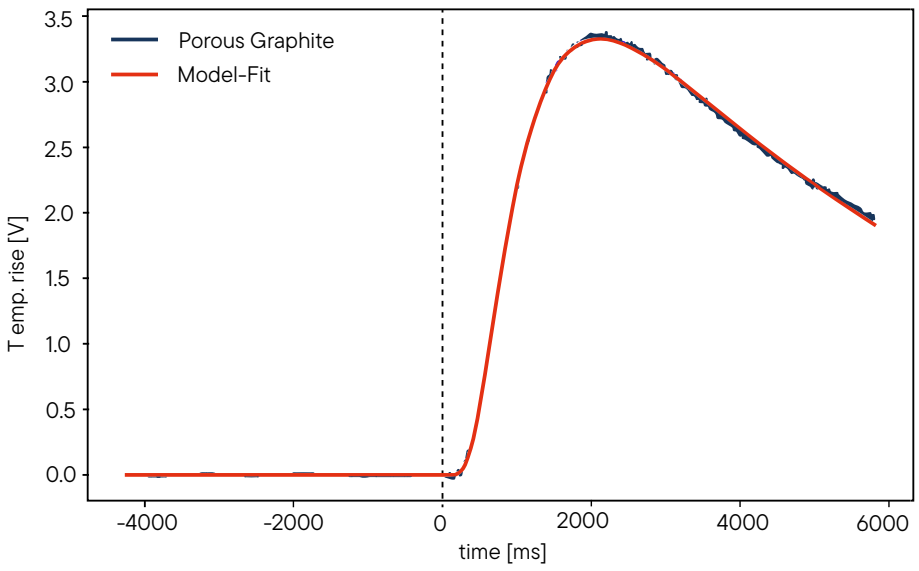
The McMasters Model is a specialized tool designed to analyze heat transfer in porous materials with precision and flexibility.

Key Features:

- One-dimensional heat transfer model for accurate analysis.
- Includes finite penetration depth of the initial pulse as a key fit parameter.
- Accounts for heat losses at both front and rear surfaces of the sample.

This advanced model, based on the work of McMasters et al.,* ensures reliable and detailed results,
making it an essential option for complex thermal investigations

** McMasters, Robert L. et al. "Accounting for Penetration of Laser Heating in Flash Thermal Diffusivity Experiments." ASME. J. Heat transfer (1999): 121(1): 15-21.*

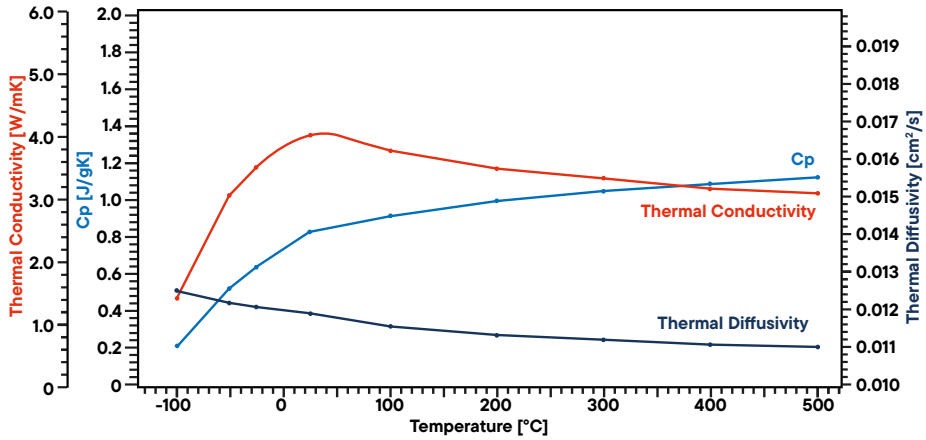


Technical **Specifications**

	LFA L52 LT/1250/1600/2000/2400/2800
Temperature range	–100 up to 500°C RT up to 1250/1600°C RT up to 2000/2400/2800°C
Heating rate	0.01 up to 50 K/min (LT/1250/1600) 0.01 up to 100 K/min (2000/2400/2800)
Thermal Diffusivity	0.01 up to 2000 mm^2/s
Thermal Conductivity	0.1 up to 4000 W/(m•K)
Accuracy	Thermal diffusivity ± 2.4 % Specific Heat ± 5 %
Repeatability	Thermal diffusivity ± 1.9 % Specific Heat ± 3 %
Flash source	Nd:YAG-Laser up to 25 J/pulse variable pulse energy: Software controlled Pulse width: 50 up to 5000 µs
IR-detector	InSb (LN_2 cooled): ≥ RT MCT (LN_2 cooled): –125 °C up to 500 °C
Atmosphere	Vacuum, inert, reducing, oxidizing
Vacuum	up to 10^{-3} mbar (2-stage rotary pump) up to 10^{-5} mbar (turbo molecular pump)
Data acquisition	2.5 MHz
Gas control	manual or MFC gas dosing systems
Sample holders	for round, square, powders, pastes, laminates, liquid samples, mechanic pressure and in-plane *Customized sample holders on request*
Sample size	ø 3/ 5/ 6/ 8/ 10/ 12.7/ 25.4 mm, or 3x3/ 5x5/ 6x6/ 10x10/ 20x20 mm^2 (from 0.01 mm up to 6 mm height)
Sample numbers	up to 3 samples (2000/2400/2800) up to 6 samples 18 on request (LT/1250/1600)
Further options	PLH upgrade for thin film measurement, Separated electronics in protected environments, Fiber or free space laser option

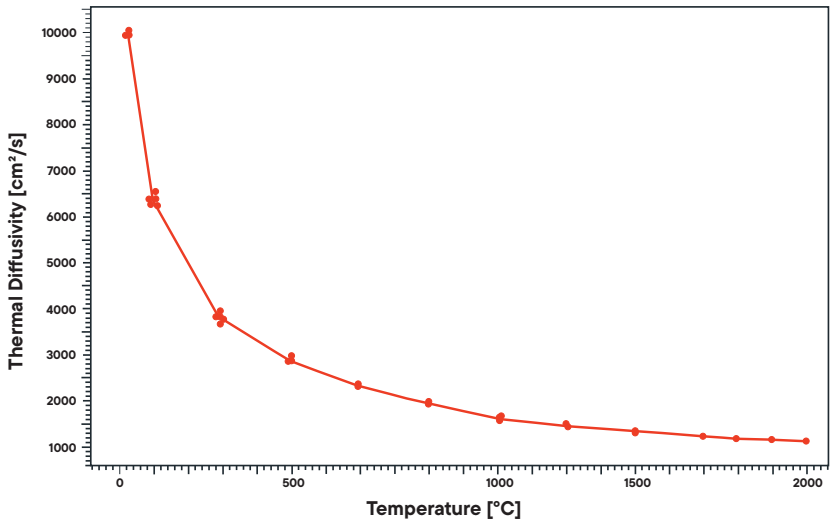
Applications

Thermal conductivity, thermal diffusivity and specific heat capacity of glass ceramics



BCR 724, a standard glass ceramic has been measured using LFA. Therefore, a small disc of 1mm thickness and 25.4mm diameter was cut out of a plate of bulk material and coated with graphite for the measurement. The LFA L52 gives the thermal diffusivity as a direct function of temperature. The Cp data was obtained in a comparative way by measuring a known ceramic standard under the same conditions in a second sample position of the same sample holder. Using this, the thermal conductivity was calculated out of the product of density, specific heat and thermal diffusivity. The result shows a slightly decreasing thermal diffusivity and conductivity while the Cp value increases over temperature.

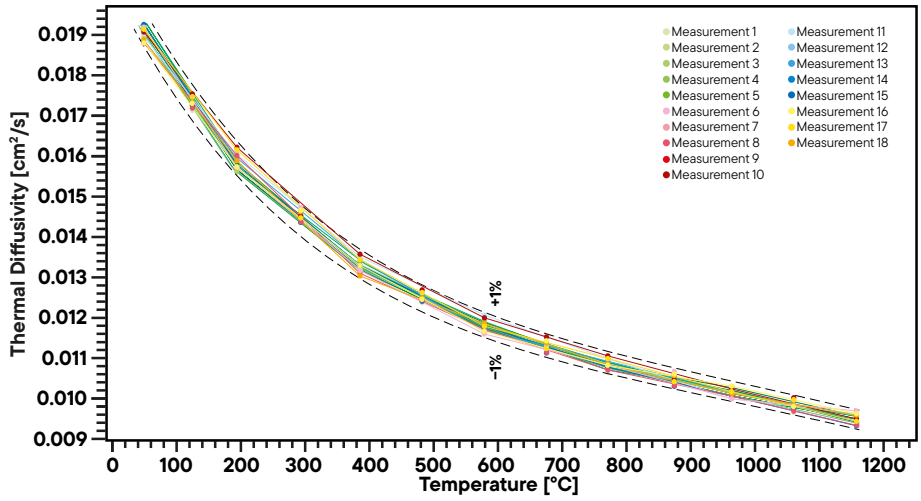
Thermal diffusivity of graphite



A graphite sample was analyzed using the LFA L52 from RT to 2000 °C. Thermal diffusivity was determined directly and specific heat capacity measured using a reference sample in the same run.
Results show a strong decrease in diffusivity with temperature, leveling off above ~1500 °C – a typical behavior of graphite due to increased phonon scattering at high temperatures.

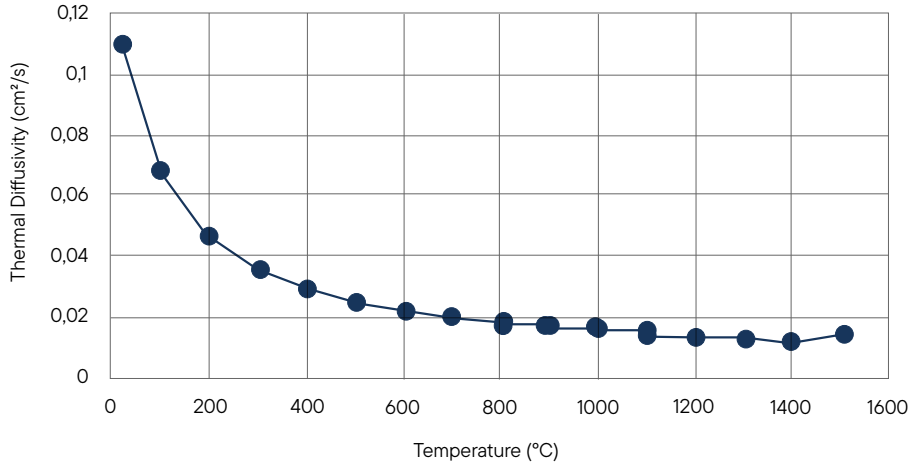
More Applications

Thermal diffusivity of glass ceramic



Pyroceram, a glass ceramic trademark of Corning used as a standard material in various applications, has been measured using the LFA to show the reproducibility of thermal diffusivity values. In total 18 measurements were performed with 18 samples that were cut out of one bulk block. Each sample was measured separately and the result shows a spread in the result that is in a range of +/- 1 % in a temperature range up to 1160°C.

Thermal diffusivity of Al_2O_3



The presented measurement shows the temperature-dependent thermal diffusivity of alumina in the range from room temperature up to 1500 °C. At low temperatures, alumina exhibits relatively high thermal diffusivity values around 0.11 cm^2/s. With increasing temperature, a strong decrease is observed, approaching values close to 0.015 cm^2/s at high temperatures.

Knowledge of this property is essential for applications in refractories, substrates and structural ceramics, where reliable heat management and long-term stability are required.

LINSEIS

pushing boundaries

LINSEIS GmbH Germany

Vielitzerstr. 43
95100 Selb

Tel.: (+49) 9287 880 0
E-mail: info@linseis.de

LINSEIS Inc. USA

109 North Gold Drive
Robbinsville, NJ 08691

Tel.: (+1) 609 223 2070
E-mail: info@linseis.com

LINSEIS China

Kaige Scientific Park
Room 120, Building T3, No.1220
Yuqiao Road, Pudong,Shanghai

Tel.: (+86) 61 90 12 03
Tel.: (+86) 50 55 06 42
E-mail: info@linseis.com.cn

LINSEIS India

Plot 65, 2nd Floor, Sai Enclave,
Sector 23, Dwarka05-800
110077 New Delhi

Tel.: +91-11-42883851
E-mail: sales@linseis.in

WWW.LINSEIS.COM

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