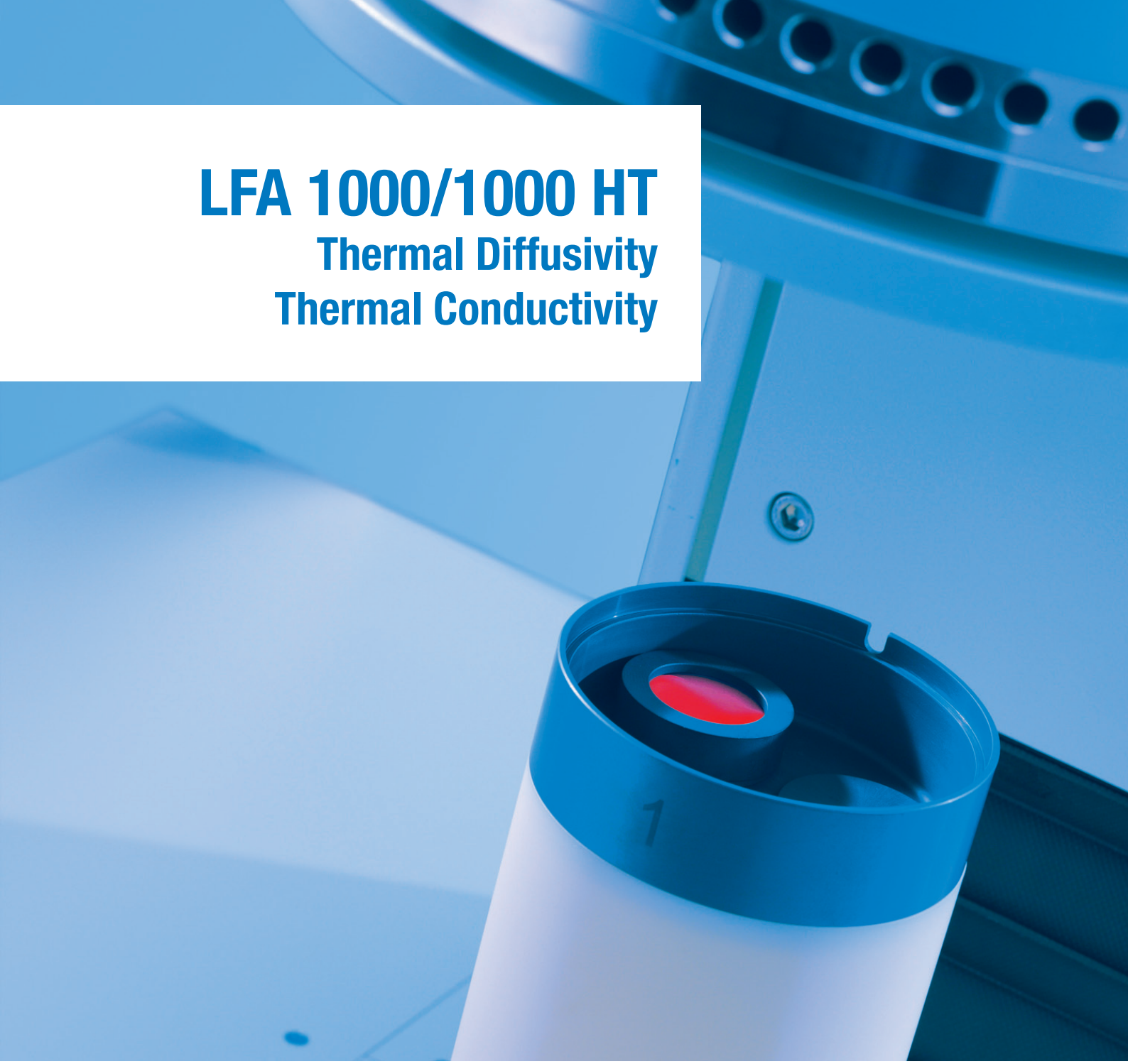
LFA 1000/1000 HT

Thermal Diffusivity
Thermal Conductivity



LINSEIS

Thermal Diffusivity, Thermal Conductivity

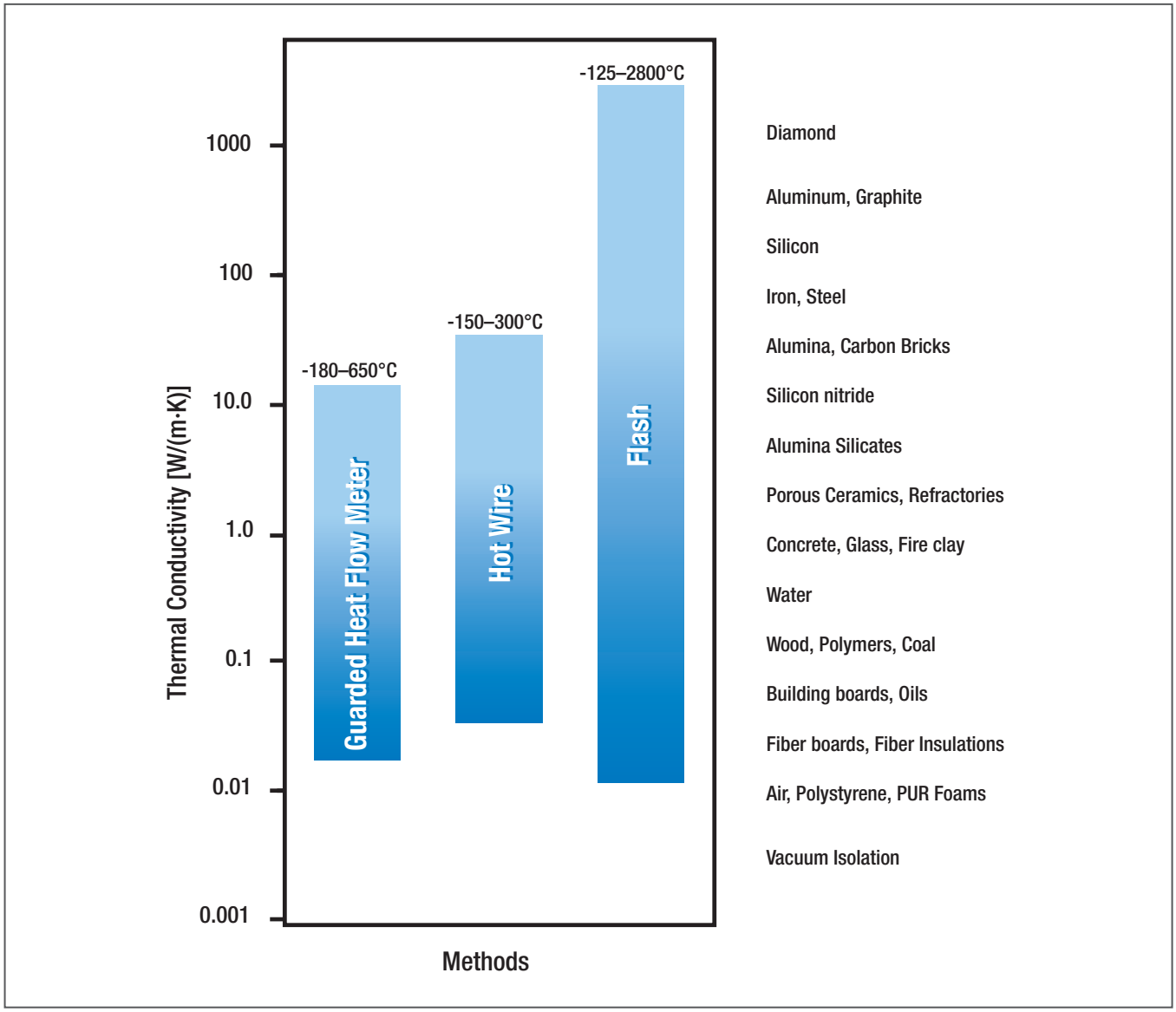
Information of the thermo physical properties of materials and heat transfer optimization of final products is becoming more and more vital for industrial applications. Over the past few decades, the flash method has developed into the most commonly used technique for the measurement of the thermal diffusivity and thermal conductivity of various kinds of solids, powders 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. The LFA 1000 provides a cost effective solution for the temperature range RT up to 1250/1600°C.

The LFA 1000/1000 HT provides unbeaten sampling rates, up to 6 samples at the same time, highest modularity, three different user exchangeable furnaces (-125 up to 2800°C) and two detectors as well as a high vacuum design (10E^{-5} mbar).

As for the calculation of the thermal conductivity, the specific heat and densitiy are requiered, LINSEIS offers a full range of Differential Scanning Calorimeters and Dilatometers.



Principle

The sample is positioned on a sample robot, located in a furnace. The furnace is then held at a predetermined temperature. At this temperature the sample surface is then irradiated with a programmed energy pulse (laser or xenon flash). This energy pulse results in a homogeneous temperature rise at the sample surface. The resulting temperature rise of the rear surface of the sample is measured by a very sensitive high speed IR detector and thermal diffusivity values are computed from the temperature rise versus time data. If the density (ρ) is identified, the thermal conductivity can be calculated:

$$\lambda(T)=a(T)\cdot c_p(T)\cdot\rho(T)$$

Thermal Diffusivity & Conductivity measuring range

The Xenon Flash technique covers the widest measuring range of all techniques, 0.1 up to 2000W(m*K) for Thermal Conductivity and 0.01 up to 1000 mm^2/s for Thermal Diffusivity.

Accuracy & Repeatability

Highest Accuracy (+/-2.2% for thermal diffusivity, +/-4% for specific heat and +/-5% for thermal conductivity) and repeatability (+/-2% for thermal diffusivity, +/-3.5% for specific heat and +/-4% for thermal conductivity). Values may vary for special applications!

Multilayer evaluation

The powerful software package enables the evaluation of two or three layer systems.

Correspondence with International Standards

The LINSEIS XFA operate in agreement with national and international standards such as ASTM E-1461, DIN 30905 and DIN EN 821.

Absolute technique

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

Speed and Flexibility

The combination of sample robot and test method allows unbeaten measurement turnaround time. A typical measurement for up to 6 samples takes only a few hours.

System Design

LINSEIS is offering an unparalleled modular system design for this Thermophysical properties Analyzer. It is possible to upgrade the temperature range (exchangeable furnaces/ measuring system) and the detector (InSb). This enables the user to start with a cost effective solution and upgrade the system whenever the budget allows or the measurement task requires it.

Software

All thermo analytical devices of LINSEIS are PC controlled, the individual software modules exclusively run under Microsoft® Windows® operating systems. The complete software consists of 3 modules: temperature control, data acquisition and data evaluation. The LINSEIS 32 – bit software encounters all essential features for measurement preparation, execution and evaluation, just like with other thermo analytical experiments. Due to our specialists and application experts LINSEIS was able to develop this easy understandable and highly practical software.

General Software

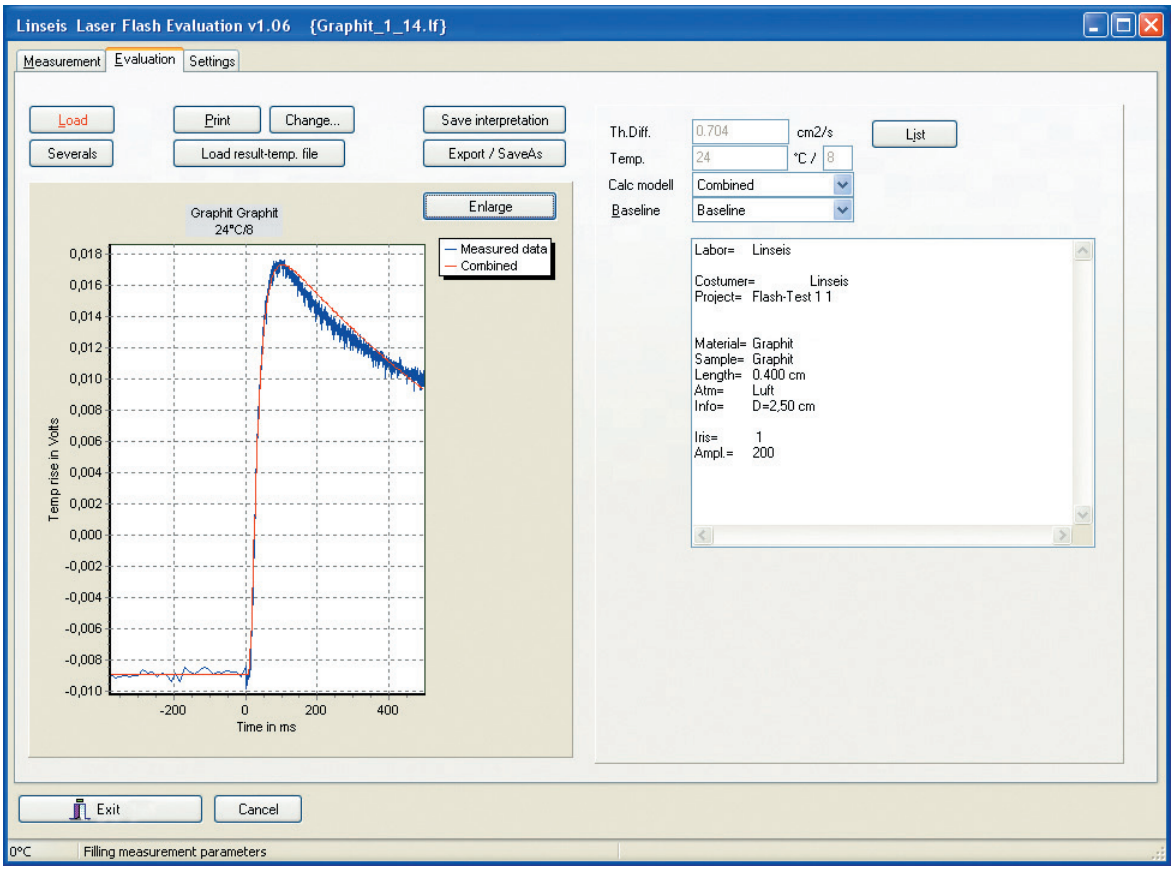
- Fully compatible MS® Windows™ 32 – bit software
- Data security in case of power failure
- Thermocouple break protection
- Evaluation of current measurement
- Curve comparison
- Storage and export of evaluations
- Export and import of data ASCII
- Data export to MS Excel
- Multi - method analysis (DSC TG, TMA, DIL, etc.)
- Programmable gas control

Evaluation Software

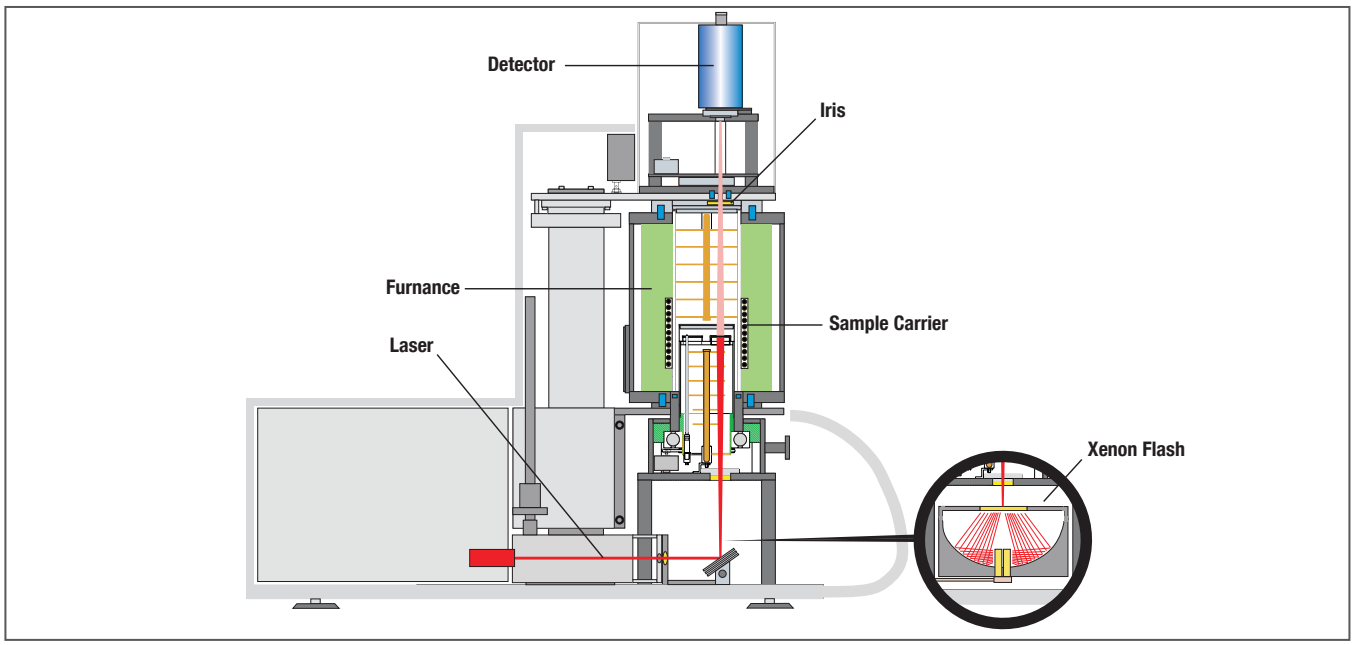
- Automatic or manual input of related measurement data: (density), Cp (Specific Heat)
- Model wizard for selection of the appropriate model
- Finite pulse correction
- Heat loss correction
- Multilayer model
- Determination of contact resistance
- Cp (Specific Heat) determination by comparative method

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



System Design



Laser

The used Nd: YAG Laser has a power output of 25J/pulse. Both the power and the pulse length can be easily adjusted by the Software. The system design includes all safety features to guarantee a secure operation, “Laser Class 1”.

Sample robot

The fully motorized sample robot can carry up to 6 samples (10 or 12.7 mm round or 10 mm square) or up to 3 samples (25.4 mm round). This design allows unbeaten sample throughput and sample size at the same time. Liquid samples can be measured in special containers. Other sample geometries or sizes are certainly possible on request.

Environmental options

The system can be operated under vacuum $10E^{-5}$mbar, oxidizing or reducing atmospheres. Furthermore a manual or automatic Software controlled gas control box (2, 3 or 4 gases) can be attached to generate specific atmospheres.

Furnace

The LFA/XFA unit can be equipped with 7 different furnaces. All furnaces are easily exchangeable.

Analyzer	Furnace Model	Temperature
LFA 1000	Cryo-Furnace	-125 up to 500°C
XFA 300	IR Furnace	RT up to 300°C
LFA 1000/XFA 600	Furnace 1	RT up to 600°C
LFA 1000	Furnace 2	RT up to 1250°C
LFA 1000	Furnace 3	RT up to 1600°C
LFA 1000 HT	Furnace 4	RT up to 2000°C
LFA 1000 HT	Furnace 5	RT up to 2800°C

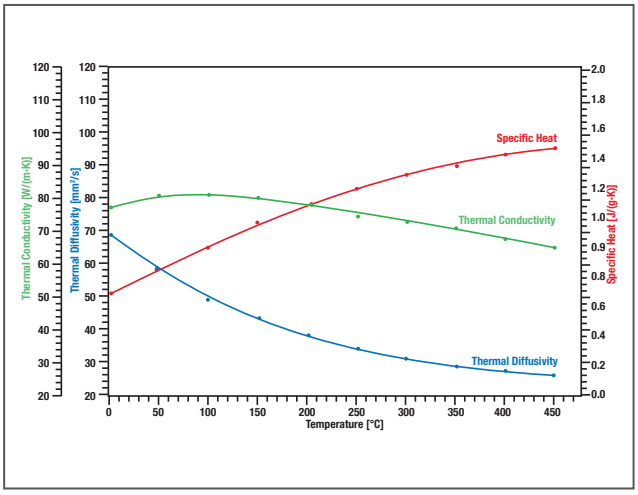
Detectors

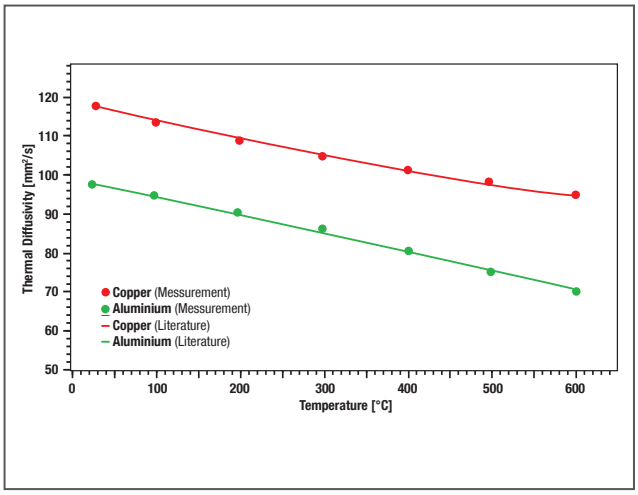
The system can be either equipped with an InSb detector or with a MCT detector. Both are easily user exchangeable. Both detectors can be ordered with an 8 hour or 24 hour Dewar. For even longer measurements an automatic cooling accessory with Dewar can be ordered.

Applications

Graphite (polycrystalline)

Graphite is an excellent material for checking the performance of a Laser/Xenon Flash Thermal Analyzer. The analyzed material shows a maximum thermal diffusivity around room temperature. The specific heat of the material which can be analyzed by comparative method or by using a DSC / High Temperature DSC shows a significant increase at higher temperatures.





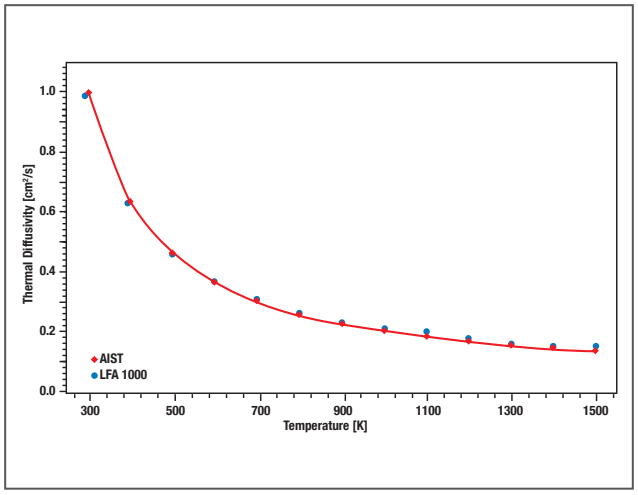
Aluminum and Copper

The pure metals Copper and Aluminum are used in this example to demonstrate the performance of the LINSEIS Laser Flash device. The measurement results of the two materials are compared with literature values. The measured results vary within 2% of the given literature values; this demonstrates the excellent performance of the instrument.

Isotropic Graphite (AIST))

This graph shows the Thermal Diffusivity values measured on a LINSEIS LFA 1000 compared to the values measured at AIST* Japan. The literature values of the used Isotropic Graphite from AIST* the measured results on the LFA 1000 vary by less than 2%.

**(National Institute of Advanced Industrial Science and Technology, Japan)*



Technical Specifications

	XFA 300	XFA 600	LFA 1000/1000 HT
Sample dimesnions	ø 10 mm, 0.1 to 6 mm thick	ø 10 mm, 0.1 to 6 mm thick	ø 10 mm, 0.1 to 6 mm thick
	ø 12.7 mm, 0.1 to 6 mm thick	ø 12.7 mm, 0.1 to 6 mm thick	ø 12.7 mm, 0.1 to 6 mm thick
	ø 25.4 mm, 0.1 to 6 mm thick	ø 25.4 mm, 0.1 to 6 mm thick	ø 25.4 mm, 0.1 to 6 mm thick
	□ 10 x 10 mm, 0.1 to 6 mm thick	□ 10 x 10 mm, 0.1 to 6 mm thick	□ 10 x 10 mm, 0.1 to 6 mm thick
Max. sample number	up to 6 samples ø 12.7 mm round	up to 6 samples ø 12.7 mm round	up to 6 samples ø 12.7 mm round
	up to 3 samples ø 25.4 mm round	up to 3 samples ø 25.4 mm round	up to 3 samples ø 25.4 mm round
Temperature range	RT up to 300°C	-125 up to 600°C RT up to 600°C	-125 up to 500°C RT up to 1250/1600°C RT up to 2000/2800°C
Vacuum	—	$10E^{-5}$ mbar	$10E^{-5}$ mbar
Atmosphere	inert, oxidizing or reducing	inert, oxidizing or reducing	inert, oxidizing or reducing
Measuring range Ther. Diffusivity	0.01 up to 1000 mm^2/s	0.01 up to 1000 mm^2/s	0.01 up to 1000 mm^2/s
Measuring range Ther. Conductivity	0.1 to 2000 W/(m·K)	0.1 to 2000 W/(m·K)	0.1 to 2000 W/(m·K)
Repeatability Thermal Diffusivity	±2% (for most materials)	±2% (for most materials)	±2% (for most materials)
Repeatability Specific Heat	±3.5% (for most materials)	±3.5% (for most materials)	±3.5% (for most materials)
Repeatability Thermal Conductivity	±4% (for most materials)	±4% (for most materials)	±4% (for most materials)
Accuracy Thermal Diffusivity	±2.2% (for most materials)	±2.2% (for most materials)	±2.2% (for most materials)
Accuracy Specific Heat	±4% (for most materials)	±4% (for most materials)	±4% (for most materials)
Accuracy Thermal Conductivity	±5% (for most materials)	±5% (for most materials)	±5% (for most materials)
Pulse source	Xenon Flash	Xenon Flash	Nd: YAG Laser
Pulse energy	10J/pulse	10J/pulse	25J/pulse
Pulse energy adjustment	yes	yes	yes
Pulse length adjustment	software adjustable	software adjustable	software adjustable
Sensor type	InSb, LN_2 cooled	InSb or MCT, LN_2 cooled	InSb or MCT, LN_2 cooled

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