THB - An innovative measuring method to determine:

- ⇨ **Thermal Conductivity**
- ⇨ **Thermal Diffusivity**
- ⇨ **Volumetric Specific Heat**

Thermophysical properties of materials belong to the fundamental characteristics. Thermal conductivity and thermal diffusivity as well as the specific thermal capacity are of great interest in the development of new types of materials in quality control, in production, and for monitoring the production process. For this, quick and easy-to-use measurement methods are advantageous. A precise measurement should only take a few minutes without enormous preparatory work by the user. Buying and maintaining the system must not be expensive . These innovative measurement methods offer a real advantage in the accurate measurement and product and production quality monitoring.

Thermal Conductivity (λ) of a solid, a liquid or a gas is its ability to transport thermal energy by means of thermal conduction in the form of heat. The thermal conductivity in W/(m·K) is a temperature dependent material constant.

Thermal Diffusivity (a) in m^2/s, is a material property that serves to describe the time change of the spatial distribution of the temperature by thermal conduction as a consequence of a temperature gradient. Or put another way: Thermal diffusivity is the speed with which the heating spreads out through the material.

Volumetric Specific Heat (c) of a material is a physical property and denotes thermal capacity with reference to the mass. The specific heat capacity in J/(kg·K) indicates what heat quantity must be supplied to a material per unit mass to increase its temperature by one degree Kelvin.

Advantages of this measurement method:

- ⇨ **Rapid measurement – typically only 1 minute**
- ⇨ **very accurate measurement results**
- ⇨ **very little preparatory work**
- ⇨ **simple and rapid operation**
- ⇨ **no special skill needed**
- ⇨ **measurement sequence guided**

Technical description

The innovative measurement method “Transient Hot Bridge” (THB) offers a great many advantages compared with previously known procedures. It is accurate, quick, easy to use and also suitable for use in the production environment.

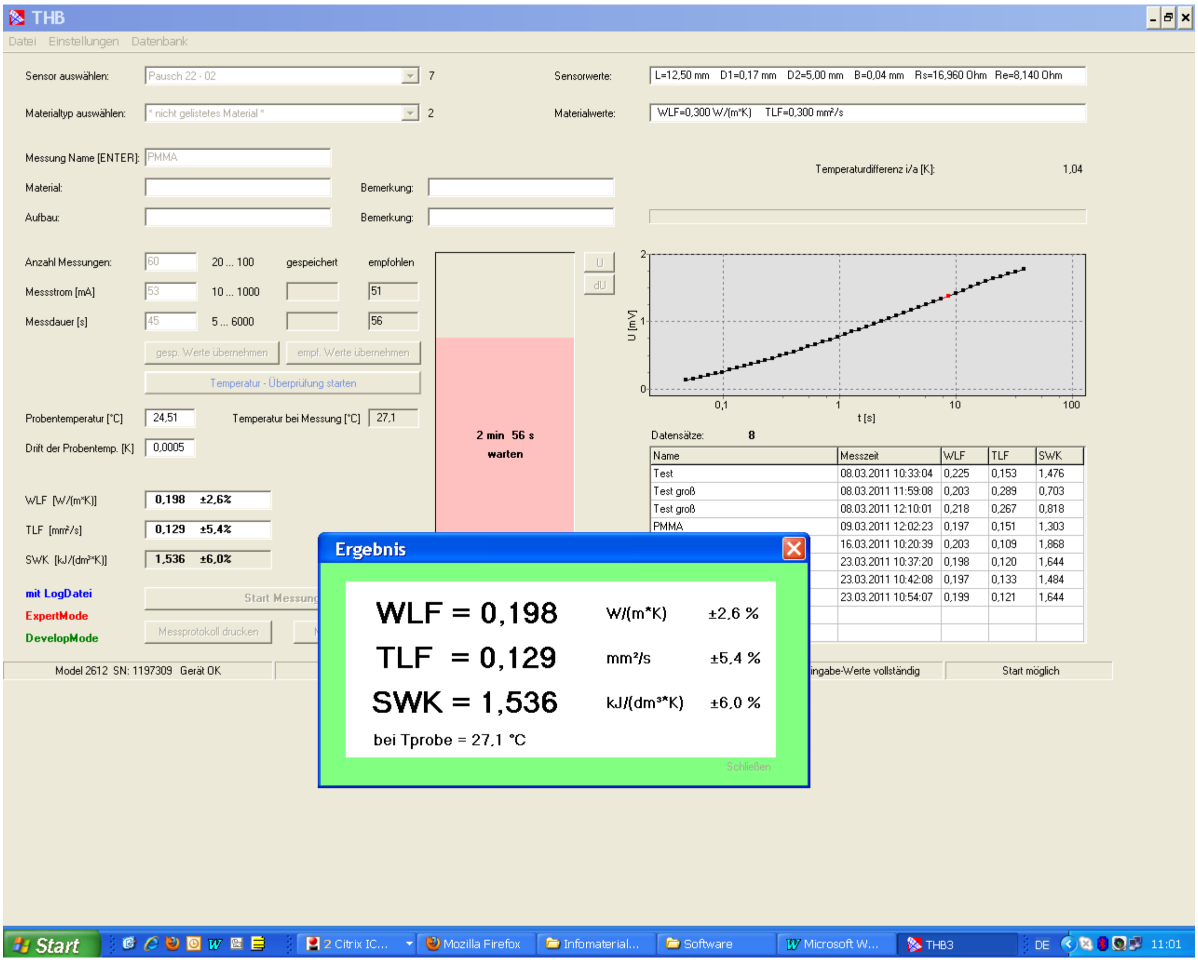
The THB sensor used for this is from an electrical point of view a bridge circuit. It enables very accurate and quick measuring. This technology and the measurement method developed from it guarantees the measurement of the following thermophysical material properties:

- ⇨ ***Thermal Conductivity,***
- ⇨ ***Thermal Diffusivity,***
- ⇨ ***Volumetric Specific Heat***

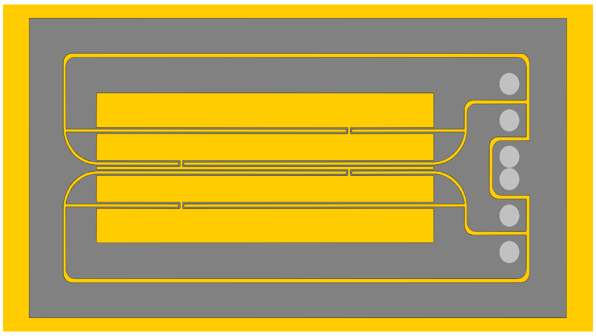
The bridge connection is embedded in a hot-foil sensor that consists of a particularly temperature-stable foil material and a special conductor. For the measurement e.g. of bulk goods similar to sand or sediment the foil sensor is inserted like a spade into the material. For rigid samples the foil sensor is laid between two equal-sized test samples and clamped so that a very good contact of the surfaces for the heat transfer is obtained. For liquid media the flexible sensor is built as the wall of a cylinder. After filling the cylinder contact with the liquid material is ensured.

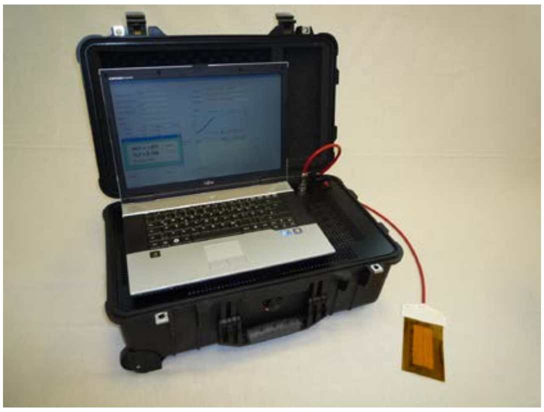
Main components of the THB measurement system:

⇨ Hot-foil sensor with special conductor path design
⇨ Measurement device with constant current source, user interface and evaluation software



User Interface and Evaluation Software THB-10, Dataexport in Excel


Hot-foil sensor with bridge circuit


Systemcomponents: Evaluation Unit, Measurement device with current source, Hot Foil Sensor

Economic significance

Environmental protection is at the present time a particular challenge. With optimised materials in many areas of application resource-friendly solutions and also energy-efficient products can be manufactured.

In order to achieve this objective a measurement method is necessary that enables determination of the thermal transport properties of materials with high precision of measurement. The advantage of the THB method is that it is easy to handle, delivers rapid measurement results and is at the same time more accurate than previous comparable systems. It is robust in use and can also be used in the production environment.

Previously known measurement methods on the market need specially trained specialist staff for the operation of the systems, evaluation and interpretation of the measurement results. Moreover these procedures require a measurement time in hours occasionally up to 8 hours for a measurement.

Advantages of the THB measurement method:

- ⇨ Very rapid measurements
- ⇨ Measurement output with the optimally required measuring current intensity and measurement duration for better results
- ⇨ Indication and documentation of measurement uncertainty for every measurement
- ⇨ Automatic recognition of operating error with warning and indication
- ⇨ Logging of temperature drift before and after the measurement
- ⇨ Guided menu prompting step by step - excluding measuring errors
- ⇨ Range of application for solid and liquid materials

Applicable for following products among others: building materials, plastics, pharmaceuticals, metals and alloys, microtechnology

Technical Data

Thermal conductivity	0,05 bis 50 W/(m·K)
Measurement uncertainty	up to 5%*
Reproducibility	better than 0,5%
Thermal diffusivity	0,05 bis 5 mm²/s
Measurement uncertainty	bis zu 6%*
Reproducibility	besser 1,5%
Vol. spez. Wärmekap. (calculated from λ and a)	Better than 1,5% in J/(kg·K)
Temperature range	-40 to 180 °C
Measuring time	30 seconds (typically 1 minute)*
Interfaces	USB 2, Ethernet, RS232, IEEE 488

Measurement device conforms:

for safety	Conforms to European Union Directive 73/23/EEC, EN 61010-1, and UL 61010-1.
for EMC	Conforms to European Union Directive 89/336/EEC, EN 61326-1.

*dependent on sensors and samples, calculated in accordance with ISO-GUM with k=2

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