

Hot Disk[®] Thermal Constants Analyser



TPS 3500



hotdiskinstruments.com

Hot Disk[®] Instrument

TPS 3500

The Hot Disk[®] TPS 3500 is the state-of-the-art instrument for testing the Thermal Conductivity, Thermal Diffusivity, Thermal Effusivity and Specific Heat Capacity of tiny, highly thermal conducting samples. The capabilities of the TPS 3500 go well beyond that of any other available instrument to date – Thermal Conductivity ranging from 0.005 to 1800 W/m/K, tackling 10-micrometer-thick slab samples, and accommodating temperatures from cryogenic to 1000°C. It has also the unique ability to analyse the anisotropic thermal transport properties of both uniaxial and biaxial materials, by use of specialized Hot Strip[®] sensors in the latter case. The TPS 3500 meets ISO 22007-2 and is CE marked.



For testing the extreme

In addition, the TPS 3500 is a general-purpose R&D instrument capable of analysing thermal transport properties of any kind of solid or liquid. Solids suitable for testing with a TPS 3500 can be dense, porous or in powder form, isotropic or anisotropic, conducting or insulating, transparent or opaque. Liquids can be thick and sticky, low viscosity solvents or anything in between.

As a badge of reliability the new TPS 3500 meets ISO 22007-2 and utilizes Hot Disk's classic double spiral sensors for maximum accuracy. All this is achieved without the use of contact fluids, light-absorbing sample surfaces or fixed sample geometries.

Each Hot Disk TPS 3500 is tailored according to application specifications and can be paired with a selection of temperature control accessories. To guarantee best possible performance, the controlling software is continuously updated and improved. Most accessories are also available for rapid acquisition.



Key Features

Sensors: The TPS 3500 operates a wide variety of Hot Disk® sensors. With sensor radius from 0.5 mm up to 30 mm the instrument is suitable for all kinds of materials and applications. Multiple sensors can be connected using an automatic sensor switcher. With sensor radius from 0.5 mm up to 30 mm the instrument is suitable for all kinds of materials and applications.

Temperature Control: Automatic Temperature series measurements (Isothermal Steps) are easy to perform using either an optional external Furnace or a temperature-controlled Bath Circulator. These external devices can be directly controlled through the Hot Disk Thermal Analyser software to ensure ease of use.

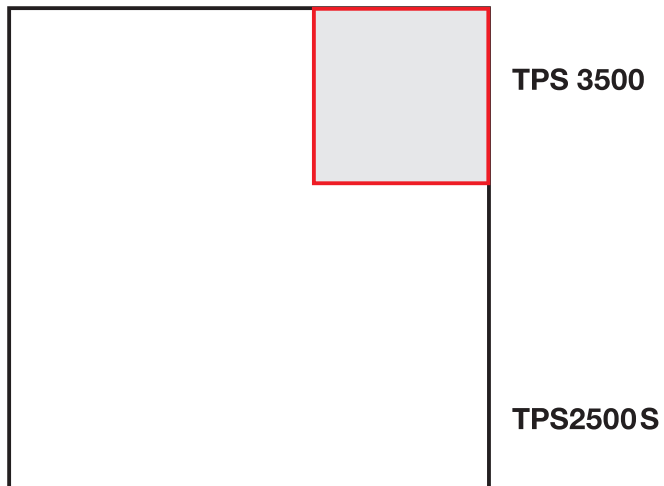
Everything to get you started: The basic TPS 3500 setup includes everything you need to begin making measurements. The system includes: Hot Disk TPS 3500 instrument; Isotropic, One-dimensional and Structural Probe measurement modules; a Sensor; Insulating Support-Material for Single-Sided testing; Stainless Steel Verification Samples and Room-Temperature Sample Holder.

Optional Software Modules: In addition to the standard Isotropic, One-Dimensional and Structural Probe modules, optional software modules for Slab, Thin Film, Anisotropic, Specific Heat Capacity and Low-Density, Highly-Insulating samples are available.

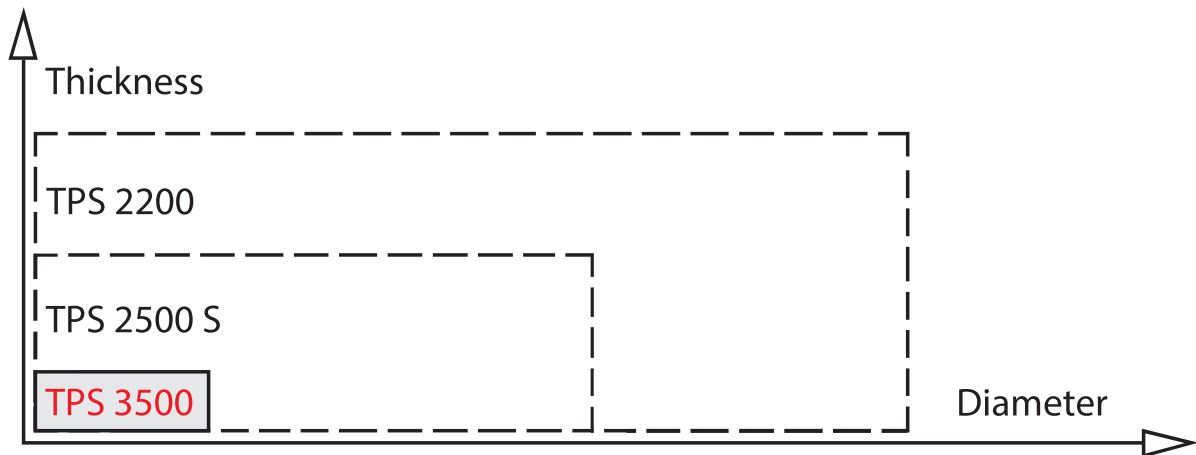


Relative minimum sample dimensions as determined by measurement time

Top view of bulk or slab sample



Side view of bulk sample



TPS 3500 Specifications¹

Measurement

Sample Types	Bulks, rods, slabs, wafers, sheets, foils, films, laminates, composites, minerals, batteries, textiles, pellets, granules, beads, grains, powders, pastes, creams, gels, liquids, foams and insulators.
Evaluation	
Anisotropy	Yes, both 2D anisotropic (uniaxial) materials and 3D anisotropic (biaxial) materials can be characterised, using optional Anisotropic Measurement Module.
One-Dimensional	Yes, axial estimations possible for a complex sample configuration.
Sample Dimensions	
Smallest	Bulk sample: 0.5 mm thick x 2 mm wide (circle or square). Rod sample: 5 mm long x 2.5 mm wide (circle or square). Slab sample: 42 µm thick x 8 mm wide (circle or square). Thin film sample: 10 µm thick x 22 mm wide (circle or square).
Largest	Bulk sample: unlimited. Rod sample: unlimited length x 60 mm wide (circle or square). Slab sample: 20 mm thick x unlimited wide (circle or square). Thin Film sample: 500 µm thick x unlimited wide (circle or square).
Sample Temperature Range	-253°C (20 K) to 1000°C.
Core Instrument	RT.
With Optional TCU	-253°C (20 K) to 1000°C. Low-to-High Temperature Chamber: -60°C to 300°C Bath Circulator: -40°C to 200°C. Convection Oven: RT to 600°C. Muffle Furnace: RT to 800°C. Tubular Furnace: RT to 1000°C (gas purging for >400°C, and inert gas flow for >800°C is recommended).

Measurement Time²	0.1 to 2560 seconds (depending on sample material and sensor dimensions).
Measurement Range	
Thermal Conductivity	Bulk sample: 0.005 to 500 W/m/K. Rod sample: 1 to 1800 W/m/K. Slab sample: 5 to 1800 W/m/K. Thin Film sample: 0.01 to 5 W/m/K.
Thermal Diffusivity	Bulk sample: 0.01 to 400 mm ² /s. Rod sample: 1 to 1400 mm ² /s. Slab sample: 5 to 1400 mm ² /s. Thin Film sample: 0.02 to 2 mm ² /s.
Thermal Effusivity	20 to 55000 W \sqrt{s} /m ² /K.
Specific Heat Capacity	Up to 5 MJ/m ³ /K.
Measurement Accuracy	
Thermal Conductivity	Better than 5%.
Thermal Diffusivity	Better than 10%.
Measurement Reproducibility³	
Thermal Conductivity	Typically better than 2%.
Thermal Diffusivity	Typically better than 5%.
Measurement Repeatability⁴	
Thermal Conductivity	Typically 0.11% (Stainless Steel bulk sample, Kapton-insulated Hot Disk [®] sensor model 5501, and 22°C sample temperature)
Thermal Diffusivity	Typically 0.44% (Stainless Steel bulk sample, Kapton-insulated Hot Disk [®] sensor model 5501, and 22°C sample temperature).
Measurement Sensitivity⁵	
Temperature	Typically 43 μ K (Stainless Steel sample, Kapton-insulated Hot Disk [®] sensor model 5501, and 22°C sample temperature).

General

Meets ISO Standard 22007-2	Yes.
Measurement Modules	
Included	Isotropic, Single-Sided Testing, One-Dimensional, Structural Probe, and Automation.
Optional	Anisotropic, Slab, Thin Film, Low-Density/Highly Insulating, and Specific Heat Capacity.
Sensor Models	
Hot Disk® sensor – Kapton-insulated	All models.
Hot Disk® sensor – Teflon-insulated	All models.
Hot Disk® sensor – Mica-insulated	All models.
Hot Strip® sensor – Kapton-insulated	All models.
Hot Cell® sensor – Cell size <250 mm	All models.
Hot Cell® sensor – Cell size >250 mm	Please inquire.
Instrument Environment	
Operating	15°C to 30°C.
Storage	-20°C to 45°C.
Instrument Line Power	
Supply Voltage	100 – 240 VAC, 50 – 60 Hz.
Power Consumption	70 W typical, 305 W maximum.
Instrument Warm-Up	2 hours to rated measurement performance.
Instrument Input and Output	
Rear Panel	USB type B connector (female) for connectivity.
Front Panel	LEMO 8 pin connector (female) for Hot Disk®, Hot Strip® or Hot Cell® sensor.
	LEMO 4 pin connector (female) for optional PT100 temperature sensor.
Instrument Dimensions	325 mm high x 455 mm wide x 615 mm deep.
Instrument Weight	29 kg.
Instrument CE Marking	Yes.

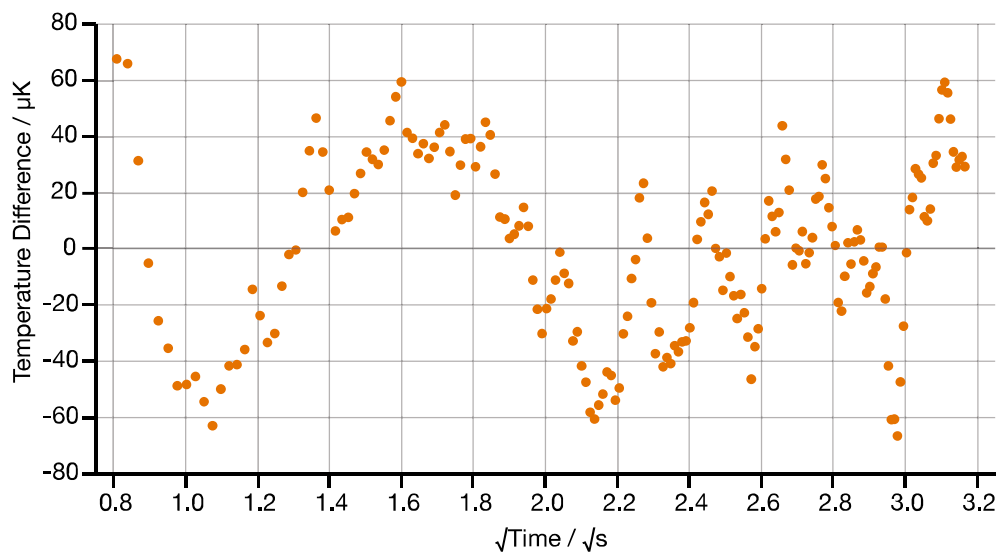
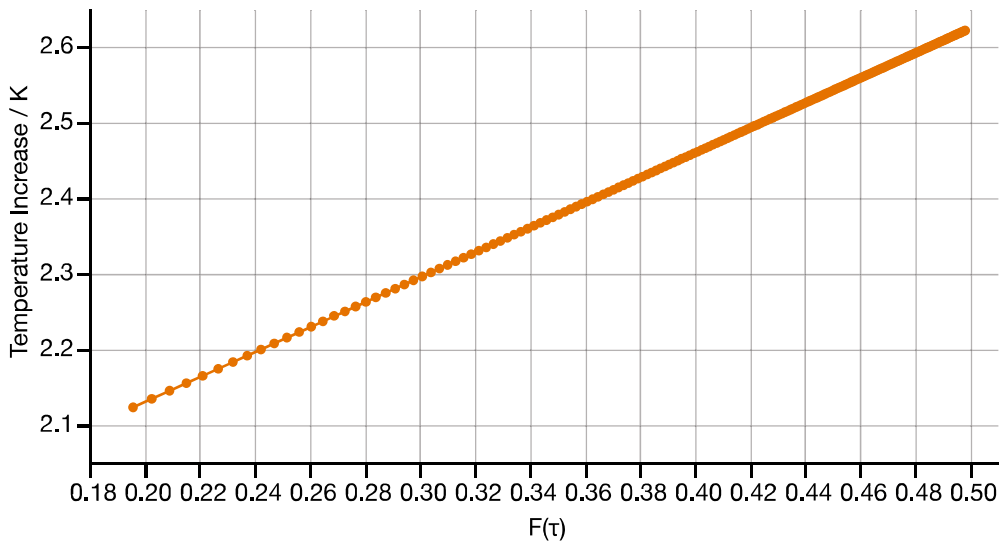
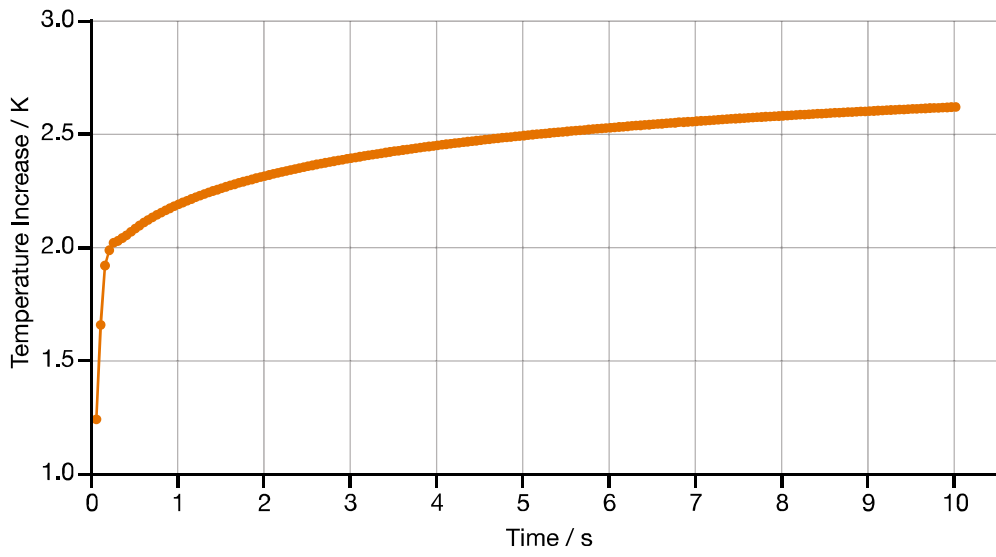
Notes:

1. Hot Disk AB reserves the right to make changes without prior notice, whether due to misprints, improved hardware, or extended software capabilities.
2. Time of transient temperature reading. An additional temperature settling time that depends on the sample material and TCU (if applied) is required to ensure isothermal condition before the reading.
3. Comparing measurements performed by different instrument set-ups.
4. Variation in consecutive measurements performed by a single instrument set-up. Note that this value depends on sample material, sensor model, and sample temperature.
5. Standard deviation in fitting $\Delta T(\tau)$ -function to the transient temperature reading. Note that this value depends on sample material, sensor model, sample temperature, and can vary considerably.

TPS 3500 Measurement Demonstration

Stainless Steel

Sample	
Material	Stainless Steel, AISI 316/316L.
Type	Bulk.
Temperature	21°C
Measurement Parameters	
Measurement Module	Isotropic.
Sensor Model	Kapton-insulated Hot Disk® sensor 5501 (radius 6.4 mm).
Measurement Time	10 s.
Heating Power	800 mW.
Measurement Results	
Data Points	13-200.
Thermal Conductivity	13.67 W/m/K.
Thermal Diffusivity	3.647 mm ² /s.
Specific Heat Capacity	3.748 MJ/m ³ /K.
Probing Depth	12.1 mm.
Temperature Increase	0.5098 K.
Standard Deviation in Fitting $\Delta T(\tau)$	31 μ K.



Included with the TPS 3500 Instrument

Basic Option

- 5 x Measurement Modules: Isotropic, Single-Sided Testing, One-Dimensional, Structural Probe, and Automation.
- 1 x Kapton-insulated Hot Disk® or Hot Strip® sensor: Model free of choice, with cable.

Regular Complete Option:

- 9 x Measurement Modules: Isotropic, Anisotropic, Single-Sided Testing, Slab, Thin Film, One-Dimensional, Specific Heat Capacity, Structural Probe, and Automation.
- 10 x Kapton-insulated Hot Disk® or Hot Strip® sensors: Models free of choice, with cable.

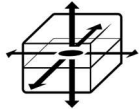
Extended Complete Option:

- 10 x Measurement Modules: Isotropic, Anisotropic, Single-Sided Testing, Slab, Thin Film, Low-Density/Highly Insulating, One-Dimensional, Specific Heat Capacity, Structural Probe, and Automation.
- 10 x Kapton-insulated Hot Disk® or Hot Strip® sensors: Models free of choice, with cable.

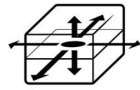
Always included:

- Hot Disk® Desktop App software (latest version)
- 1 x Stainless Steel verification bulk sample.
- 1 x Single-sided background insulation (single-sided testing).
- 1 x Room temperature sample holder (protective hood included).
- Instructions manual.
- Instrument test protocol.
- Power supply cord and USB cable.

Available measurement modules for the TPS 3500



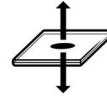
Isotropic
(Standard)



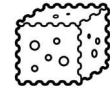
Anisotropic



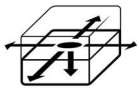
Slab



Thin Film



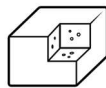
Low-Density /
Highly-Insulating



Single-Sided
Testing



One-Dimensional



Structural
Probe



Automation



Specific Heat
Capacity

Available sensors for the TPS 3500



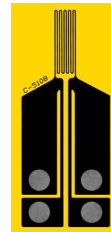
Kapton-insulated
Hot Disk® sensor
All models.



Teflon-insulated
Hot Disk® sensors
All models.



Mica-insulated
Hot Disk® sensors
All models.



Kapton-insulated
Hot Strip® sensor
All models.



Aluminium & Gold
Hot Cell® sensors
All models.

Hot Disk[®]

Instrument Portfolio

A wide range of Hot Disk[®] instrument models is available for testing and measuring Thermal Conductivity, Thermal Diffusivity, Thermal Effusivity and Specific Heat Capacity following ISO 22007-2. While typically generous of measurement spectrum, our top-of-the-line instruments are unique in monitoring ultra-short transient temperature readings, thereby tackling sub-millimeter-thick samples and highly-thermal conducting materials, beyond 1800 W/m/K. A further unique feature of our instrumentation is that it requires no external calibration. Our clients can confidently continue its employ, without worrying over the inconvenience of being obliged to return their instruments for re-calibration at regular intervals. Each Hot Disk[®] instrument includes two LEMO connector ports: one for the relevant Hot Disk[®] sensor, and one for the optional PT100 ambient temperature sensor. Please consult our interactive links below, to help determine which Hot Disk[®] instrument is best suited to your intended applications and needs.



TPS 3500
For testing the extreme.



TPS 2500 S
The benchmark instrument.



TPS 2200
For day-to-day testing.



TPS 1500
For heavy-duty testing.



TPS 500S
For the small-scale lab.



TPS 500
For the economical lab.



M1
Portable and educational.



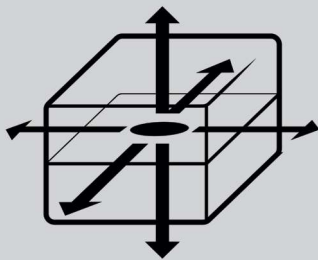
TPS 1000
For cost-effective quality assurance.

Notes

Hot Disk®

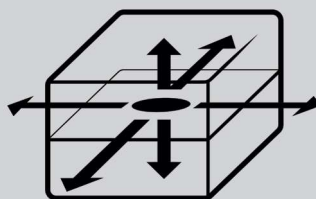
Measurement Modules

Hot Disk® instruments can be tailored to specific testing needs not only by the selection of sensors, but also by the wide range of measurement modules available. These modules allow for the testing of samples of special geometries, thermal conductivity ranges and material types. The Isotropic Module is the standard module for measuring bulk samples, and is included in all instruments. The add-on modules in turn extend the capabilities of your instrument, for example to tackle anisotropic-, slab-, or thin film samples. Based on long client experience, Hot Disk conveniently offers its clients clustered configurations along with many instrument models, via grouping several modules of related interest together, or by providing for the full available range. In effect, this means Hot Disk customers have the option of ordering several add-on modules at a quantity discount. Please contact your local Hot Disk sales representative for available cluster options.



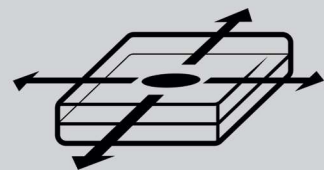
Isotropic (Standard)

All-round testing of bulk samples.



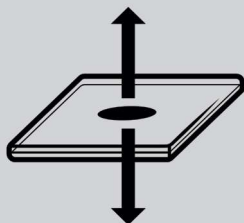
Anisotropic

Testing samples with direction dependent properties.



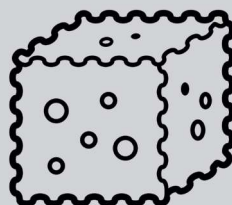
Slab

Testing highly thermal conductive slab or sheet samples.



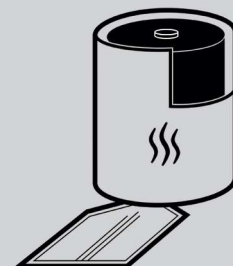
Thin Film

Testing thermal insulating thin film samples.



Low-Density / Highly-Insulating

Testing the lightest and most insulating samples.

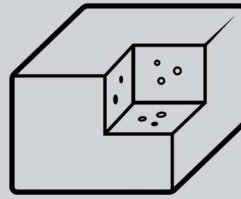


Specific Heat Capacity

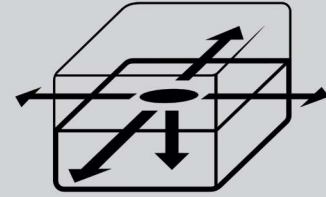
Testing Cp of complex samples and batteries.



One-Dimensional
Testing rod-like samples.



Structural Probe
Identify defects and structural changes inside samples and components.



Single-Sided Testing
Rapid production line QC testing.



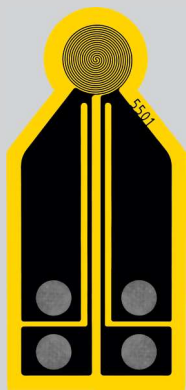
Automation
Remote-controlled testing.

Notes

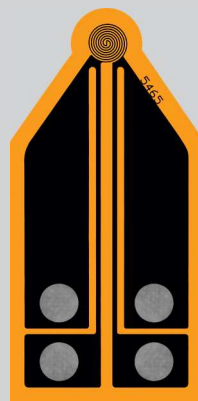
Hot Disk[®] Sensors

We currently supply three different types of sensors to be used with our Hot Disk[®] instruments – configured in tandem with our range of Measurement Modules. All three sensor types make use of a TPS element – a patterned Nickel foil with electrically insulating cladding – that is used for simultaneous transient heating and precise temperature reading.

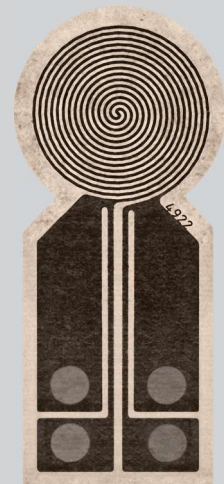
Our patented Hot Disk[®] sensor is our baseline sensor for measuring Thermal Conductivity and Thermal Diffusivity of isotropic samples. It is also used for testing 2D anisotropic samples, e.g. uniaxial crystals and layered composites with different properties in the in- and through-plane directions. Our patented Hot Strip[®] sensor is used as complement to our Hot Disk[®] sensor, primarily for testing 3D anisotropic samples, e.g. biaxial crystals and fiber composites with different properties along, across, and through the fiber orientation direction. Our Hot Cell[®] sensor is our newest type addition, developed in-house to measure the Specific Heat Capacity of materials or components (with focus on batteries) of arbitrary type, shape, and size.



Kapton-insulated
Hot Disk[®] sensor



Teflon-insulated
Hot Disk[®] sensors



Mica-insulated
Hot Disk[®] sensors



Kapton-insulated
Hot Strip[®] sensor



Aluminium & Gold
Hot Cell[®] sensors



Notes

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