

Hot Disk[®] Thermal Constants Analyser



TPS 1000



hotdiskinstruments.com

Hot Disk[®] Instrument

TPS 1000

The Hot Disk[®] TPS 1000 is a powerful instrument for QC testing, measuring Thermal Transport Properties at very high precision. The TPS 1000 is scalable, where in its most basic configuration it functions primarily as a price-attractive simple Thermal Conductivity meter for 1D (through-plane) testing. Yet the TPS 1000 can also be used as a dedicated Specific Heat Capacity meter. In an upgraded configuration, the instrument can also be used as an advanced Thermal Conductivity, Thermal Diffusivity, and Thermal Effusivity meter, with performance and capability close to our TPS 2200 laboratory instrument. In other words tackles millimeter-thick bulk samples, measures Thermal Conductivity from 0.01 to 500 W/m/K, handles a temperature range from -100°C to 750°C, and be used to analyse the anisotropic thermal transport properties of uniaxial materials. The TPS 1000 meets ISO 22007-2 and is CE marked.



For cost-effective quality assurance

The adaptable Hot Disk® TPS 1000 Thermal Constants Analyser is an instrument with scalable measurement capability. It is intended specifically for QC testing, as its scalability allows for precise configuration for a targeted product line set-up, where the testing scenario is fixed over time. This enables a custom-built QC instrument at an attractive price with the same unmatched precision as our laboratory instruments meeting ISO 22007-2.

In its most basic configuration, the TPS 1000 operates as a simple Thermal Conductivity meter devoted for 1D testing of medium to high conducting rod-like samples. It then employs our Hot Strip® sensor model 101474 (16 x 19 mm) and our One-Dimensional Module, where the through-plane Thermal Conductivity is directly measured. This is achieved via either double- or single-sided testing, where the former is recommended for maximum precision. The TPS 1000 also supports our Specific Heat Capacity Module, where the Specific Heat Capacity is directly measured. This means that the TPS1000 can also function as a Specific Heat Capacity meter. Such measurements are in general time-consuming, especially for testing larger samples/components. Thus, the TPS 1000 can complement other Hot Disk® instruments in a laboratory set-up as a valuable stand-alone Specific Heat Capacity meter – increase measurement through-put at low additional cost.



Notably, the TPS 1000 can at any time be configured for further specialized measurement capabilities via six different optional Hot Disk® sensor packages (targeting Hot Disk sensors of categorized sizes), each with dedicated Hot Disk® sensor models and associated measurement modules. By adding such a sensor package, the TPS 1000 can be upgraded into a powerful Thermal Conductivity, Thermal Diffusivity, and Thermal Effusivity meter for sample sizes and types that particular Hot Disk® sensor models can tackle with associated measurement modules. Moreover, by adding the full range of sensor packages, the TPS 1000 instrument achieves close to the measurement performance and capability as our TPS 2200 laboratory instrument. This means that the TPS 1000 can – with our patented and powerful TPS technology, now standardized with ISO 22007-2 – be used for testing Thermal Transport Properties of films, foils, sheets, slabs, rods, bulks, solids, liquids, pastes, gels, powders, and insulators over a temperature range of -100 °C to 750 °C, and all with high accuracy. Finally, applying the Anisotropic Module, the TPS 1000 can be used to analyse the 2D (in-plane and through-plane) Thermal Transport Properties of uniaxial materials.



The following optional Hot Disk® sensor packages are available for extended and customized QC testing capability of the TPS 1000:

- **Hot Disk® sensor package – 4 mm diameter** – to support Hot Disk® sensor model 7577 as well as its associated Measurement Modules: Isotropic, Anisotropy, Slab, Thin-Film, Low-Density/Highly-Insulating. One Hot Disk® sensor model 7577 with Kapton-insulation and cable for max 50 °C is included.
- **Hot Disk® sensor package – 7 mm diameter** – to support Hot Disk® sensor model 5465 as well as its associated Measurement Modules: Isotropic, Anisotropy, Slab, Thin-Film, Low-Density/Highly-Insulating. One Hot Disk® sensor model 5465 with Kapton-insulation and cable for max 50 °C is included.
- **Hot Disk® sensor package – 13 mm diameter** – to support Hot Disk® sensor models 5501 and 5082 as well as their associated Measurement Modules: Isotropic, Anisotropy, Slab, Thin-Film, Low-Density/Highly-Insulating. One Hot Disk® sensor model 5501 with Kapton-insulation and cable for max 50 °C is included.
- **Hot Disk® sensor package – 20 mm diameter** – to support Hot Disk® sensor models 8563, 7854, and 4921 as well as their associated Measurement Modules: Isotropic, Anisotropy, Slab, Thin-Film, Low-Density/Highly-Insulating. One Hot Disk® sensor model 8563 with Kapton-insulation and cable for max 50 °C is included.
- **Hot Disk® sensor package – 30 mm diameter** – to support Hot Disk® sensor models 4922 and 7280 as well as their associated Measurement Modules: Isotropic, Anisotropy, Slab, Thin-Film, Low-Density/Highly-Insulating. One Hot Disk® sensor model 4922 with Kapton-insulation and cable for max 50 °C is included.
- **Hot Disk® sensor package – 60 mm diameter** – to support Hot Disk® sensor models 5599, and 7281 as well as their associated Measurement Modules: Isotropic, Anisotropy, Slab, Thin-Film, Low-Density/Highly-Insulating. One Hot Disk® sensor model 5599 with Kapton-insulation and cable for max 50 °C is included.

The test and analysis software – included in the Hot Disk® Desktop App – for the TPS 1000 instrument incorporates tools for scheduled measurements, as well as for automatic ambient temperature control – with the latter set-up employing our temperature control unit accessories (e.g. Bath Circulator and Convection Oven). For precise ambient temperature readings, optional PT100 Temperature Sensors are also available. The TPS 1000 test and analysis software furthermore includes automated sensor switching functionality applying our Sensor Switch Unit accessories. It also incorporates tools for exporting measurement data and results to xlsx- or txt-files, for further processing or more advanced statistical analysis. In addition, with the optional Automation Module it is possible to remotely control the TPS 1000 instrument. This facilitates isolation of the testing set-up from the operator, particularly useful for QC-testing at robotic-controlled production line applications.

TPS 1000 Specifications¹

Basic Configuration

Measurement

Sample Types	
One-Dimensional testing	Rods.
Specific Heat Capacity testing	Bulks, rods, slabs, wafers, sheets, foils, laminates, composites, minerals, batteries, pellets, granules, beads, grains, powders, pastes, creams, gels, and liquids.
Evaluation	
Anisotropy	No.
One-Dimensional	Yes, axial estimations possible for a complex sample configuration.
Sample Dimensions	
Smallest	Rod sample: 10 mm long x 4.5 mm wide (circle or square) for One-Dimensional testing (using Hot Disk [®] sensor 7577).
Largest	Rod sample: unlimited length x 60 mm wide (circle or square) for One-Dimensional testing (using Hot Disk [®] sensor 5599).
Sample Temperature Range	-100°C to 750°C.
Core Instrument	RT.
With Optional TCU	Cryostat: -100°C to RT 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 750°C. Tubular Furnace: RT to 750°C (gas purging for >400°C is recommended).
Measurement Time²	2.5 to 2560 seconds (depending on sample material and sensor dimensions).
Measurement Range	
Thermal Conductivity	Rod sample: 1 to 500 W/m/K.
Specific Heat Capacity	Up to 5 MJ/m ³ /K.
Measurement Accuracy	
Thermal Conductivity	Better than 5%.
Measurement Reproducibility³	
Thermal Conductivity	Typically better than 2%.

Full Configuration

(With All **Hot Disk**[®] Sensor Packages):

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, 2D anisotropic (uniaxial) materials can be characterised, using Anisotropic Measurement Module.
One-Dimensional	Yes, axial estimations possible for a complex sample configuration.
Sample Dimensions	
Smallest	Bulk sample: 2 mm thick x 8 mm wide (circle or square). Rod sample: 10 mm long x 4.5 mm wide (circle or square). Slab sample: 100 µm thick x 15 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	-100°C to 750°C.
Core Instrument	RT.
With Optional TCU	Cryostat: -100°C to RT 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 750°C. Tubular Furnace: RT to 750°C (gas purging for >400°C is recommended).
Measurement Time²	2.5 to 2560 seconds (depending on sample material and sensor dimensions).
Measurement Range	
Thermal Conductivity	Bulk sample: 0.01 to 500 W/m/K. Rod sample: 1 to 500 W/m/K. Slab sample: 5 to 500 W/m/K.

Thermal Diffusivity	Thin film sample: 0.01 to 5 W/m/K.
	Bulk sample: 0.01 to 300 mm ² /s.
	Rod sample: 1 to 300 mm ² /s.
	Slab sample: 5 to 300 mm ² /s.
	Thin Film sample: 0.02 to 2 mm ² /s.
Thermal Effusivity	20 to 40000 W√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 0.08% (Stainless Steel bulk sample, Kapton-insulated Hot Disk [®] sensor model 5501, and 22°C sample temperature).
Thermal Diffusivity	Typically 0.29% (Stainless Steel bulk sample, Kapton-insulated Hot Disk [®] sensor model 5501, and 22°C sample temperature).
Measurement Sensitivity⁵	
Temperature	Typically 18 μK (Stainless Steel sample, Kapton-insulated Hot Disk [®] sensor model 5501, and 22°C sample temperature).

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.

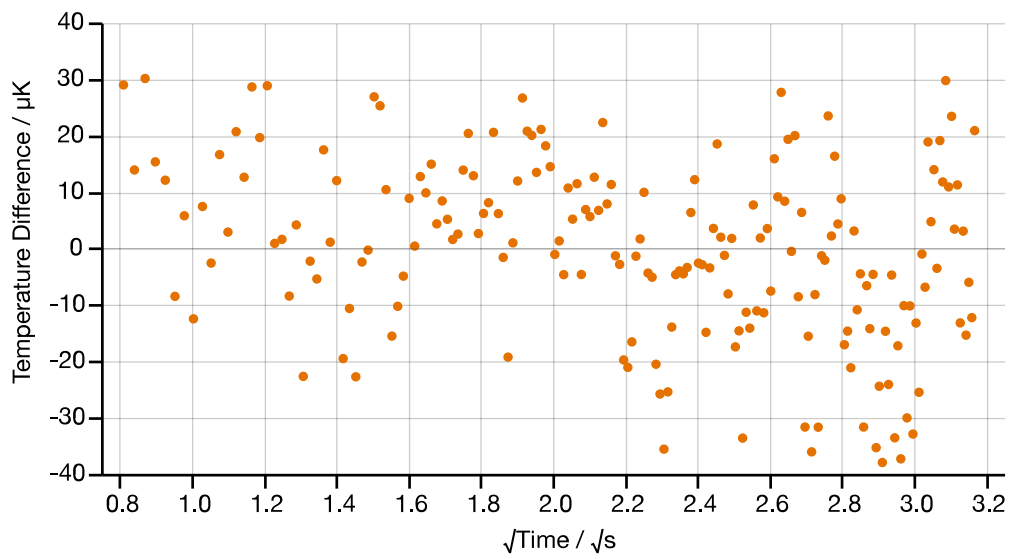
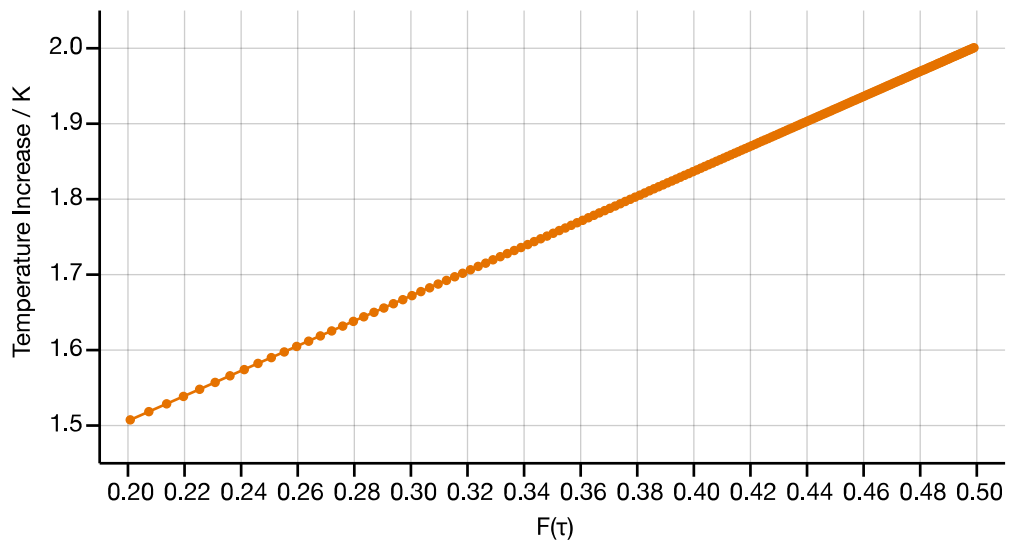
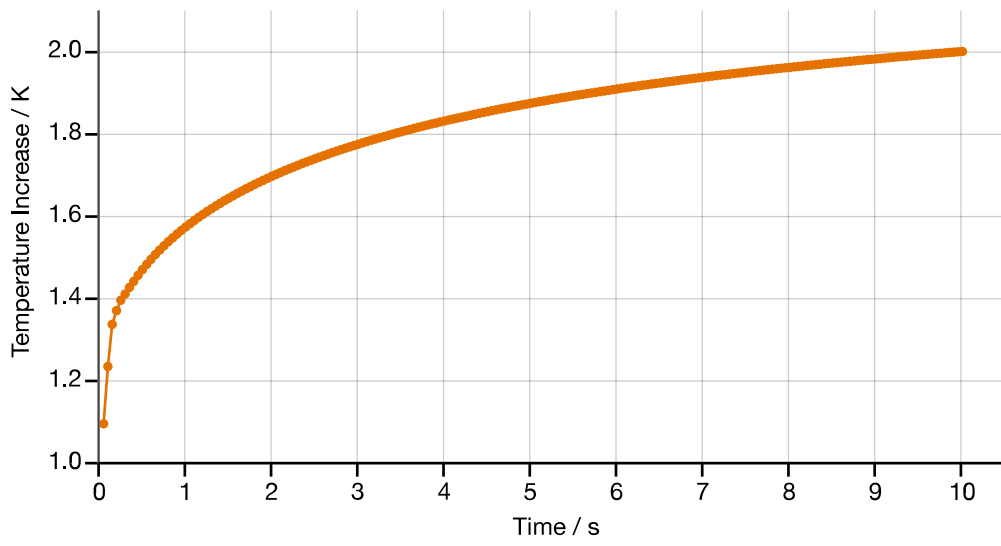
General

Meets ISO Standard 22007-2	Yes.
Measurement Modules	
Included	Single-Sided Testing, One-Dimensional, and Specific Heat Capacity (Hot Cell [®] sensor optional).
Optional	Isotropic, Anisotropic, Slab, Thin Film, Low-Density/Highly Insulating, and Automation.
Sensor Models	
Hot Disk [®] sensor – Kapton-insulated	Models 7577, 5465, 5501, 8563, 4922, and 5599.
Hot Disk [®] sensor – Teflon-insulated	Models 7577, 5465 and 5501.
Hot Disk [®] sensor – Mica-insulated	Models 5465, 5082, 4921, 4922, and 5599.
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	59 W typical, 315 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 490 mm deep.
Instrument Weight	28 kg.
Instrument CE Marking	Yes.

TPS 1000 Measurement Demonstration

Stainless Steel

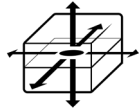
Sample	
Material	Stainless Steel, AISI 316/316L.
Type	Bulk.
Temperature	23°C
Measurement Parameters	
Measurement Module	Isotropic.
Sensor Model	Kapton-insulated Hot Disk® sensor 5501 (radius 6.4 mm).
Measurement Time	10 s.
Heating Power	800 mW.
Measurement Results	
Data Points	13-200.
Thermal Conductivity	13.61 W/m/K.
Thermal Diffusivity	3.673 mm ² /s.
Specific Heat Capacity	3.705 MJ/m ³ /K.
Probing Depth	12.1 mm.
Temperature Increase	0.5046 K.
Standard Deviation in Fitting $\Delta T(\tau)$	16 μ K.



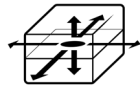
Included with the TPS 1000 Instrument (Basic Configuration)

- 3 x Measurement Modules: Single-Sided Testing, One-Dimensional, and Specific Heat Capacity.
- 1 x Kapton-insulated Hot Strip[®] sensor: Model 101474, with cable (Kapton-insulated Hot Disk[®] sensors: Models 5465, 5501, or 8563, with cable, optional).
- Hot Disk[®] Desktop App software (latest version).
- 1 x Aluminum or Brass 1D verification sample (Stainless Steel verification bulk sample optional).
- 1 x Single-sided background insulation (single-sided testing).
- 1 x Room temperature sample holder (protective hood optional).
- Instructions manual.
- Instrument test protocol.
- Power supply cord and USB cable.

Available measurement modules for the TPS 1000



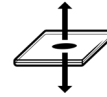
Isotropic
(Standard)



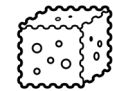
Anisotropic



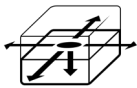
Slab



Thin Film



Low-Density /
Highly-Insulating



Single-Sided
Testing



One-Dimensional



Specific Heat
Capacity



Automation

Available sensors for the TPS 1000



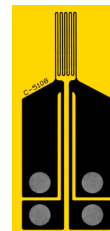
Kapton-insulated
Hot Disk® sensor
Models 7577,
5465, 5501, 8563,
4922, and 5599.



Teflon-insulated
Hot Disk® sensors
Models 7577,
5465 and 5501.



Mica-insulated
Hot Disk® sensors
Models 5465, 5082,
4921, 4922, and 5599.



Kapton-insulated
Hot Strip® sensor
All models.
(Works only with the
One-Dimensional
Measurement Module.)



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.



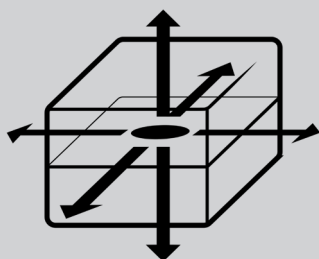
TPS 1000
For cost-effective quality assurance.

Notes

Hot Disk®

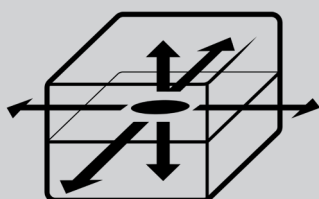
Measurement Modules

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.



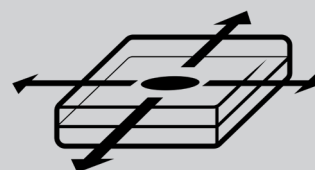
Isotropic (Standard)

All-round testing of bulk samples.



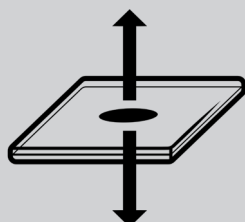
Anisotropic

Testing samples with direction dependent properties.



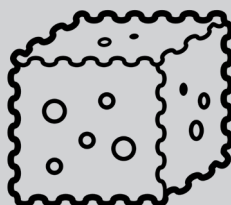
Slab

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.

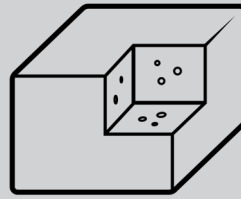


Specific Heat Capacity

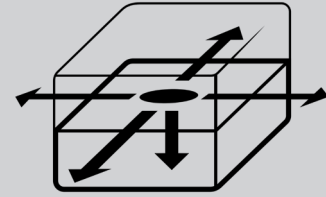
Testing Cp of complex samples and batteries.



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

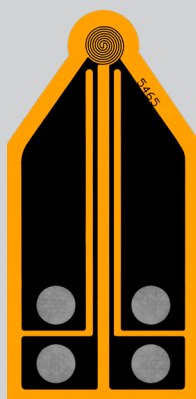
Hot Disk[®] Sensors

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.



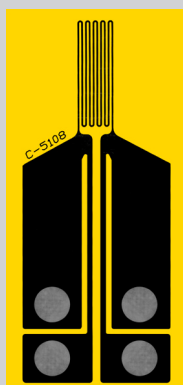
Kapton-insulated
Hot Disk[®] sensor



Teflon-insulated
Hot Disk[®] sensors



Mica-insulated
Hot Disk[®] sensors



Kapton-insulated
Hot Strip[®] sensor



Aluminium & Gold
Hot Cell[®] sensors



Notes

Hot Disk[®]

Johanneberg Science Park
Sven Hultins Gata 9 A
412 58 Gothenburg
Sweden

+4631 411 410
www.hotdiskinstruments.com
info@hotdiskinstruments.com

