Conforms to ASTM D7984, D5334 and D5930

SIMPLIFYING Thermal Conductivity (*k*)

FAST, ACCURATE TESTING
0 to 500 W/mK in seconds

WIDE TEMPERATURE RANGE
-50 ˚C to 200 ˚C
With option to extend to 500 °C

NO SAMPLE PREPARATION
Unlimited sample size

NON-DESTRUCTIVE
Leaves sample unaltered

EASY-TO-USE
“Plug & Play” testing

HIGHLY VERSATILE
Tests solids, liquids, powders and pastes

C-THERM TCi™
Thermal Conductivity Analyzer

ALSO PROVIDES: EFFUSIVITY | DIFFUSIVITY | HEAT CAPACITY | DENSITY

SIMPLIFYING

THERMAL CONDUCTIVITY

C-Therm's patented sensor technology makes thermal conductivity simpler and more accessible to measure. There is simply no faster or easier way to measure thermal conductivity and effusivity.

With the C-Therm TCi there is no complex regression analysis necessary as with other transient methods. No special sample preparation is required and there is no need to measure additional sample material properties such as heat capacity.

The TCi is provided with one versatile sensor for testing all types of materials; including solids, liquids, powders and pastes. A second sensor can be added for increased capacity.

C-Therm TCi pictured with TLS sensor (left) and patented MTPS sensor (right).

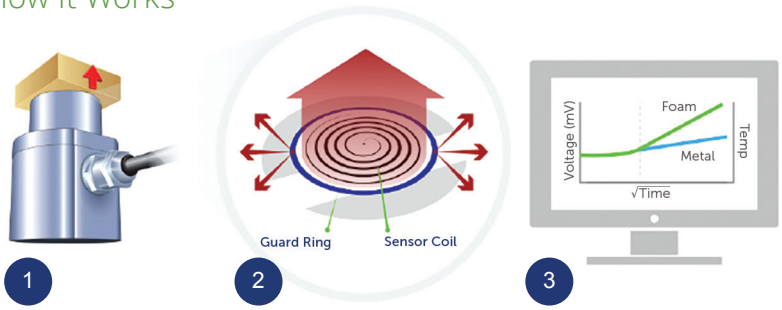
The testing procedure is noninvasive; samples remain unaltered and reusable. The system offers users exceptional versatility in being able to operate in a variety of environments, including thermal chambers, high pressure vessels and glove boxes. Fast and accurate testing made easy!

Principles of Operation - MTPS

The C-Therm TCi's default configuration employs the patented Modified Transient Plane Source (MTPS) technique. The one-sided, interfacial heat reflectance sensor applies a momentary constant heat source to the sample. Thermal conductivity and effusivity are measured directly, providing a detailed overview of the thermal characteristics of the sample.

MTPS GUARD RING TECHNOLOGY

How It Works



The TCi is factory-calibrated for directly measuring both thermal conductivity (k) & thermal effusivity:

k & $\text{Effusivity} = \sqrt{k\rho c_p}$

Thermal Conductivity

Where:
k = thermal conductivity (W/m • K)
ρ = density (kg/m³)
c_p = heat capacity (J/kg • K)

1. A known current is applied to the sensor's spiral heating element, providing a small amount of heat.
2. The sensor's guard ring is fired simultaneously supporting a one-dimensional heat exchange between the primary sensor coil and the sample. The current applied to the coil results in a rise in temperature at the interface between the sensor and sample, which induces a change in the voltage drop of the sensor element.
3. The increase in temperature is monitored with the sensor's voltage and is used to determine the thermo-physical properties of the sample. The thermal conductivity is inversely proportional to the rate of increase in the sensor voltage (or temperature increase). The voltage rise will be steeper for lower thermal conductivity materials (e.g. foam) and flatter for higher thermal conductivity materials (e.g. metal). Results are reported in real-time making thermal conductivity measurement fast and easy.

MODULAR

SCALABLE SOLUTIONS

ACCESSORIES

Compression Test Accessory (CTA)

Compression of sample material increases the density and impacts the effective thermal conductivity of the material. It is important that the level of compaction is controlled and representative of the application conditions of the material. C-Therm's Compression Test Accessory (CTA) enables researchers testing such materials to precisely control the densification in providing highly reproducible results that better reflect the effective thermal conductivity. The CTA is particularly recommended to users testing textiles/fabrics, insulation batting, thermal interface materials, and powders.

High Pressure Cell (HPC)

C-Therm offers a range of high pressure cells to safely characterize the thermal conductivity of samples under elevated pressure environments up to 2000 PSI (~138 bar). C-Therm's HPCs are popular with researchers in the Oil & Gas, Nuclear and Fuel Cell industries.

Tenney Jr. Thermal Chamber

The TPS Tenney Jr. Thermal Chamber is recommended to users who wish to measure the thermal conductivity at non-ambient temperatures, from -50ºC to 200ºC.

Small-Volume Test Kit (SVTK)

The Small-Volume Test Kit was originally developed with the US Navy Surface Warfare Division specifically for testing energetic materials. The effectiveness of the accessory in reducing convection effect on testing samples make it ideal for characterizing the thermal conductivity of liquid samples. The SVTK is commonly applied in testing nano and heat transfer fluids, as well as emulsions.

TRANSIENT LINE SOURCE (TLS) MODULE

C-Therm's TCi can be configured with a Transient Line Source (TLS) Needle Probe Sensor.

TLS sensors are suitable for testing a wide range of materials including plastic resins, melts, slurries, pastes, paints, thermal interface materials, foodstuffs, powders and soils.

Test method: Transient Line Source (TLS)

Standards: ASTM D5334, D5930 and IEEE Std 442-1981

Needle length: 150 mm

Thermal Conductivity Range: 0.1 to 6 W/m.K

Temperature Range for Needle: -55 to +180 °C

VERSATILE

EASILY TEST SOLIDS, LIQUIDS, POWDERS AND PASTES

APPLICATIONS

- Thermal Interface Materials
- Heat Transfer Fluids
- Explosives
- Batteries
- Textiles
- Geological
- Thermoelectric
- Thin Films
- Rubber and Polymers
- Nanomaterials
- Concrete and Asphalt
- Insulation
- Oil & Gas
- Nuclear
- Metal Hydrides
- LED Lighting
- Automotive

Solids: Conductive Polymers

C-Therm has provided a breakthrough in the characterization of critical performance attributes of conductive polymers used in electronics and automotive industries. The main advantage the technique offers is the flexibility to test a wide range of sample geometries. As an example, clients at a large polymer producer use the test samples from their tensile testing regimen to also test the in-plane and through-plane thermal conductivity with the C-Therm TCi. There is no longer the need to destructively machine or form specific sample sizes/dimensions to test thermal conductivity!

Powders: From Explosives to Ink Toners

The C-Therm TCi is being used to safely test the stability, degradation, and shelf life of explosives because it is the only instrument engineered for evaluating the thermal conductivity of powders safely. Sample volumes are as small as 1.25 ml. This is also critical to a rapidly growing client base in metal hydrides, where materials are expensive and available in low quantities. The technology is also migratable to manufacturing environments as a cost-effective way to monitor powder processes for moisture and homogeneity.

Pastes: Keeping the Hottest Electronics Cool

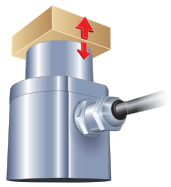
The faster and smaller microprocessors become, the more heat they generate. C-Therm's TCi is providing vital insights into the development of all materials that contribute to the overall thermal budget, including thermal interface materials such as thermal grease and gap pads. These materials are typically compressible and the thermal conductivity varies with changes in the densification of the material. Clients use the C-Therm Compression Test Accessory (CTA) to precisely control the compaction of the sample in producing results reflective of the actual application conditions for the material.

Liquids: Under Pressure

The C-Therm TCi is helping manufacturers improve the heat transfer properties of liquids. C-Therm is unique in offering the capability to accurately measure the thermal conductivity of liquids; the short test time (<1 second) and small sample volume requirements negate the convective errors typical in liquid testing with traditional techniques. As an example, clients in the Oil & Gas field use C-Therm's High Pressure Cell (HPC) accessory in measuring the impact of elevated atmospheric conditions and temperature on the thermal conductivity of fluids.

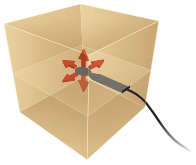
COMPARISON

FASTER, EASIER, MORE VERSATILE

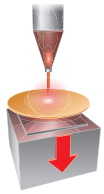


C-Therm TCi
(Modified Transient Plane Source)

Guarded Hot Plate



Transient Plane Source



LaserFlash Diffusivity

SPEED & FLEXIBILITY				
Sample Preparation	None Required	Extensive	Some	Extensive
Testing Time	Seconds	Hours	Minutes	Hours*
Training Time	Minimal	Moderate	Significant**	Extensive
Non-Destructive	Yes	No	No	No
Method Development				
RANGE				
k-Range (W/mK)	0 – 500	0 – 2	0 – 100 (100 – 500 requires C_p)	0 – 500 (requires density & C_p)
Temperature Range (°C)	-50 °C to 200 °C With option to extend to 500 °C	-100 °C to 1400 °C	-100 °C to 700 °C	-150 °C to 2800 °C
SAMPLE CONFIGURATION				
Minimum	0.67" diameter (17 mm)	6" x 6" (150 x 150 mm)	Two Identical Samples 1" x 1" (25 x 25 mm)	0.5" diameter (12.4 mm) 0.004" thick (1 mm)
Maximum	Unlimited	24" x 24" (600 x 600 mm)	Two Identical Samples Unlimited	0.5" diameter (12.4 mm) 0.004" thick (1 mm)
Material Testing Capabilities	Solids, Liquids, Powders, Pastes	Solids	Solids, Liquids	Solids
PRICING	$	$ $	$ $	$ $ $

1 Based on publicly available information and feedback from users.
* Calculation of thermal conductivity from Laser Flash Diffusivity Measurement requires the additional following material properties: heat capacity (C_p) density, and coefficient of thermal expansion.
** Traditional Transient Plane Source requires iterative testing to obtain the correct experimental parameters in terms of power flux, test time, and sizing of sensor necessary to obtain accurate results.

PROVEN

For over twenty years, C-Therm's innovative sensor technology has been pioneering the way for many of the world's most prominent manufacturers, research facilities, and academic institutions to test and measure thermal properties of materials.

The technology behind the C-Therm TCi represents a paradigm shift in thermal conductivity measurement and earned the inventor behind the technology the Manning Innovation Principle Award and an R&D 100 Award. These coveted awards are given to the top global innovators, and place C-Therm in the distinguished company of such other winners as the developers of the ATM, Polaroid™ and anti-lock brakes.

Since its launch, C-Therm's unique technology has evolved to new levels of accuracy, speed, and flexibility. Today, it is being used around the globe for R&D, quality control, and on-line production monitoring in a wide range of industries.

C-THERM TCI SPECIFICATIONS	
Thermal Conductivity Range	0 to 500 W/mK
Test Time	0.8 to 3 seconds
Minimum Sample Testing Size	17 mm diameter
Maximum Sample Testing Size	Unlimited
Test Methods	Modified Transient Plane Source (MTPS) Transient Line Source (TLS)
ASTM	D7984, D5334, D5930
Minimum Thickness	Nominally 0.5 mm, dependent on thermal conductivity of material
Maximum Thickness	Unlimited
Temperature Range	-50 °C to 200 °C With option to extend to 500 °C
Precision	Typically better than 1%
Accuracy	Better than 5%
Extra Hook-Ups Required	None
Software	TECAS™ with Intuitive Windows®-based software interface. Easy export to Microsoft Excel®. Additional functionality offers indirect, user-input capabilities for a number of other thermo-physical properties including: Thermal Diffusivity, Heat Capacity, and Density.
Input Power	110-230 VAC 50-60 Hz
Certifications	FCC, CE, CSA

For more information, contact:

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COMPANIES AND ORGANIZATIONS USING C-THERM'S PATENTED TECHNOLOGY:

NASA
University of California (Berkely)
Philips
Kodak
Avery
3M
Philip Morris
Astra Zeneca
US Navy
Patheon
Universidade de Aveiro
Raytheon
Corning
Engelhard
Universidade Federal de Santa Caterina
Wyeth
Stowe Woodward
INSA
Dow Corning
Exxon Mobil
Hewlett Packard
NRC
Liberec University
National University of Singapore
Petrobas
Henkel
Nanocomposix
Canadian Explosives Research Lab