

# THERMAL CONDUCTIVITY ( $k$ )



## FAST, ACCURATE TESTING

0 to 120 W/mK in 5 seconds

## WIDE TEMPERATURE RANGE

-50° to 200°C

## NO SAMPLE PREPARATION

Unlimited sample sizes

## NON-DESTRUCTIVE

Leaves sample intact

## HIGHLY FLEXIBLE

Tests solids, liquids, powders and pastes

## EASY-TO-USE

No calibration required

## VERSATILE

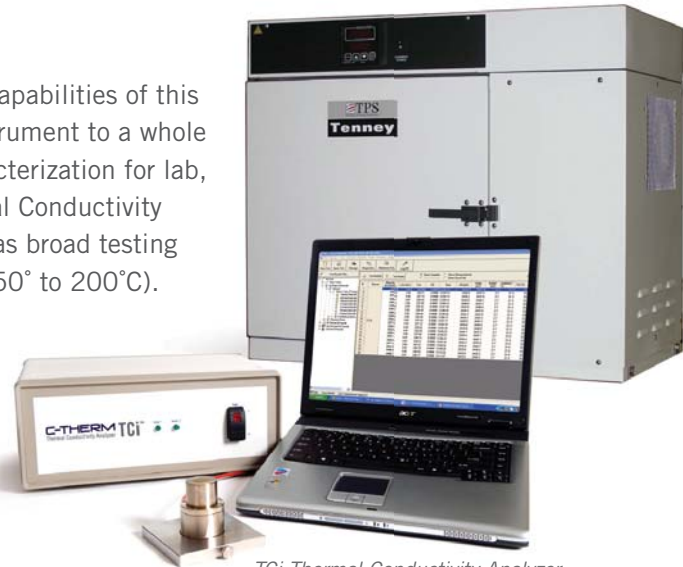
Compatible with various environments; thermal chambers, pressure vessels and glove boxes

**C-THERM TCI™**  
Thermal Conductivity Analyzer

# SIMPLE.

The third generation of C-Therm's patented technology expands the capabilities of this rapid, non-destructive thermal conductivity and effusivity testing instrument to a whole new level. Designed to provide simple, highly accurate thermal characterization for lab, quality control and production environments, the C-ThermTCi Thermal Conductivity Analyzer requires no calibration or sample preparation. The system has broad testing capabilities (0 to 120 W/mK) across a wide range of temperatures (-50° to 200°C).

The TCi can be equipped with one or two sensors for increased capacity, and provides accurate thermal analysis of solids, liquids, powders and pastes in less time than any other instrument – less than 5 seconds. And because the procedure is non-destructive, samples remain intact, undisturbed and reusable after testing. The sensors offer users exceptional versatility in being able to operate in various environments, including thermal chambers, high pressure vessels and glove boxes.



TCi Thermal Conductivity Analyzer shown with optional thermal chamber

## Principles of Operation

The C-Therm TCi is based on the modified transient plane source technique. It uses a one-sided, interfacial, heat reflectance sensor that applies a momentary, constant heat source to the sample.

Both thermal conductivity and effusivity are measured directly and rapidly, providing a detailed overview of the thermal characteristics of the sample material.

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

Where:

$k$  = thermal conductivity (W/m • K)

$\rho$  = density (kg/m<sup>3</sup>)

$c_p$  = heat capacity (J/kg • K)

## How It Works

Sample material can be a solid, liquid, paste or powder.

A known current is applied to the sensor's heating element providing a small amount of heat.

The heat provided results in a rise in temperature at the interface between the sensor and the sample - typically less than 2° C.

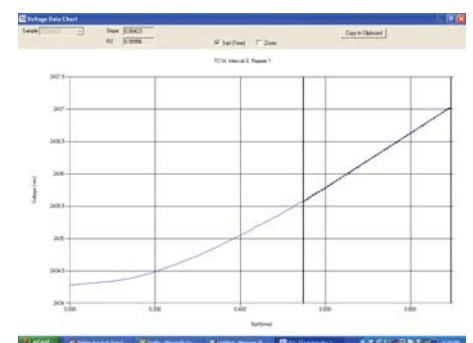
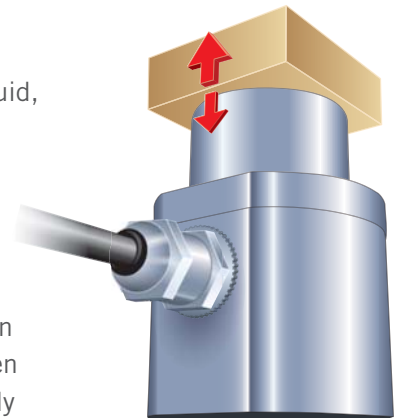
This temperature rise at the interface induces a change in the voltage drop of the sensor element.

The rate of increase in the sensor voltage is used to determine the thermo-physical properties of the sample material.

The thermo-physical properties of the sample material are inversely proportional to the rate of increase in the sensor voltage.

The more thermally insulative the material is - the steeper the voltage rise.

Results are displayed on the system's laptop computer in real-time.



# FAST.



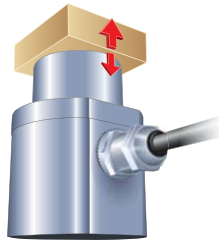
## FAST TEST PREPARATION – NO CALIBRATION OR SAMPLE PREP REQUIRED:

A key advantage of the C-Therm TCi is the fact that it does not require time consuming calibration or sample preparation. The instrument comes fully calibrated from the factory. The auto-test function even allows hands-free testing at pre-determined intervals.

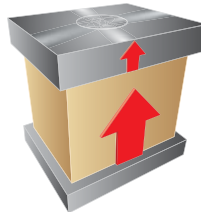
**RAPID TESTING – 0 TO 120 W/MK IN SECONDS:** The C-Therm TCi helps you accelerate your research and development processes and also is fast enough to migrate from the lab to the production floor as a powerful quality control tool. Test times are less than a second. The high accuracy, precision instrument provides a powerful and versatile addition to your material characterization tools.

**ADD A SECOND SENSOR FOR INCREASED TESTING CAPACITY:** The C-Therm TCi can be equipped with a second sensor, allowing you to double your throughput. With its rapid testing capabilities, and two sensors, the C-Therm TCi provides real-time thermal characterization for a wide range of materials.

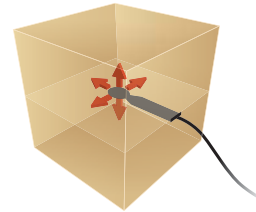
## Comparison to Other Methods: Faster, Easier, & More Versatile



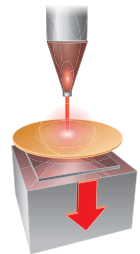
**C-Therm TCi**  
(Modified Transient Plane Source)



**Traditional Guarded Hot Plate**



**Transient Plane Source**



**LaserFlash Diffusivity**

SPEED & FLEXIBILITY				
Sample Preparation	None Required	Extensive	Some	Extensive
Testing Time	Seconds	Hours	Minutes	Seconds*
Training Time	Minimal	Moderate	Significant	Extensive
Non-Destructive	Yes	No	No	No
Integrated, Downloadable Test Results Database	Yes	No	No	No
RANGE				
k-Range (W/mK)	0 – 120	0 – 2	0 – 100 (100 – 500 requires C <sub>p</sub> )	0 – 500
Temperature Range (°F) (°C)	-58° to 392°F -50° to 200°C	-148° to 1292° F -100° to 700° C	-148° to 2552°F -100° to 1400°C	-238° to 5072° F -150° to 2800° C
SAMPLE CONFIGURATION				
Minimum	0.67" diameter (17mm)	6" x 6" (150 x 150mm)	Two Identical Samples 1" x 1" (25 x 25mm)	0.5" diameter (12.4mm) 0.004" thick (1mm)
Maximum	Unlimited	24" x 24" (600 x 600mm)	Two Identical Samples Unlimited	0.5" diameter (12.4mm) 0.004" thick (1mm)
Material Testing Capabilities	Solids, Liquids, Powders, Pastes	Solids	Solids, Liquids	Solids
PRICING	\$	\$ \$	\$ \$	\$ \$ \$

<sup>1</sup> Based on publicly available information and feedback from users.

\* Calculation of thermal conductivity from Laser Flash Diffusivity Measurement requires heat capacity (C<sub>p</sub>) from Differential Scanning Calorimeter (DSC).

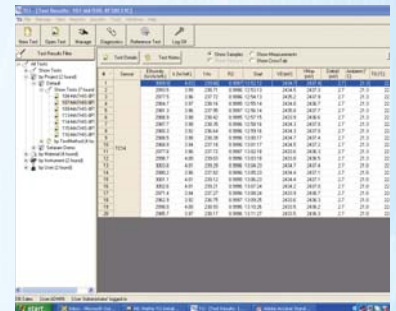


# EASY.

## Testing Made Simple – Start to Finish

C-Therm has made accurate thermal characterization of materials both fast and simple. The TCi eliminates the need for special training, pain-staking calibration, or extensive sample preparation. The system includes a laptop with C-Therm's intuitive, Windows®-based software interface and a full relational database with importing and exporting capabilities. Downloading your results to Excel® is a snap.

### 4 Simple Steps:



**1** PLACE SAMPLE ON THE SENSOR  
1 SEC

**2** CLICK ON THE SOFTWARE  
2 SEC

3 SEC

**4** REVIEW THE RESULTS  
4 SEC  
5 SEC

The C-Therm TCi features multiple graphical and tabular display options, and provides direct, indirect\* (calculated), and user input\*\* capabilities for a number of thermal testing properties, including:

**THERMAL CONDUCTIVITY**  
EFFUSIVITY • DIFFUSIVITY\* • HEAT CAPACITY\* • DENSITY\*\*

## WHAT OUR CUSTOMERS ARE SAYING

“The main benefit of the TCi to our testing lab is its **ease of use and short test times**. It allows us to get **accurate results** as quickly as possible and with excellent repeatability. Our test times are only a fraction of what they are using steady state methods. Equally important, the service level from the staff at C-Therm has exceeded our expectations.” - *Dr. Ernest Wolff, CEO, PMIC Lab (Sector: Contract Lab)*

“We wanted something that was going to measure small volumes and do it in a rapid and easy format and the TCi Thermal Conductivity instrument was perfect for our needs. The thing I like most about the TCi is it is extremely easy to use.” - *Dr. Steven Oldenburg, CEO, NanoComposix (Sector: NanoMaterials)*

“The **outstanding technical support** and fundamental understanding of the mathematics and engineering complexities of heat transfer issues has greatly impressed me. I am very pleased with the financial and scientific value of the TC technology.”  
- *Keith Kociba, Research Chemist, Lubrizol, Cleveland, OH (Sector: Petroleum)*

*Dr. Steven Oldenburg, CEO, NanoComposix, (Sector: nano materials)*



# VERSATILE.



The C-Therm TCi is truly a “one size fits all” thermal conductivity tool. No other instrument can test solids, liquids, powders, and pastes. Within a material type, the technology has the attributes necessary as a lab tool to accelerate your research & development efforts or improve your quality control. As an added bonus, the technology can be migrated to the shop floor to gain insights into your production processes.

## SOLIDS

### Taking Ceramics to New Heights

C-Therm has provided a breakthrough in the characterization of critical performance attributes of ceramics used for aerospace applications. The main advantage for solids applications is the simplicity of the sample format. The C-Therm TCi eliminates technician time required for sample preparation. The sample size flexibility allows the evaluation of actual product formats - avoiding the need for mocking-up samples.

## LIQUIDS

### Fluids That Take The Heat Off

The C-Therm TCi is helping manufacturers improve the heat transfer properties of advanced nano-filled liquids. For engineered liquids, the wide range of operating temperatures make the TCi an attractive solution. The low amount of heat introduced during testing and small sample volume requirements minimize the convective errors typical in liquid testing. Lab users can opt to test through a bag, while process users can measure directly in contact with the fluid in a vessel.



## POWDERS

### From Explosives to Pharmaceutical Excipients 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 capable of evaluating the thermal conductivity of powders. Sample volumes are as small as 1.85ml, which is critical to a rapidly growing client base in pharmaceutical manufacturing, where active ingredients are expensive and available in low quantities. The technology is also migratable to manufacturing environments as a cost-effective way to monitor powder processes.



## PASTES

### Keeping the Hottest Electronics Cool

The faster and smaller microprocessors become, the more heat they generate. C-Therm technology is providing vital insights into the development of all materials that contribute to the overall thermal budget, including thermal interface pastes and compounds. By altering the calibration timing parameters the C-Therm TCi allows testing with different amounts of heat penetration. This feature results in a variable scale of scrutiny to probe the material to ensure the homogeneous distribution of vital filler components.



**Modular System to Meet Your Needs** The C-Therm TCi can be configured to meet your specific requirements, based on the materials you are testing. Modules for solid, liquid, powder and paste testing are available with the base unit and controlled through the systems calibration settings. The modular system offering enables clients to access the most advanced thermal conductivity testing capability at minimal budget and to scale their investment specifically to their testing requirements.

# PROVEN.



For over a decade, C-Therm's innovative sensor technology has been pioneering the way many of the world's most prominent manufacturers, research facilities, and academic institutions test and measure thermal properties of solids, liquids, powders and pastes. 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 international awards are given to the top innovators worldwide, and puts C-Therm in the distinguished company of other winners, including developers of the ATM, Polaroid film, 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 to ensure specifications compliance in a wide range of industries.

## C-Therm TCi Specifications:

Thermal Conductivity Range	0 to 120 W/mK
Test Time	0.8 to 5 seconds
Minimum Sample Testing Size	17mm (0.67") diameter
Maximum Sample Testing Size	Unlimited
Minimum Thickness	Nominally 0.02" (0.5mm), dependent on thermal conductivity of material
Maximum Thickness	Unlimited
Temperature Range	-50° to 200°C (-58° to 392°F)
Precision	Better than 1%
Accuracy	Better than 5%
Extra Hook-Ups Required	None
Software	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: <ul style="list-style-type: none"><li>• Thermal Diffusivity</li><li>• Heat Capacity</li><li>• Density</li></ul>
Input Power	110-230 VAC 50-60 Hz
Certifications	FCC, CE, CSA

For more information about the C-Therm TCi Thermal Conductivity Analyzer, contact:



North America: 1-877-827-7623

Worldwide: 1-506-457-1515

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## Companies and Organizations using C-Therm's patented technology:

IBM  
Whirlpool  
Pioneer  
General Electric  
Kodak  
Avery  
3M  
Philip Morris  
Astra Zeneca  
US Navy  
Patheon  
Wyeth  
Corning  
Engelhard  
Raytheon  
Stowe Woodward  
Dow Corning  
Exxon Mobil  
Hewlett Packard  
NRC