DynTIM

DynTIM is a high precision test environment designed to measure the bulk thermal conductivity of thermal interface materials, in connection with T3Ster, our leading thermal transient testing solution. The system is mainly designed for the measurement of soft materials, such as thermal greases and compressible pads, however with some additional considerations, the test of adhesives and solid samples is also possible.

Overview of operation

Using DynTIM the material to be tested is placed to a realistic thermal environment, between a real diode package and a nickel plated copper cold-plate. The system can set up the distance of the two surfaces with a resolution of 1 micrometer in an automated way. This way the system can accurately control the BLT (BondLine Thickness) of the material under test.

The thermal conductivity of samples is calculated based on the change of the thermal resistance of the TIM as a function of its thickness. This idea resembles the ASTM D5470 standard, however the measurement of the temperature is carried out at semiconductor diode in the top grip. This fine temperature measurement (0.01°C temperature resolution) and the calculation of the applied power based on accurate electrical parameters is responsible for the high repeatability of the testing solution.

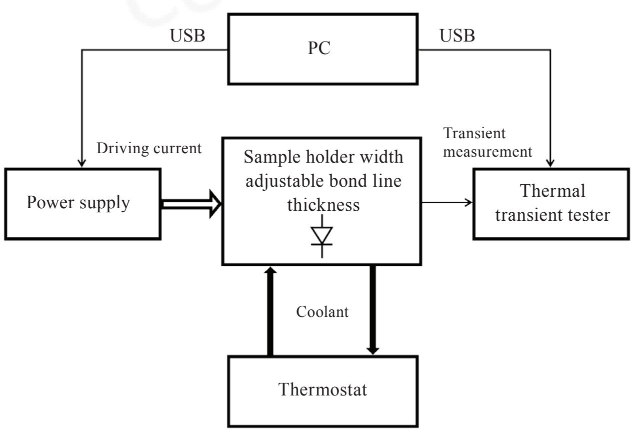

Figure 1: Schematic of the measurement system

By plotting the measured thermal resistance values as a function of the distance between the measurement surfaces, the thermal conductivity of the TIM is inversely proportional to the slope of the resulting curve based on the following equations:

$$k = \frac{\Delta L}{\Delta R_{th}} \cdot \frac{1}{A} = \frac{1}{m \cdot A} \qquad (1)$$

$$m = \frac{\Delta R_{th}}{\Delta L} \qquad (2)$$

where k is the calculated thermal conductivity of the material, L is the distance between the grips, R_{th} is the measured thermal resistance , A is the contact area and m is the slope.

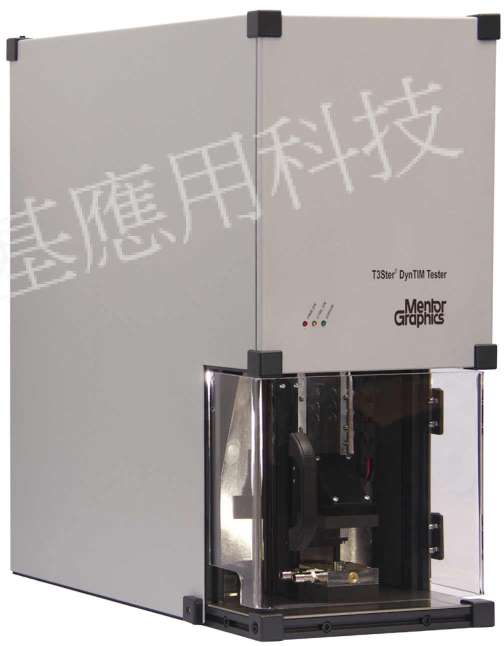

Figure 2: T3Ster DynTIM Tester

DynTIM takes advantage of T3Ster's high temperature measurement accuracy, therefore it always requires one for its operation. A current source required for heating up the diode is built into DynTIM itself. The control of T3Ster is realized from DynTIM's own measurement control tool, in simple and automated way.

The bottom grip's temperature is maintained constant using a liquid circulator thermostat. DynTIM software can control major brands, such as Julabo, Cole-Parmer or Lauda models having RS-232 interface.

Measurement of different material types

Although determining the thermal conductivity based on the relationship between the thermal resistance and the varying bondline thickness is proven to be an accurate methodology, unfortunately changing the material thickness is not always possible. For this reason the ASTM standard differentiates between three different material types. DynTIM can handle the test of all three material types in the following way:

For Type I materials, such as greases and pastes, DynTIM realizes strict BLT control, without maintaining any pressure on the sample, assuming that due to its low viscosity, the excess material leaves the space between the grips as the BLT decreases during the test.

For Type II materials, viscoelastic solids, such as gap pads and gap fillers, BLT control with pressure limit is used, making sure that the material is kept at the target thickness. Setting up a pressure limit is important, so the system can identify the minimum achievable BLT corresponding to a given pressure level. Beside BLT controlled operation, pressure controlled operation is also an option.

For Type III materials, non-compressible solids, pressure control is used. This way the measurement of different samples at different thicknesses is possible, assuming that the contact resistances remain the same due to the comparable pressure at each tested thickness. The use of high conductivity thermal grease is recommended between the surfaces of the sample and the grips in order to reduce the contact resistances.

All these measurement modes are directly supported by DynTIM's measurement control software tool, all you need to do is to select the proper material type prior to the tests. In each of the three cases the measurement accuracy improves with the increase of the measurement points taken and also with the increase of the R_{th} difference between them.

In addition, by testing a wide range of TIMs, users can choose a narrowed selection of the best performing materials. Use in combination with T3Ster thermal characterization hardware to test the materials in-situ and in their target environment, for the best possible design decision.

Thermal conductivity data measured by DynTIM can also be applied to add thermal properties to simulation models in our CFD solutions, such as FloTHERM or FloEFD.

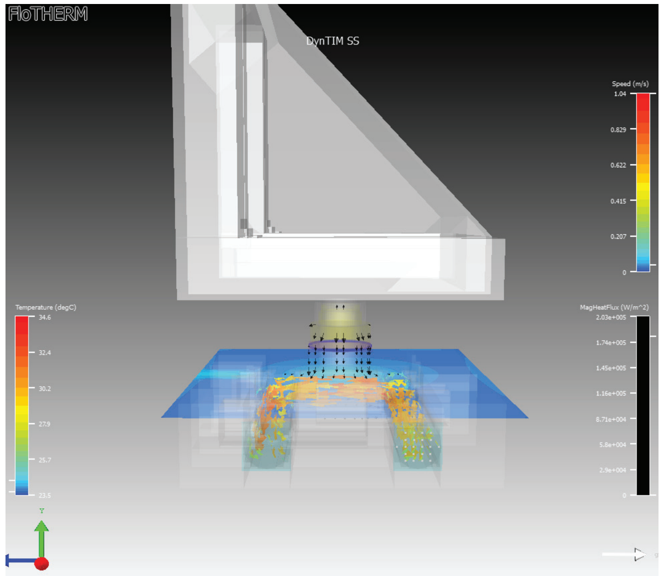

Figure 3: FloTHERM simulation showing the measurement grips of DynTIM and the heat-flux through the sample

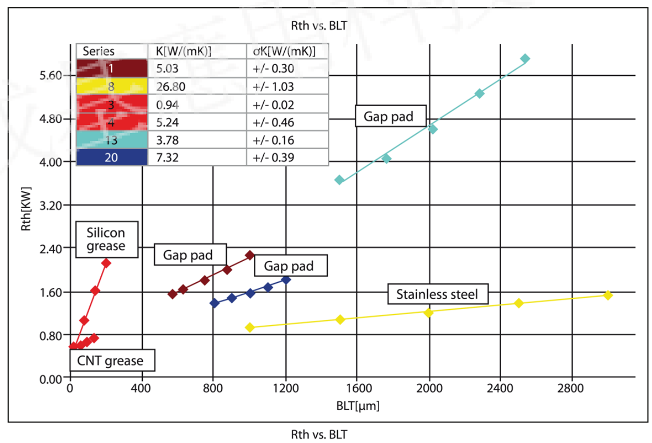

Figure 4: Measurement examples on all the 3 ASTM material types

T3Ster® DynTIM™ Tester - Technical Specifications

Feature	Value	Note
Sample size and shape	⃠ 12.5 mm, circular	
Sample resistance range	0.01..5 K/W	For highest measurement accuracy
Sample holder materials	Bottom: nickel plated copper, Top: copper	
Cold-plate temperature range	5-90 °C	Set by external fluid thermostat
Sample thickness range	0-70 mm	
Sample thickness setting resolution	1 µm	Measurement above 5mm thickness not recommended
Sample thickness setting accuracy	1 µm for Type I materials 5 µm for Type II materials	Thickness measurement of Type III materials is better than 10 µm
Temperature measurement resolution	0.01 °C	
Relative accuracy of derived heat conductivity	Typically better than 5%	For Type I materials
Pressure range	1060..3600 kPa	Measurement of Type I materials is carried out at 0 pressure
Pressure reading/setting accuracy	80 kPa	
Measurement modes	ASTM TYPE I materials : Bondline thickness control ASTM Type II materials: Bondline thickness control + pressure limit ASTM Type III materials: Constant pressure mode	Bondline thickness values set by the user in case of Type III materials
Data output	Raw data export: XML, CSV Report generation: HTML, Export conductivity value as a FloTHERM assembly	Raw measurement data can also be processed using T3Ster Master
Dimensions	(LxHxW) 590mm x 570mm x 260mm	
Weight	40 kg	
Supply voltage	100-230 VAC 50/60 Hz	
Additional hardware requirements	T3Ster unit Liquid circulator unit, min. 10 L/min, min. 10 W cooling capacity (Third party) PC running Windows XP/Windows 7 OS (Third party)	Thermostated circulator unit required for tests carried out at different than ambient temperatures Tubing not included, for assembly instructions refer to illustrated Quick Start Guide For the list of recommended third party elements, please contact your official Mentor Graphics partner

For the latest product information, call us or visit: www.mentor.com/mechanical

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