Hukseflux
Thermal Sensors

THASYS

THIN HEATER APPARATUS FOR THERMAL CONDUCTIVITY MEASUREMENT

THASYS offers measurement of the thermal conductivity or total thermal resistance of plastics, composites and electrical insulation / interface materials. THASYS works according to the ASTM 1114-98 standard; providing an accurate, fast, uncomplicated and absolute measurement. It consists of a Thin Heater Apparatus (THA01) and a Measurement and Control Unit (MCU). Employing a specially designed high accuracy thermopile sensor, THA01 can handle thin sample materials (typically 0.1 to 6 mm; 0.1 mm samples must be stacked). The method is considered superior to procedures according to ASTM D5470. Using a climate chamber a large temperature range can be covered, performing measurements at regular intervals. THASYS is fully PC controlled. For use with high thermal conductivity thin foil materials a different model, type THISYS, is available.

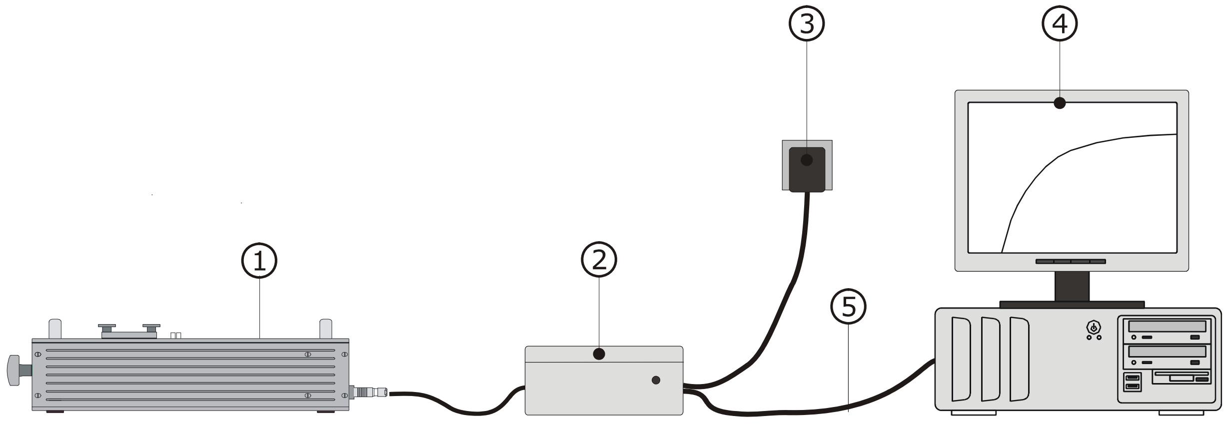

Figure 1 *THASYS consists of the Thin Heater Apparatus (THA01), (1) and a Measurement and Control Unit (MCU), (2). It is PC controlled through RS232 (4,5). The PC is not included. The measurement result appears on screen automatically. The THA01 housing contains two heat sinks in a bath of glycerol. It has a slot on top through which two equally thick samples are inserted. They are placed on either side of the thin heater. This heater also contains the hot joints of the thermopile sensor. The samples plus heater are then pressed together with the heat sinks using a screw on the side, creating a perfectly symmetrical setup. The glycerol fluid eliminates the problem of contact resistance.*

INTRODUCTION

For determining the thermal conductivity of materials various types of measurement equipment can be used. Proven methods are described in standards of the American Society for Testing and Materials (ASTM).

ASTM C 1114-98 " Standard Test Method" for "Thin Heater Apparatus" (THA) is a relatively new standard (1998) that offers the possibility to perform fast measurements with high accuracy, across a fairly large temperature range.
The THA principle relies on the fact that a thin heater has negligible lateral heat flow. With a combination of a very thin heater, two relatively thin samples of similar thickness and two heat sinks it is possible to generate a homogeneous thermal field with known heat flux through the samples.

By measuring the flux φ (derived from heater power), the differential temperature across the samples, ΔT_{amp}, and the effective sample thickness, H_{eff}, it is straightforward to calculate the thermal conductivity λ:

$$\lambda = \varphi \text{ Heff} / \Delta T_{amp}$$

The measurements of φ, H_{eff} and ΔT_{amp} are all direct measurements of power, dimensions and temperature. This is contrary to methods like the " guarded hot plate", that require reference materials or calibrated heat flux sensors. The THA provides an absolute instrument.

THA01 DESIGN

The technological novelties are a thin thermocouple thermopile (proprietary Hukseflux design) performing an accurate and ultra-

THA01 DESIGN (CONTINUED)

sensitive differential ΔT measurement, and the fact that the measurement is performed in a bath of glycerol. The latter reduces contact resistance and facilitates the THA operation.
Commonly used methods like ASTM D 5470 – 01 have shown to be highly sensitive to contact resistance. THASYS offers a solution to this problem.
The THA01 can handle samples of 0.1 to 6 mm thickness. Samples typically are sheet materials with a size of 70 by 110 mm.
The measurement accuracy depends on the total thermal resistance of the samples. In case of very thin samples (0.1mm), measurement accuracy is attained by “stacking”, i.e. using four or more samples instead of the usual two.
The measurement essentially is done at the temperature of the THA01. If necessary the temperature can be changed by putting the whole THA01 in a climate chamber, performing measurements while the instrument temperature changes across the required range. The thermopile is attached with its cold joints to one of the heat sinks. Its hot joints are incorporated in the thin heater. The samples are put in between the heat sinks and the heater. Errors due to contact resistance are minimized by using glycerol fluid. In a simplified description, the measurement consists of a heating cycle and a measurement to establish ΔT.

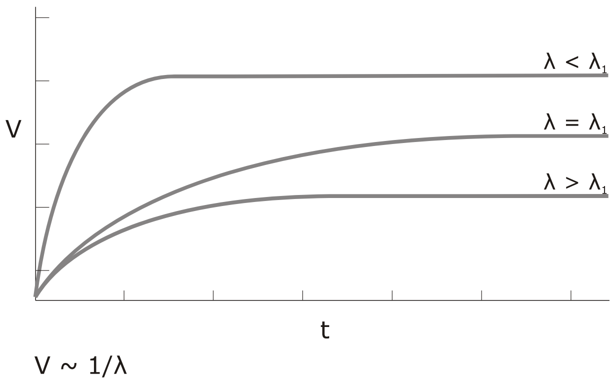

Figure 2 *Analysis of several samples of filled plastics using the THASYS. The graphs represent the signals when putting the heater on. The signal amplitude is inversely proportional to the thermal conductivity λ.*

MCU DESIGN

The MCU performs the functions of measurement and control as well as data storage. It is PC operated. Software in a Windows environment is part of the delivery. The parameters cycle time, sample thickness and heater area are entered and the experiment is started from the screen.

CALIBRATION

Verification of the stability can be done by repeated (yearly) testing of Pyrex 7740 samples that are included in the delivery. The calibration is traceable to NPL. THASYS is suitable for use by ISO certified laboratories.

MORE INFORMATION / OPTIONS

Please consult the manual for a full list of THA01 specifications. This manual is available free of charge as a PDF file via e-mail. The ASTM standard C1114-98 can be obtained from ASTM as a PDF file. A pressure cell is optional on THASYS. For use with high thermal conductivity materials the model THISYS is available.

SUGGESTED USE

- Plastics and composites thermal analysis
- Electrical interface materials

THA01 SPECIFICATIONS

Test method:	Test method ASTM C 1114-98
Sensitivity traceability (ΔT):	ANSI MC96.1-1982
Temperature range:	-30 to +120 °C
Accuracy (λ) (examples)	all @ 20 °C
@ H/λ> 15 10^{-3} m^2K/W:	+/- 3% (2 samples)
@ H/λ> 5 10^{-3} m^2K/W:	+/- 6% (2 samples)
@ H/λ> 5 10^{-3} m^2K/W:	+/- 3% (4 samples)
@ H/λ> 2.5 10^{-3} m^2K/W:	+/- 3% (6 samples)
@ H/λ> 2.5 10^{-3} m^2K/W:	+/- 3% (6 samples)
@ H/λ> 0.5 10^{-3} m^2K/W:	worse than 14 % (6 samples)
Repeatability (λ):	+/- 1% @ 20 °C
Total measurement time:	3000 s (typical)
Sample thickness:	H = 0.1 - 6 mm (see accuracy specs for stacking)
Sample surface A:	preferred: 70 x110 mm, always > 50 x 50 mm
Traceability:	NPL National Physical Laboratory UK
Pressure cell (optional):	200 N or max 80.0 kN/m^2

MCU SPECIFICATIONS

Differential temperature readout:	0.5 μV @ 0 - 30 °C
Pt100 readout:	+/- 0.2 °C @ 20 °C
Voltage input/output:	220-110 VAC / 15 VDC
Communication:	RS232