

## Transient Plane Source (TPS): Thermal Constants Analyser

The TPS is an instrument designed to non-destructively measure the thermal conductivity of solid and fluid materials in the range of 0.01 W/mK to 400 W/mK over temperatures ranging from -230°C to 400°C. Measurements can be performed under normal as well as under micro-gravity conditions. Materials studied so far with this system include metals, alloys, ceramics, minerals, polymers, thin films, composites, glass, fabrics, paper, glass wool, foams, powders, bio-materials - in vitro and in vivo, and liquids as well as materials with anisotropic thermal properties.



Main advantages of the system are the accuracy achieved, the flexible sample size and shape, the fact that it is an absolute method, and rapid testing.

### Principles

The basic TPS system operates on the principle of placing a thin TPS sensor between two pieces of the object or material being tested. The plane sensor consists of a Nickel double spiral (10  $\mu\text{m}$  thick) sandwiched between two thin electrically insulating sheets of material. This insulating material is a polyimide (Kapton) for temperatures from -230°C to 230°C+ and a Mica material from 230°C+. During a transient recording the sensor is electrically heated (from 0.5 K to 5 K) and at the same time the resistance or the temperature increase of the Nickel double spiral is monitored. The heat generated in the sensor is dissipating in all directions into the surrounding two sample pieces.

### Operation

The instrument is measuring the absolute values of the thermal conductivity and thermal diffusivity during a transient recording. From these results the specific heat is calculated. In order to extract these parameters from a single recording, the total time of the transient should be selected within a particular time window determined by the characteristic time (the square of the radius of the sensor divided by the diffusivity of the material being tested). The software provides automatically necessary indicators, telling that these requirements are fulfilled and that the experiment have been performed correctly. This interaction with the software, allows the operator to get a confirmation that the results are trustworthy.



In order to cover as large a range of materials as possible, sensors with different radii of the double spiral are available - standard values are 0.5, 3.3, 6.7, 9.8, 15 and 30 mm. In addition to select the **size** of the sensors, only the **power** and the **time** for the measurement have to be decided.

### Special Software Modules

*Thin films* for testing samples between 0.01 to 2 mm thick.

*Slab* for testing conductive sheets.

*Anisotropic* for testing directional thermal conductivity.

### Results

The TPS Thermal Constants Analyser provides information on the thermal conductivity for within-sample testing is +/- 2 % for the thermal conductivity.