

1. THERMAL CONDUCTIVITY SYSTEM (TCS)

a. Basic Method

Apparent thermal conductivity λ_{app} is measured by plate steady state method according to ASTM E 1225. A test specimen is inserted under load between two similar specimens of a material of known thermal properties. A temperature gradient is established in the test stack and heat losses minimized using a longitudinal guard having approximately the same temperature gradient conditions. At equilibrium conditions, the thermal conductivity is derived in terms of the temperature gradients in the respective specimens and the thermal conductivity of the reference materials. In addition, testing can be performed according to modified ASTM E 1225 (for vacuum conditions, for semitransparent materials) and to C 518 Steady State **Method**.

b. Testing Environment

The testing environment can be provided according to customer requirements by placing of the measurement cell in a vacuum, atmospheric or hermetically sealed chamber with a chosen gas environment. The geometry of the measurement cell can be adjusted to the size of the environmental chamber. *Note: Influence of any environment (very low and high gas pressure, aggressive gases, very low and high temperatures) can be also evaluated theoretically*

c. Special Features

Among the specific features of the proposed test method for semitransparent materials that allows to measure the radiative component of thermal conductivity λ_{rad} one can mention:

- The absorption and the scattering of radiation characteristics are measured;
- The surfaces of standards are treated in a special way to stabilise their surface radiative properties;
- Various mathematical models and software are developed depending on mechanisms of radiative heat transfer in homogenous absorbing materials (pure glasses, crystal materials), absorbing and scattering materials (porous ceramic, foam materials), materials with anisotropic scattering (fiber insulation) etc.;
- At the end of testing the following characteristics of the sample are available:
 - the apparent thermal conductivity,
 - the conductive and radiative thermal conductivities,
 - the characteristics of absorption and scattering of radiation in the specimens.

d. TCS Description

The system consists of a measuring cell, **system of power control**, and a computer system with interfacing board and specially developed software (see Fig. 1).

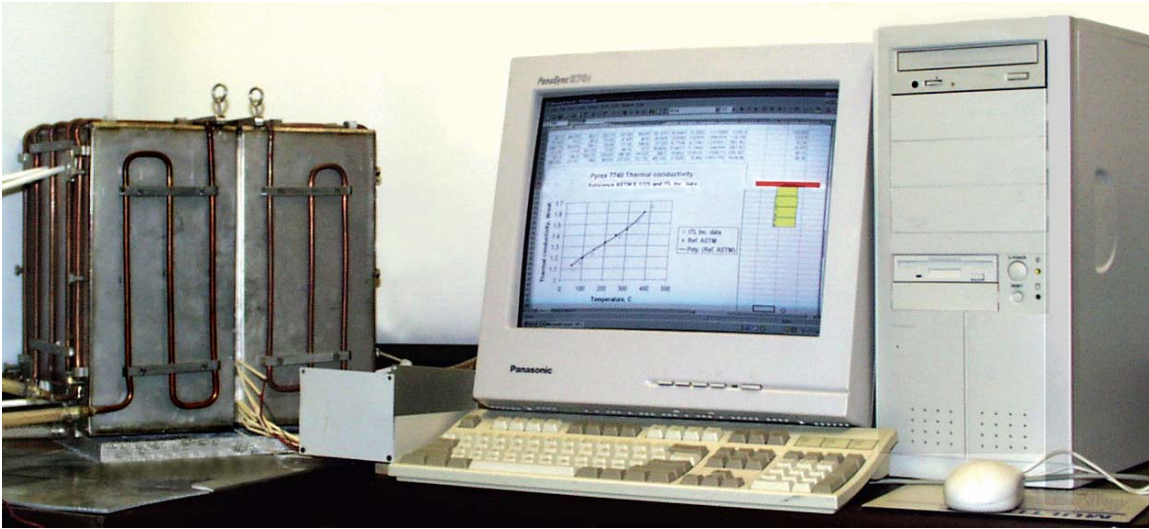


Figure 1 – System for measurement of thermal conductivity at atmospheric gas pressure. The 8A model is shown.

e. Application Notes

An example of application of the TCS system to measure the thermal conductivity of dense alumina samples is shown below.

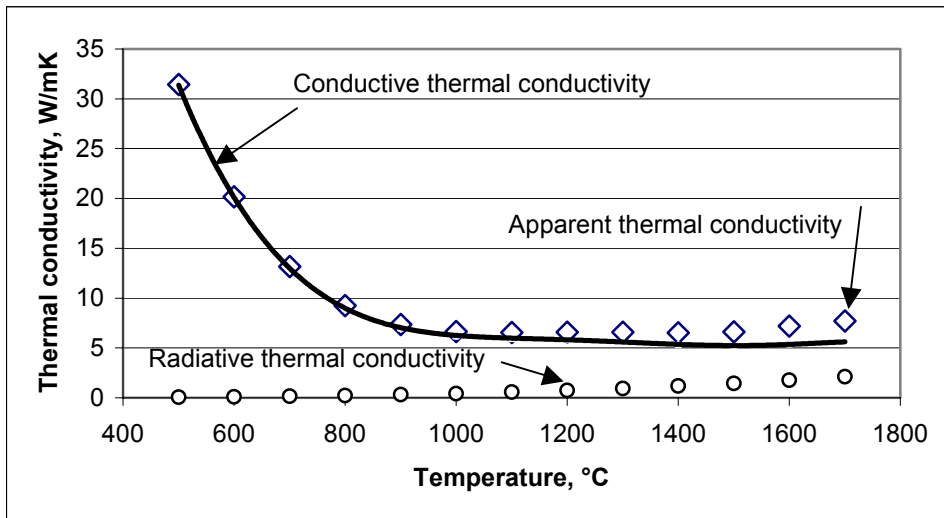


Figure 2 - Thermal conductivity of dense alumina [9].

Gas pressure p has a strong effect on thermal conductivity. The complicated behavior of thermal conductivity with temperature in a vacuum environment. **The gas pressure dependence of**

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thermal conductivity differs dramatically at low and high temperatures T . For an explanation of this phenomena and additional experimental data the reader is referred to Ref. [1, 4-8].

TCS Technical Data:

<i>Measurement range</i>	0.05-100 Wm ⁻¹ K ⁻¹
<i>Accuracy</i>	7 % (will be specified in accordance with the design)
<i>Temperature range:</i>	30-1200° C
<i>Productivity</i>	1-2 samples per day (depending on sample and other requirements)
<i>Working environment</i>	air, inert gas, vacuum according to customer specifications.
<i>Sample dimensions</i>	10- 30 mm thickness with any given shape.
<i>Type of Specimen Phase</i>	solids, powders, or liquid
<i>Specimens' Shape</i>	can be in the form of square plates or discs
<i>Sample preparation</i>	flat and cylindrical surfaces are acceptable, e.g. drill cores or grooves
<i>Geometrical dimensions of measurement cell:</i>	standard size 50x50 x15 mm. Note: the geometrical size of the measurement cell can be designed and adjusted according to customer specifications.
<i>Weight</i>	20-30 kg (for atmospheric gas pressure)
<i>Control</i>	Notebook or PC with Windows 95, 98, ME, 2000,NT ^(TM) , steering software with online help functions and

f. Advantages

TCS is fast:

- Up to 2 samples/points per day can be measured, depends on the temperature intervals and thermal conductivity, .

TCS is easy to use:

- the measurements are controlled by a PC or laptop computer.
- User-friendly software with online help functions.

TCS can use a variety of sample forms and shapes:

- no polishing, works on various types of surfaces.

TCS can measure semitransparent to IR radiation materials
