Testing and Analysis

Thermal Conductivity of Rubber and Plastic Materials

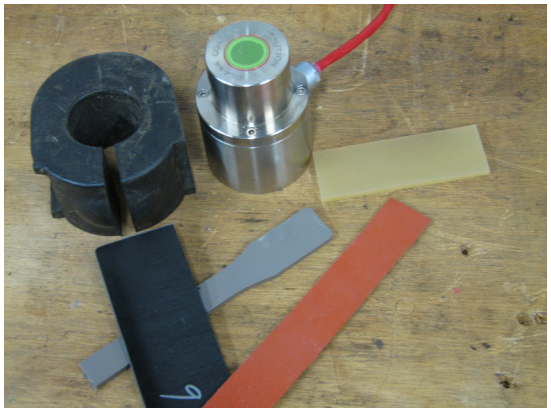

Figure 1, The TCi sensor surrounded by typical test specimens.

Introduction

Thermal conductivity, thermal diffusivity and specific heat are important material properties for engineering and analysis of rubber and plastic parts. At Axel Products, a transient plane source measurement technique is used to measure these properties for rubber and plastic materials.

There are many good techniques to measure thermal properties. Some are described by standards organizations and some are documented in the scientific literature. The primary reason that the transient plane source measurement technique is used at Axel Products is that this technique may be used on readily available material shapes. For example, rubber sheets used for other physical experiments and the ends cut off of plastic tensile specimens are typically acceptable material specimens (Figure 1). Specimens can often be cut from actual parts.

The instrument used at Axel Products is manufactured by C-Therm Technologies as the C-Therm TCi Thermal Property Analyzer. Although the instrument is capable of a broader range of measurements, testing at Axel Products is restricted to measurements of thermal conductivity below 10 W/mK.

The Transient Plane Source Technique

The TCi system measures thermal conductivity and effusivity of materials directly, based on the transient plane source method, and can provide user-inputted capabilities in the calculation of thermal diffusivity and heat capacity.

The system is comprised of a sensor, control electronics and computer software. The sensor has a central heater/sensor element in the shape of a spiral surrounded by a guard ring. The guard ring generates heat in addition to the spiral heater, thus approximating a one-dimensional heat flow from the sensor into the material. The voltage drop on the spiral heater is measured before and during the transient. The voltage data is then translated into the effusivity value of the tested material. The conductivity is calculated from the voltage data by C-Therm's patented iterative method.

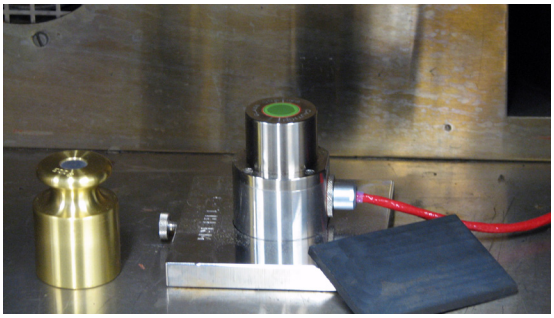

Figure 2, TCi sensor with test specimen and weight used to add contact pressure.

Data
By performing a separate material density experiment and providing the density value to the TCi, thermal conductivity, thermal diffusivity and specific heat can be reported(Figure 4).

Specimen Dimensions
One flat piece of the subject material, larger than 5 mm thick with a diameter larger than 30 mm. Thin materials may be stacked.

References
1. C-Therm TCi Principles of Operation, available at: www.axelproducts.com/pages/downloads.html

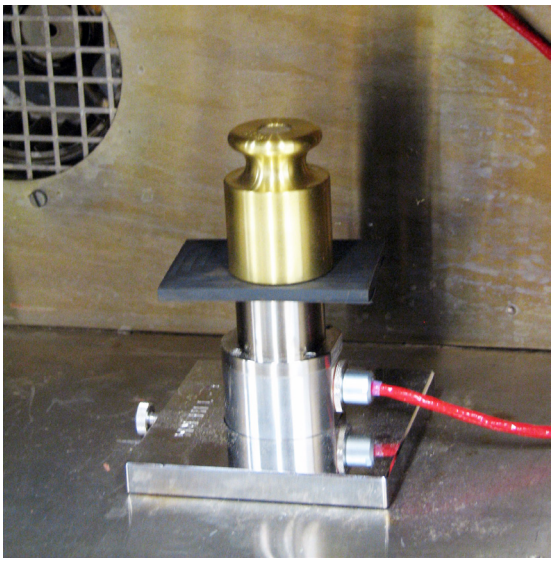

Figure 3, TCi sensor with specimen in testing position in an environmental box.

File:	Temperature °C	Th.Conductivity (W/mK)	Th.Diffusivity (mm^2/s)	Spec.Heat ($MJ/m^3 K$)
ABC_160C_TC_1	140	0.277	0.118	2.34
ABC_160C_TC_2	140	0.285	0.129	2.20
ABC_160C_TC_3	140	0.282	0.126	2.24
Average		0.281	0.125	2.26

Figure 4, Typical test data

For more information, visit www.axelproducts.com.

Axel Products provides physical testing services for engineers and analysts. The focus is on the characterization of nonlinear materials such as elastomers and plastics.

Data from the Axel laboratory is often used to develop material models in finite element analysis codes such as ABAQUS, MSC.Marc, ANSYS and LS-Dyna.

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