Application Note

Silicone Rubber Sheet Thermal Conductivity Measurement

Industry	:	Plastic & rubber
Instrument	:	Quick Thermal Conductivity Meter
Measurement method	:	Hot wire comparative method
Standard	:	

1. Scope

Silicone rubber is a rubber-like synthetic resin mainly composed of silicone.
Because of its excellent heat resistance, water resistance and chemical resistance, it is used in many applications, and here, the Quick Thermal Conductivity Meter has adopted silicone rubber block as the reference plate. In this study, we measured silicone rubber sheet with thicknesses of 2 mm, 3 mm, 5 mm in the [Thin Film Measurement] mode, to verify whether the thermal conductivity characteristics of the rubber block match with those of the rubber sheet.

2. Precautions

Avoid trapping air between the sample and the probe when setting.
If pockets of air exist, they will affect the thermal conductivity measurement result.

- Prepare a flat specimen with no irregularities or undulations on the sample surface.
- If there is dust on the sample surface or probe, wipe it off.

For the amount of heat applied to the sample, determine the heater current value so that the temperature rise during measurement is 5 to 20 °C.
Set the heater current value from [HEATER] on the main unit and select the heater current value to be used according to the sample. Excessive heating may cause breakage of samples and references. Refer to the instruction manual for current value guidelines.
Measure the sample by allowing it to fully conform to the measurement environmental temperature.

3. Apparatus

Main unit	:	Quick Thermal Conductivity Meter (Thin Film Measurement)
Probe	:	PD-11N(Box type probe)
Reference plate	:	Polyethylene foam, Silicone rubber , Quartz glass

4. Procedure

1) Prepare the reference plate.
2) Place the probe on each reference plate, apply constant power (calories) to the heater, and record the temperature rise change.
3) Place the samples in close contact with each reference plate sequentially. On each plate, place the probe, apply constant power (calories) to the heater, and at the same time record the temperature rise change as in step 2) above.
4) Regard the case of only the reference plate (step 2) above) as a reference, and calculate the deviation from the rate of temperature rise when adding the sample (step 3) above).
   Plot the thermal conductivity of the reference plate on the horizontal axis, and the deviation on the vertical axis, to find the optimum approximate curve passing through the points.
   The thermal conductivity which is equal to zero, that is, the thermal conductivity whose temperature rise rate is equal, is the conductivity for the sample.

NOTE: For details, please refer to the instruction manual.

5. Example

- Measurement principle-

○Ambient condition: 23℃

○The values used and heater values for the following are given in the figure.

Reference plate	Display value (W/(m K))	Heater current value (A)
Foam polyethylene	0.0360	0.5
Silicone rubber	0.2144	1.4
Quartz glass	1.418	2

NOTE: The heater current value was set so that the temperature rise during measurement was 5 to 20 °C.

- Measurement conditions -

Table 1 shows the measurement results of the thermal conductivity of the silicone rubber sheet. Measurement was performed three times, with the result of average value, standard deviation and relative standard deviation.

Fig. 1 shows the deviation of the silicone rubber from the block display value.

Table 1. List of thermal conductivity measurement results of silicone rubber sheet

Name of specimen		Silicone rubber sheet		
Thickness		2 mm	3 mm	5 mm
Thermal Conductivity λ [W/(m K)]	1	0.2168	0.2184	0.2175
	2	0.2167	0.2183	0.2177
	3	0.2169	0.2184	0.2169
Mean value		0.217	0.218	0.217
Standard deviation		0.0001	0.0001	0.0004
RSD (%)		0.05	0.03	0.19

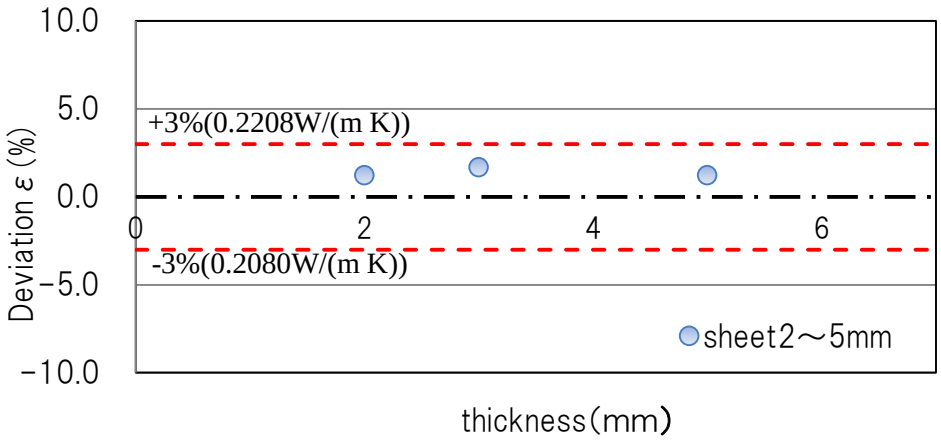
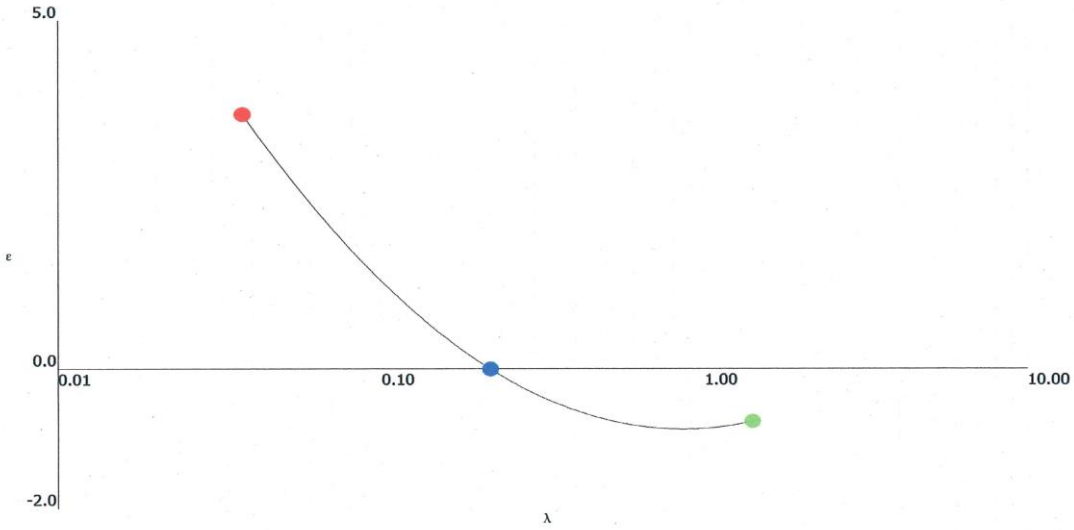


Fig .1 Deviation from silicone rubber block display value (0.2144W/(m K))

-Measurement example-

Model:	QTM-710		Print: 2017/04/26 15:30
Serial:	22660002		Page: 1/1
Operator:	User	Date:	2017/03/02 17:10
Sample No:	02-001	Sample ID:	Silicon 2mm n1
Meas.Mode:	Thin Film Measurement		
Probe Unit:	PD-11N		
Probe No:	22760003		
Probe Const:	Main		
λ :	0.2168 [W/(m K)]		

	λ [W/(m K)]	1st	2nd	3rd	4th	5th	AVG.
Polythylene foam	0.03724	3.651	-.----	-.----	-.----	-.----	3.651
Silicon rubber	0.2170	-0.00119	-.----	-.----	-.----	-.----	-0.00119
Quartz glass	1.406	-0.7529	-.----	-.----	-.----	-.----	-0.7529



6. Summary

Measurement of a sheet sample of the same material as the reference plate (block shaped) revealed that the thermal conductivity matched within 2% of the block shape's performance and the relative standard deviation was within 1%. As long as the material is the same, it was confirmed that the thermal conductivity of block material and of sheet material is the same, and that the [Thin Film Measurement] mode is valid.

For other sheet-like specimens, it may be necessary to separately verify the relationship between thermal conductivity and thickness; in such cases please consult us as necessary.

7. References

None.