Application Note

Thermal Conductivity Measurement of PTFE Sheet

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

1. Scope

Polytetrafluoroethylene (PTFE) is a polymer of tetrafluoroethylene, and it is a fluorocarbon resin composed of only fluorine atoms and carbon atoms.
It is chemically stable, excellent in heat resistance, chemical resistance and electrical properties, and is widely used as a processing material.

In this study, several types of polytetrafluoroethylene sheets with different thickness were prepared and measured in the [Thin Film Measurement] mode, where the results of examining the relationship between thickness and thermal conductivity are presented.

Polytetrafluoroethylene is referred to as PTFE below.

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 PTFE sheet. Measurement was performed three times, with the result of average value, standard deviation and relative standard deviation.

Fig. 1 shows the relationship between PTFE sheet thickness and thermal conductivity.

Table 1. List of thermal conductivity measurement results for PTFE sheet

Name of specimen		PTFE sheet							
Thickness t (mm)		0.03	0.05	0.13	0.2	0.3	0.5	0.8	1.0
Thermal conductivity λ W/(m K)	1	0.1751	0.1753	0.2057	0.2069	0.2033	0.2119	0.2249	0.2157
	2	0.1371	0.1627	0.2028	0.2086	0.2003	0.2173	0.2205	0.2180
	3	0.1437	0.2091	0.1987	0.2075	0.2013	0.2123	0.2266	0.2158
Mean value		0.152	0.182	0.202	0.208	0.202	0.214	0.224	0.217
Standard deviation		0.0203	0.0240	0.0035	0.0009	0.0015	0.0030	0.0031	0.0013
RSD (%)		13	13	1.7	0.42	0.76	1.4	1.4	0.6

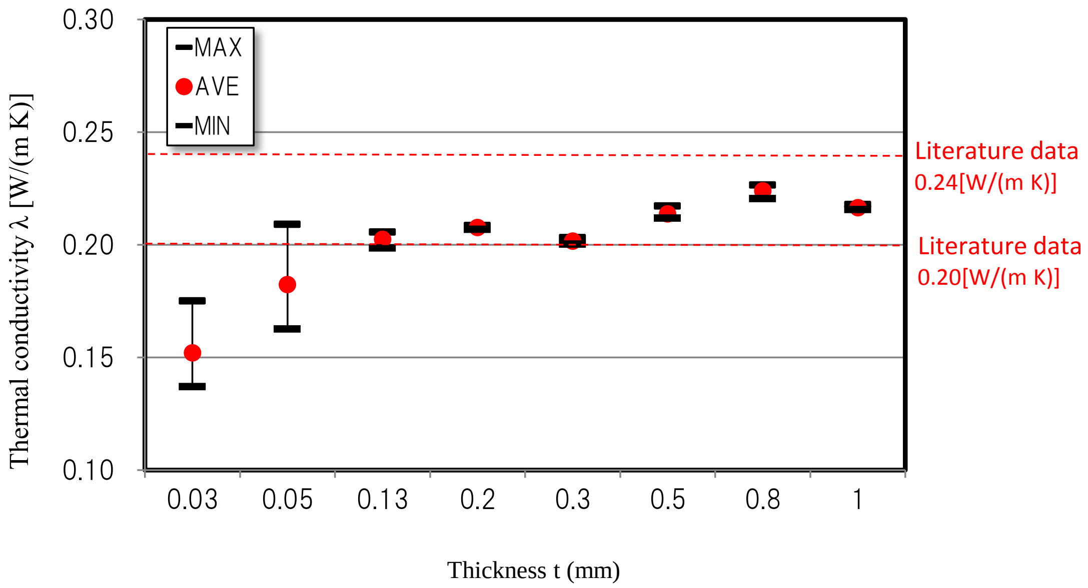

Fig .1 Thickness and thermal conductivity of PTFE sheet

6. Summary

As shown in Fig. 1, the thermal conductivity becomes stable when the thickness of the sample reaches a certain value. When the thickness is 0.2 mm or more, the value falls within the range of the literature quoted value, and when the thickness is 0.5 mm or more, the value converges almost in the median of the literature quoted value. Also, the relative standard deviation becomes smaller as the specimen thickens.

The "Thin Film Measurement" mode of the Quick Thermal Conductivity Meter estimates the thermal conductivity of the sample from the deviation between the temperature rise rate of "reference plate only" and that of "reference plate + sample".

Accordingly, if the sample is thin, the deviation is small, which was considered to make the measurement error larger.

For this PTFE sheet, it was confirmed that if the thickness is 0.2 mm or more, the relative standard deviation is stable at 2% or less which assures reliable thermal conductivity measurement.

For other sheet-like specimens, the relationship between specimen thickness and thermal conductivity must be separately verified.

In such cases please consult us as necessary.

7. References

None