Application Note

Wood Thermal Conductivity Measurement

Industry	:	Ceramic
Instrument	:	Quick Thermal Conductivity Meter
Measurement method	:	Hot wire comparative method
Standard	:	

1. Scope

Wood is made up of tissues consisting of countless cells which have air in the voids in the cells, so density is low and thermal conductivity is only about 1/10 of that of concrete. Also wood has dense annual growth ring structures, and it is not a homogeneous material.

For such an uneven structure, the thermal conductivity is expected to be different between the material along the direction of the grain and that of perpendicular to the grain.

In this study, we measured with the probe oriented in the direction of the wood grain and in the direction perpendicular to the wood grain. We examined whether the thermal conductivity differs according to the direction to which the probe is mounted.

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 (Normal Measurement)
Probe	:	PD-11N(Box type probe)

4. Procedure

1) Place the probe on the sample.
2) Apply constant power (calories) to the heater and at the same time record the change in temperature rise to obtain the thermal conductivity.

NOTE: Refer to the instruction manual for details.

5. Example

- Measurement principle-

Our Quick Thermal Conductivity Meter is a thermal conductivity meter that can perform simple and quick measurement with excellent operability. Measurement begins when the probe is pressed (Fig. 1) against a sample surface of uniform temperature, and the operation can be completed in just 60 seconds.

The probe consists of a linear heating element and a thermocouple, and as the constant power (calories) is continuously applied to the heater, the temperature of the heater rises exponentially.

When the time axis uses a logarithmic scale, the temperature rise curve becomes a straight line (Fig. 2).

The slope of this straight line increases with lower sample thermal conductivity, and if the sample has high thermal conductivity, the slope decreases. In other words, the thermal conductivity of the sample can be obtained from the slope of the temperature rise graph in which the horizontal time axis has a logarithmic scale.

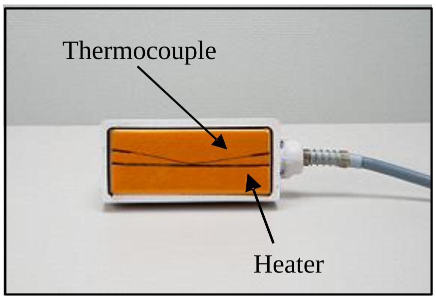


Fig1.Probe

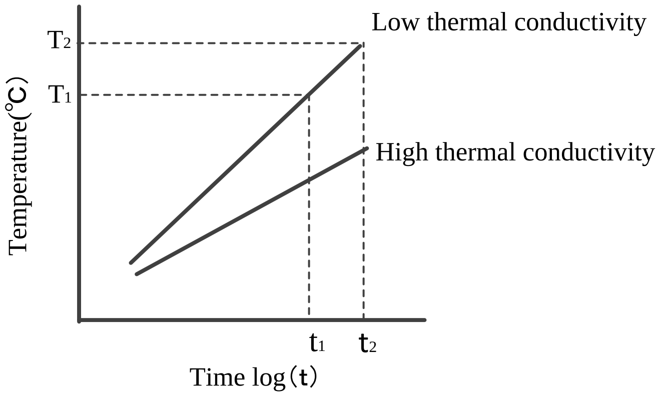


Fig 2.log(t)vsTemp. graph

-Measurement conditions-

○Ambient condition : 23℃
○Heater current value : 1.0A
○Measurement time : 60 seconds

- Measurement results-

Shown are the measurement results for the thermal conductivity of wood.

For the measurements, we attached the probe to the sample and then removed the probe on each iteration.

Measurement was performed three times.

Table 1 shows average value, standard deviation and relative standard deviation.

Table 1. List of wood measurement results

	Wood			
	Measurement point A	Measurement point B	Measurement point C	Measurement point D
Thermal conductivity λ (W/(m K))	0.1106	0.1628	0.1419	0.2987
	0.1112	0.1649	0.1434	0.3135
	0.1084	0.1628	0.1421	0.2959
Mean value	0.1101	0.1635	0.1425	0.3027
Standard deviation	0.00147	0.00121	0.00081	0.00946
RSD (%)	1.3	0.7	0.6	3.1

Measurement point A

Measurement point B

Measurement point C

Measurement point D

NOTE:

Measurement point A: The probe was placed parallel to the wood grain (the heat flow was perpendicular to the grain)

Measurement point B: The probe was placed perpendicular to the wood grain (the heat flow was parallel to the grain)

Measurement point C: The probe was placed at 45 °C to the wood grain (the heat flow was 45 °C against the grain)

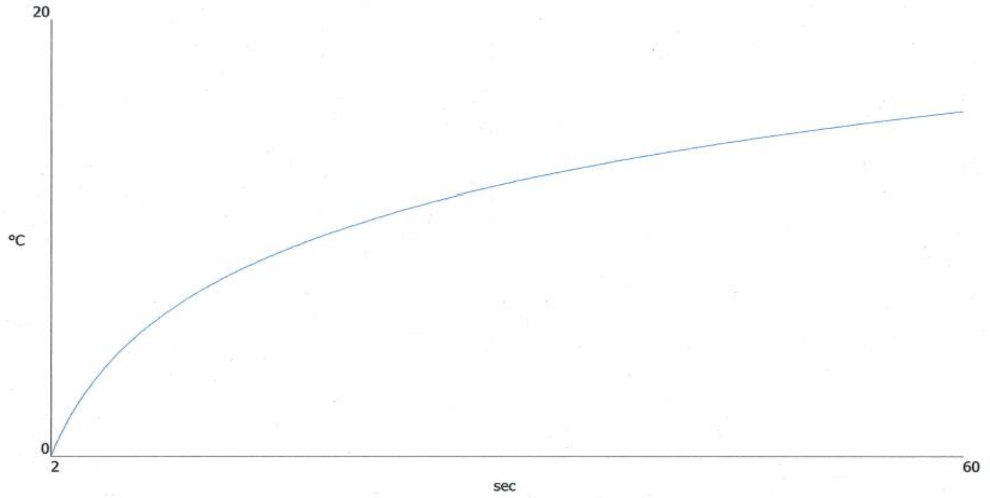
Measurement point D: The probe was placed on a knot in the wood grain.

-Measurement example-

Model:	QTM-710		
Serial:	22660002		Page: 1/1

Operator:	User	Date:	2017/06/14 14:46
Sample No:	01-032	Sample ID:	WOOD A
Meas.Mode:	Normal Measurement		
Probe Unit:	PD-11N		
Probe No:	22760003		
Probe Const:	Main		
λ :	0.1106 [W/(m K)]		

dT:	15.78	[°C]	
T0:	23.3	[°C]	
T1:	35.6	[°C]	
T2:	39.0	[°C]	
Tm:	31.1	[°C]	(T0+T2)/2
I:	1.0	[A]	
Stab:	Fine		



6. Summary

Good accuracy was confirmed in which the relative standard deviation of wood was approximately 0.5 to 3.0%.

It was also confirmed that the thermal conductivity is different according to the grain direction, as the thermal conductivity was 0.11 W / m K for the case parallel to grain direction, and 0.16 W / m K for the perpendicular orientation.

It was demonstrated that, for a sample whose thermal conductivity differs in one direction to another perpendicular direction, such as wood, changing the set position of the probe with the Quick Thermal Conductivity Meter enables confirmation of the differences in in-plane thermal conductivity.

For other samples, verification is separately required; in such cases please consult us as necessary.

7. References

None.