We are supporting global environment protection of an enterprise through quality improvement of thermophysical property measurement.

**Theory for measuring Thin Films**

Thermal diffusivity length is the length that the thermal wave propagates through surface of a specimen when periodically heated the surface.

\[ L_d = \sqrt{\frac{\lambda}{\pi fC}} = \sqrt{\frac{\lambda f}{\pi bC}} \]

- \( \lambda \): Thermal Conductivity
- \( f \): Heating Frequency
- \( b \): Thermal Diffusivity
- \( C \): Heat Capacity (per unit volume)

If thermal diffusivity length is longer than the thickness of the film, the thermal wave propagates through the film within one cycle.

For example, the thermal diffusivity length of Zirconia is less than 0.1 mm for 1 MHz.

Therefore, by using high frequency, measurements of thin film become possible to perform in sub-second scale.

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**Specifications**

<table>
<thead>
<tr>
<th>Mode</th>
<th>Thermophysical property distribution measurement: Line, 2D, Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement</td>
<td>Thermal diffusivity, (Heat Capacity), (Thermal Conductivity)</td>
</tr>
<tr>
<td>Spot size</td>
<td>about 3 [μm]</td>
</tr>
<tr>
<td>Time of measurement</td>
<td>10 seconds per point</td>
</tr>
<tr>
<td>Thickness</td>
<td>Sub micrometers to μm</td>
</tr>
<tr>
<td>Repetition Accuracy</td>
<td>±10% for Pyrex and Silicon in thermal diffusivity</td>
</tr>
</tbody>
</table>
| Sample | Sample size : 30 x 30 x 5 [mm]
Sample surface must be polished,
Sample surface must be sputtered with Molybdenum |
| Operating Temperature | 20 ± 1 [°C], Sensor inside the system |
| XY Stage Displacement | X axis : 28 [mm], Y axis : 20 [mm], Z axis : 4 [mm] |
| Heating Laser | Laser Diode : 808 [nm] |
| Probe Laser | Laser Diode : 633 [nm] |
| Power Supply | AC 100 [V], 1.5 [W] |
| Accessories | Sample holder, Reference sample |
| Option | Optional table, Air-conditioning equipment, Booth for air-conditioning, Sputtering equipment |
| Main Body | External size : 750 [W] x 620 [mm] x 560 [mm], Weight : 80 [kg] |
| Power Supply Box | External size : 620 [W] x 480 [mm] x 310 [mm], Weight : 26 [kg] |

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**Caution for Safety**

Before using, please read manual and operate correctly for the safety.

**Inquiry about products:**

https://hrd-thermal.jp/en/contact/

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We wish to contribute to technological innovation and creating the future through our thermal measurement technology.

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Non contact measurement of nano order thin film with micro scale spatial resolution

Multiple samples could be automatically measured 10 seconds each

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BETHEL Co., Ltd.
Thermal Microscope

**TM3B**

**FEATURES**
- Thermophysical property measurement for thin films, 100nm order.
- 2 dimensional measurement with 63 μm resolution.
- Non contact measurement with laser.

A small improvement in the material characteristics can be expected by evaluating the thermophysical property of thin film and the thermophysical property distribution inside the material.

The thermophysical property measurement for the thin film can be performed in 100nm-order, and the thermophysical property distribution measurement can be performed in micrometer order.

**THEORY**

Light Heating Thermoreflectance Method:
Thermophysical property measurement become easier

Sputter Mo thin film on a sample and periodically heat the surface with heating laser.
Heat propagates through the Mo thin film and reaches to the sample. A phase lag occurs to the temperature response.
The phase lag varies with sample's thermophysical characteristics.

Since reflectance of Mo changes according to the temperature, by irradiating and detecting the amplitude variation of a probe laser beam which is coaxial to the laser heating, relative temperature variation of the surface could be measured.
By using this method, thermal effusivity measurement in high spatial resolution become possible.

Heat capacity per unit volume and thermal conductivity could be calculated be optical software.

Ref: Thermoreflectance technique to measure thermal effusivity distribution with high spatial resolution

**APPLICATION**

- **Electrode of Laser Diode**
- **SiC**
- **Ceramics (AlN)**

It is the best to measure the thermal effusivity of the thin film and the micro region. A contactless and high-resolution measurement can be performed.

Sample off: National Institute of Advanced Industrial Science and Technology, Advanced Manufacturing Research Institute

**CONFIGURATION**

Function Generator
Lock in Amp
Heating Laser
Sample/AIC
Optical Microscope

Sample off: National Institute of Advanced Industrial Science and Technology, Advanced Manufacturing Research Institute