

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



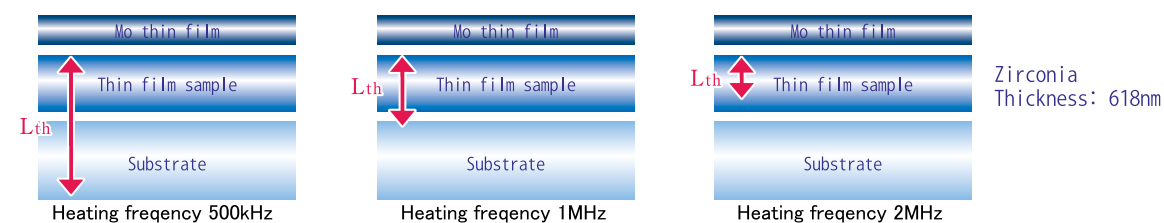
Theory for measuring Thin Films

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

$$L_{th} = \sqrt{\lambda / \pi f C} = 1 / \sqrt{\pi f} \times b / C$$

λ = Thermal Conductivity
 f = Heating Frequency
 b = Thermal Effusivity
 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 618nm for 1MHz. Therefore, by using high frequency, measurements of thin film become possible to perform in sub-micron scale.



Specifications

	TM3B
Mode	Thermophysical property distribution measurement (Line, 2D, Point)
Measurement	Thermal Effusivity, (Heat Capacity), (Thermal Conductivity)
Spot size	about 3 [μ m]
Time of measurement	10 seconds per point
Thickness	Sub micrometers to μ m
Repetition Accuracy	$\pm 10\%$ for Pyrex and Silicon in thermal effusivity
Sample	Holder size : 30 \times 30 \times 5 [mm] Sample size : less than 30 \times 30 \times 3 [mm] Sample surface must be polished. Sample surface must be sputtered with Molybdenum.
Operating Temperature	20 \pm 1 [$^{\circ}$ C] (sensor inside the system)
XY Stage Displacement	X axis 20 [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 [kVA]
Accessories	Sample holder, Reference samples
Option	Optional table, Air-conditioning equipment, Booth for air-conditioning, Sputtering equipment
Main Body	Externals size : 730(W) \times 620(D) \times 560(H) [mm], Weight : 80 [kg]
Power Supply Box	Externals size : 620(W) \times 480(D) \times 310(H) [mm], Weight: 26.4 [kg]

- The numbers shown in this catalog are results from our examinations. The same results are not guaranteed in different circumstances.
- The performance and appearance may be changed for improvement without notice.



Caution for Safety

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

CLASS 1 LASER PRODUCT
IEC/EN 60825-1 :2007

Inquiry about products : <https://hrd-thermal.jp/en/contact/>

<Manufactured and Distributed>

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材料固化測試儀器(熱固化/UV固化) 熱擴散測試儀器
表面輪廓粗度量測儀器 光學影像尺寸量測儀器

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



Light Heating Thermoreflectance method : Thermophysical property measurement become easier

Thermal Microscope

BETHEL THERMAL

Search

Non contact measurement of nano order thin film with micro scale spatial resolution
 Multiple samples could be automatically measured 10 seconds each

TM3B

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Thermal Microscope

TM3B



FEATURES

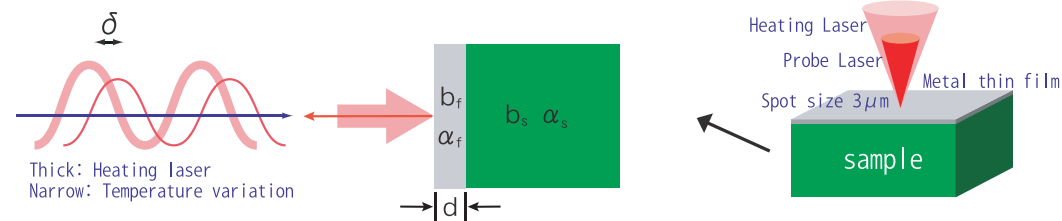
- Thermophysical property measurement for thin films, 100nm order.
- 2 dimensional measurement with $\phi 3 \mu\text{m}$ resolution.
- Non contact measurement with laser.

An 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-orders, 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 heating laser, 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 by optional software.



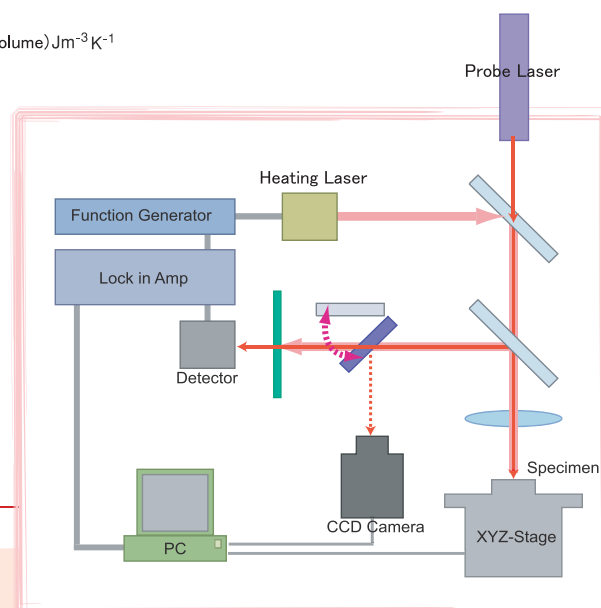
$$\text{Related equation } \delta = \arctan \left[-\frac{1 + \sqrt{\frac{\omega \tau_s}{2}}}{\sqrt{\frac{\omega \tau_s}{2}}} \right] + \frac{3}{4} \pi \quad \tau_s = \frac{b_f^2}{b_s^2} \frac{d^2}{\alpha_f} \quad b = \sqrt{C\lambda} \quad \lambda = \frac{b^2}{C} \quad b = C\sqrt{\alpha}$$

$$\omega = 2\pi f$$

b = Thermal Effusivity $\text{Js}^{-0.5}\text{m}^{-2}\text{K}^{-1}$ C = Heat Capacity(per unit volume) $\text{Jm}^{-3}\text{K}^{-1}$
 λ = Thermal Conductivity $\text{Wm}^{-1}\text{K}^{-1}$ α = Thermal Diffusivity m^2s^{-1}

Ref: Thermoreflectance technique to measure thermal effusivity distribution with high spatial resolution
 K.Hatori, N.Taketoshi, T.Baba, H.Ohta,
 Rev. Sci. Instrum. 76, 114901 (2005)

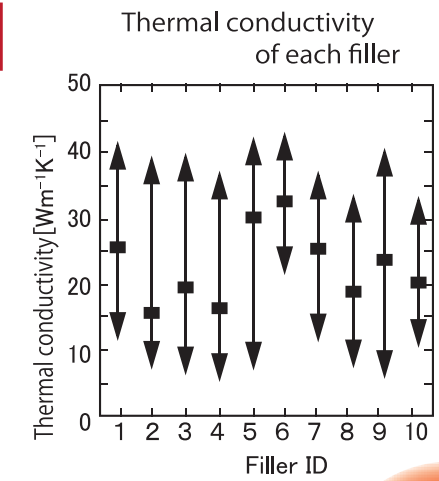
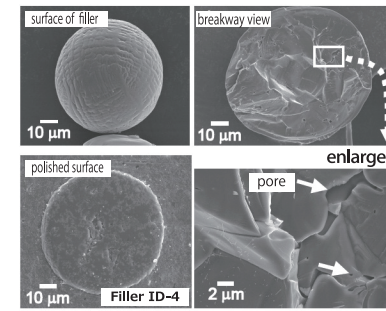
CONFIGURATION



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.

[case-1]

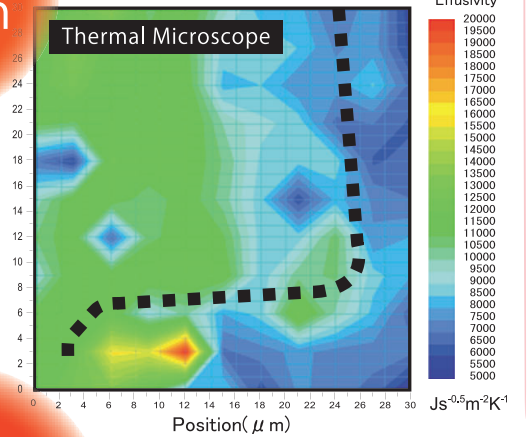
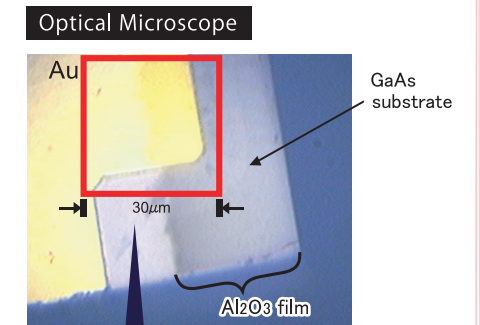
Alumina Filler



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

[case-2]

Electrode of Laser Diode



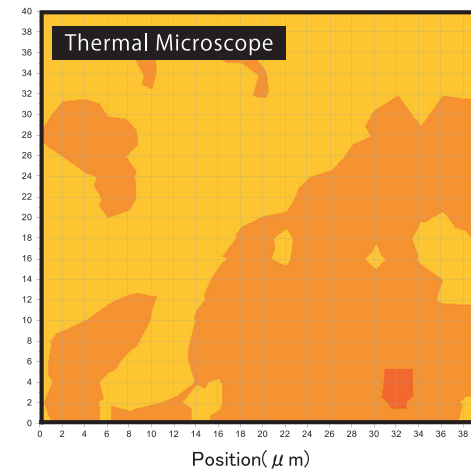
Micro Region

Mapping Measurement

The thin film Measurement

[case-3]

SiC



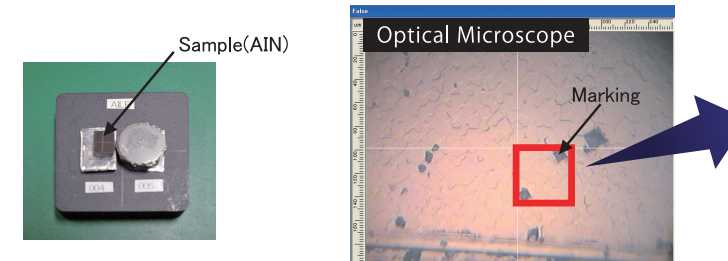
SiC Sample	Thermal Conductivity [Wm⁻¹K⁻¹] ※	Thermal Effusivity [Js⁻⁰.⁵m⁻²K⁻¹]
4H-C SiC Single Crystal	440	30400
6H-C SiC Single Crystal	366	28100
SiC Polycrystal	274	24200

※ The value calculated as $C = 2.1 \times 10^6 [\text{Jm}^{-3}\text{K}^{-1}]$

APPLICATION

[case-4]

Ceramics (AlN)



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

