

National Institute of Advanced Industrial Science and Technology

## National Metrology Institute of Japan



## Reference Material Certificate

NMIJ CRM 5808-b  
No. +++)

## Molybdenum Film for Thermal Diffusivity Measurement (400 nm)

This certified reference material (CRM) is produced in accordance with the NMIJ's management system and is in compliance with ISO 17034 and ISO/IEC 17025. This CRM is intended for the calibration of instruments, and validation of instruments for thermal diffusivity and thermal conductivity measurements.

**Certified Values**

The certified values for thermal diffusivity and thermal conductivity in thickness direction of molybdenum film are given in the tables below. The uncertainty of the certified value is the expanded uncertainty obtained by multiplying the combined standard uncertainty by a coverage factor ( $k$ ) of 2, and it is the half-width of an interval estimated to have a level of confidence of approximately 95 %.

Material	Certified value Thermal diffusivity ( $\text{m}^2/\text{s}$ )	Relative expanded uncertainty $U$ (%)
Molybdenum film	$3.28 \times 10^{-5}$	6.2

Material	Certified value Thermal conductivity ( $\text{W}/(\text{m K})$ )	Relative expanded uncertainty $U$ (%)
Molybdenum film	82.1	7.6

**Analysis**

The certified values of the CRM were determined from the thickness, the heat diffusion time in thickness direction and the heat capacity per unit volume of the molybdenum film at  $22.5 \text{ }^\circ\text{C} \pm 0.5 \text{ }^\circ\text{C}$ . The film thickness was evaluated by the stylus instrument calibrated using the step height standard. The heat diffusion time and the heat capacity per unit volume were evaluated by the pulsed light heating thermoreflectance method originally developed by NMIJ. The measurements were carried out at the center of the specimens within a radius of 5 mm.

**Metrological Traceability**

The certified values were determined based on the calibrated function generator, the step height standard, NMIJ CRM 5809-a (Quartz Glass for Thermal diffusivity measurement), the Differential Scanning Calorimetry in accordance with the procedures for commercial test of specific heat capacity (QMC SH), and the calibrated electronic balance. The certified values, therefore, are traceable to the International System of Units (SI).

**Expiration of Certification**

This certificate is valid from the date of shipment to March 31, 2026, provided that the material remains unopened and is stored in accordance with the instructions given in this certificate.

**Description of the Material**

This CRM is in the form of a wafer with a diameter of 38.1 mm and a thickness of 0.525 mm. One wafer is kept in a polypropylene case, which is sealed in a plastic bag with a desiccant and an oxygen absorber.

### Instructions for Storage

This CRM should be stored in the sealed plastic bag at a temperature between 5 °C and 35 °C in clean environment.

### Instructions for Use

Use the CRM surface within a radius of 10 mm from the center of the specimen, avoiding the line shape pattern with a width of 0.1 mm and a length of 3.0 mm. The molybdenum film must be damaged by water and oil. Wear gloves or use tweezers during handling to protect the CRM against contamination.

### Precautions for Handling

The CRM is composed of molybdenum and quartz glass. Refer to the safety data sheet (SDS) on this CRM before use.

### Preparation

Molybdenum film was deposited on 50 pieces of synthesized quartz glass wafer by the dc magnetron sputtering. Deposited films were chemically etched using a lithography technique in order to remove the outer edge of the film and to make a line shape pattern at the center of the specimen.

### Technical Information

Please note that the thermal diffusivity and the thermal conductivity in-plane direction were not evaluated. There is a line shape pattern with a width of 0.1 mm and a length of 3.0 mm, at the center of the specimen, which is utilized for measuring thickness of the specimen in accordance with ISO 5436-1:2000. The averaged thickness at the center of the sampled 8 specimens was 421.3 nm and the standard deviation was 0.5 nm.

### NMIJ Analysts

The technical manager for this CRM is AKOSHIMA M, the production manager is YAGI T., and analysts are YAGI T. and ABE H.

### Information

If substantive technical changes occur that affect the certification before the expiration of this certificate, NMIJ will notify the registered customer. Customer registration on the NMIJ Website (given below) will facilitate notification. Technical reports regarding this CRM can be obtained from the contact details given below.

### Reproduction of Certificate

In reproducing this certificate, it should be clearly indicated that the document is a copy.

February 24, 2023

ISHIMURA Kazuhiko  
President

National Institute of Advanced Industrial Science and Technology

If you have any questions about this CRM, please contact:  
National Institute of Advanced Industrial Science and Technology,  
National Metrology Institute of Japan,  
Center for Quality Management of Metrology, Reference Materials Office,  
1-1-1 Umezono, Tsukuba, Ibaraki 305-8563, Japan  
Phone: +81-29-861-4059; Fax: +81-29-861-4009, <https://unit.aist.go.jp/nmij/english/refmate/>