

National Institute of Advanced Industrial Science and Technology

National Metrology Institute of Japan



Reference Material Certificate

NMIJ CRM 5802-a

No. +++



Silica Glass for Thermal Expansivity Measurement

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 use in the calibration and validation of instruments for thermal expansivity measurements.

Certified Values

The certified values of thermal expansivity α and the expanded uncertainties U of this CRM are given by the following equations. The uncertainty U 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 %.

$$\alpha / (10^{-6} \text{K}^{-1}) = -3.4862 \times 10^{-1} + 5.2504 \times 10^{-3} \cdot (T/\text{K}) - 9.1581 \times 10^{-6} \cdot (T/\text{K})^2 + 4.7802 \times 10^{-9} \cdot (T/\text{K})^3$$

$$U / (10^{-6} \text{K}^{-1}) = 0.046$$

at 293.15 K \leq T \leq 800 K.

The calculated results from above equations for this CRM at typical temperatures are shown in the table below.

Temperature T/K	Thermal expansivity $\alpha / (10^{-6} \text{K}^{-1})$	Expanded uncertainty $U / (10^{-6} \text{K}^{-1})$
293.15	0.524	0.046
300	0.531	
350	0.572	
400	0.592	
450	0.595	
500	0.585	
550	0.564	
600	0.537	
650	0.508	
700	0.479	
750	0.454	
800	0.438	

Analysis

The equation for calculating the certified values of this CRM was derived from the thermal expansivity measurements of five rectangular specimens (15 mm long, 26 mm wide, and 6.35 mm thick), all of which were cut from the base material of this CRM. The thermal expansivity was measured at temperatures ranging from 293.15 K to 800 K by using a laser interferometric dilatometer based on the following principle;

$$\alpha(T) = \frac{1}{L_0} \left(\frac{dL(T)}{dT} \right)$$

where L_0 is the length of a specimen at room temperature (293.15 K) and T and $L(T)$ are the temperature and length change of the specimen at T , respectively. The value of L_0 was obtained by a digital linear scale.

In order to determine the certified values, the measured values of the thermal expansivity for the five specimens were fitted into a third-order polynomial function of temperature based on the least-squares method.

Metrological Traceability

Thermal expansivity, derived from the temperature and length of a specimen, was determined by a laser interferometric dilatometer. A gauge block, a frequency-stabilized He-Ne laser, and Pt/Pd elemental thermocouples of the dilatometer were calibrated with their primary standards traceable to the International System of Units (the SI), and thus the certified values (thermal expansivity) are traceable to the SI.

Expiration of Certification

This certificate is valid from the date of shipment to March 31, 2027, provided that this CRM is stored in accordance with the instructions given in this certificate.

Description of the material

This CRM is distributed in the form of quadrangular prism (6.35 mm × 6.35 mm × 30 mm) of silica glass in a plastic case.

Instructions for Storage

This CRM should be stored at temperatures of 23 °C ± 10 °C and relative humidity of 50 % or less.

Instructions for Use

This CRM is allowed to be made in any shapes by using any means appropriate for the calibration or verification of measuring instruments, provided that its quality is not significantly deteriorated. No serious heat- or mechanical-shock should be applied to this CRM to prevent crack formation. This CRM should not be heated to above 800 K. Care should be taken prior to use about potential chemical reactions between this CRM and other materials which come in contact with it at elevated temperatures.

Precautions for Handling

This CRM can be handled in a similar way to ceramics. Refer to the safety data sheet (SDS) on this CRM prior to use.

Preparation

This CRM was cut out from the base material plates of silica glass, all of which were prepared in a single process with a single charge of raw materials.

Technical Information

No significant variation in thermal expansivity of a specimen of this CRM was detected after the total of 16 cycles of heating and cooling process in which temperatures were varied between room temperature and 800 K in helium atmosphere.

NMIJ Analysts

The technical manager for this CRM is AKOSHIMA M., and the production manager and analyst are WATANABE H.

Information

If substantive technical changes occur that affect the certification before the expiration of this certificate, NMIJ will notify the registered customers. 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, 2022

ISHIMURA Kazuhiko

President

National Institute of Advanced Industrial Science and Technology

If you have any questions about this CRM, please contact:
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