Date of Shipment: Xxxxx xx, 20xx 5601a00-070521-210325

National Institute of Advanced Industrial Science and Technology

National Metrology Institute of Japan

Reference Material Certificate

NMIJ CRM 5601-a

No. +++

Synthetic Fused Silica for Positron Hole-size Measurements

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 controlling the precision of measured data, and validating the measurement conditions and obtained results by the positron annihilation lifetime technique for polymers and insulators having a positronium component with a lifetime longer than 1 ns.

Certified Value

The certified value of ortho-positronium lifetime is given in the table below. The uncertainty of the certified value is the half-width of the expanded uncertainty interval calculated using a coverage factor (k) of 2, which gives a level of confidence of approximately 95 %.

	Certified value (ns)	Expanded uncertainty (ns)
ortho-Positronium lifetime	1.62	0.05

Analysis

The certified value was evaluated as the longest of three positron lifetimes, each of which was obtained by fitting the positron lifetime data for quartz samples to a convoluted model function. This function was a linear combination of three exponential decays, linked together with a resolution function. The positron lifetime data were collected by recording time intervals between the birth and annihilation of positrons emitted from ^{22}Na. The uncertainty was calculated as the combined standard uncertainty, taking into account the uniformity of the sample, repeatability of the measurements, time-based accuracy of a digital oscilloscope, total time resolution of the measurement system, and positron annihilation intensity outside the sample.

Metrological Traceability

The positron annihilation lifetime measurement system with a digital oscilloscope, calibrated using a SI-tracible standard frequency counter and frequency measurement, was employed to determine the certified value, which assured the SI traceability of the measured time of the certified value and uncertainty.

Expiration of Certification

This certificate is valid for one year from the date of the shipment, provided that the material is stored following the instructions given in this certificate.

Description of the material

This CRM consists of a set of transparent synthetic fused silica in the form of 1.5-mm-thick square plates with dimensions of 15 mm × 15 mm and is kept in a plastic container.

Homogeneity

The homogeneity of this CRM was determined by measuring positronium lifetimes for 36 specimens randomly sampled from 150 plates of quartz glass, and a standard uncertainty in the homogeneity was considered to estimate the expanded uncertainty.

Instructions for Storage

This CRM must be stored in a clean environment at room temperature. It is recommended to store this CRM under a dried atmosphere away from any radioactive sources.

Instructions for Use

This CRM has to be used without cutting or grinding.

Precautions for Handling

This CRM is made of a fragile glass. To prevent any damage or breakage, any serious physical impact to the CRM must be avoided. Refer to the safety data sheet (SDS) on this CRM before use.

Preparation

Commercially available fused silica from a single lot was employed as the raw material for producing this CRM.

Technical Information

The certified value of the *ortho*-positronium lifetime τ [ns] is converted to a hole radius (R) of 0.248 nm on the basis of the quantum mechanical model expressed as

$$\tau = 0.5\left[1-\frac{R}{R_0}+\frac{1}{2\pi}\sin\left(\frac{2\pi R}{R_0}\right)\right]^{-1} \quad \text{with} \quad R_0 = R + 0.166\ \text{nm}$$

The equivalent hole volume is calculated as 0.0639 [nm^3] by using $V = (4/3)\pi R^3$.

NMIJ Analysts

For this CRM, the technical and production managers are KOBAYASHI Y., and the analyst is ITO K.

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.

Note

An interlaboratory comparison was carried out using this CRM. The averaged value of reported *ortho*-positronium lifetimes was confirmed to be in agreement with the certified value within a range of the expanded uncertainty. The laboratories listed below participated in this interlaboratory comparison test:

The University of Tokyo
Osaka University, Graduate School of Engineering
Osaka University, Institute of Scientific and Industrial Research
Tohoku University
Chiba University
University of Tsukuba
Tokyo Gakugei University
Japan Atomic Energy Agency
NITTO DENKO
Toray Research Center
National Institute of Advanced Industrial Science and Technology, Energy Technology Research Institute

April 1, 2020

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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National Metrology Institute of Japan,
Center for Quality Management of Metrology, Reference Materials Office,
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Phone: +81-29-861-4059; Fax: +81-29-861-4009, https://unit.aist.go.jp/nmij/english/refmate/

Revision history
March 23, 2012: The expiration date of this CRM was extended to March 31, 2017, from March 31, 2012, taking into consideration the stability monitoring results.
April 1, 2015: "Metrology Management Center" was renamed to "Center for Quality Management of Metrology."
November 12, 2015: The description in "Expiration of Certification" was changed to "one year from the date of the shipment."