

National Institute of Advanced Industrial Science and Technology

## National Metrology Institute of Japan



## Reference Material Report

NMIJ RM 5607-a

No. +++



## Stainless Steel for Positron Annihilation Lifetime Measurements of Defect

This reference material (RM) is stainless steel for positron annihilation lifetime measurements of defect, and is produced in accordance with the NMIJ's management system and in compliance with ISO 17034 and ISO/IEC 17025. This RM is intended for use in controlling the precision of measured data and in confirming the validity of the measurement condition and the obtained results by positron annihilation lifetime measurements of defect for metals, semiconductors and similar materials having a mean lifetime shorter than about 500 ps.

**Indicative Value**

The indicative value of this RM is given in the table below. The uncertainty of the indicative 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 %.

	Indicative value (ps)	Expanded uncertainty (ps)
Positron lifetime	106.2	2.4

**Analysis**

The indicative value was evaluated as a mean of the lifetimes of positrons annihilated in a measurement sample, which is obtained from the inverse number of the annihilation rate for the first component with performing a least-squares fitting of the positron lifetime histogram, recorded by accumulating time intervals between the birth and annihilation of positrons emitted from  $^{22}\text{Na}$ , to a model function consisting of two exponential decays. The uncertainty was estimated as the combined standard uncertainty taking account of the sample homogeneity, the repeatability and reproducibility of the measurements, and the time-base accuracy of the measurement system.

**Metrological Traceability**

A measurement system equipped with the digital oscilloscope calibrated by using the frequency counter and the oscillator traceable to the national standards was employed to determine the indicative value, which assures the International System of Units (SI) traceability of the measured time of the indicative value and its uncertainty.

**Expiration of Report**

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

**Sample Form**

This RM consists of two 3-mm-thick square plates with dimension of 15 mm  $\times$  15 mm, kept in a plastic container.

**Homogeneity**

The homogeneity of this RM was determined by analyzing 24 pieces sampled at random from 110 pieces cut from a plate. Positron annihilation lifetime measurements were performed twice for each specimen to obtain the mean lifetime of positrons, and the homogeneity was estimated from the analysis of variance for the obtained lifetimes. The homogeneity of the RM is

reflected in the uncertainty of the indicated value, and thus the RM is confirmed to be homogeneous.

**Instructions for Storage**

This RM should be stored at a temperature between 15 °C and 35 °C in clean environment and away from any radioactive sources.

**Instructions for Use**

This RM is limited for use in testing and research. One side of the RM is finished with a polished surface and the other side has a coarse surface; the polished surface has to be employed for the measurement.

**Precautions for Handling**

Refer to the safety data sheet (SDS) on this RM before use.

**Preparation**

This RM consists of metal pieces cut down from a commercial stainless-steel SUS304 plate.

**NMIJ Analysts**

The technical manager for this RM is ITO K. The production manager is YAMAWAKI M., and the analysts are YAMAWAKI M. and ITO K.

**Information**

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

**Reproduction of Report**

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

April 1, 2020

ISHIMURA Kazuhiko  
President

National Institute of Advanced Industrial Science and Technology

If you have any questions about this RM, please contact:  
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Revision history

April 1, 2015: “Metrology Management Center” was renamed to “Center for Quality Management of Metrology.”