

National Institute of Advanced Industrial Science and Technology

National Metrology Institute of Japan



Reference Material Certificate

NMIJ CRM 5603-a
No. +++



Low Energy Arsenic Implanted Silicon (Implantation dose level: 3×10^{15} atoms/cm²)

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 calibrating the response of a secondary ion mass spectrometry (SIMS) instrument and a Rutherford backscattering spectrometry instrument both of which measure dose of arsenic ions implanted to a silicon substrate with an average implantation depth of ca. 10 nm.

Certified Value

The certified value of this CRM for arsenic mass per unit area 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 %.

Element	Certified value, Area density (ng/cm ²)	Expanded uncertainty, Area density (ng/cm ²)
As	381.7	9.0

Analysis

The certified value of this CRM was determined as arsenic mass per unit area of the CRM surface, measured optically, to which arsenic ions had been implanted. The arsenic mass was determined by calculating the weighted means of arsenic mass values obtained by the inductively coupled plasma mass spectrometry (ICP-MS) and the instrumental neutron activation analysis (INAA).

Metrological Traceability

The certified value of this CRM is determined using NMIJ CRM 7912-a (Arsenate [As(V)] Solution) and NIST SRM 3103a (Arsenic Standard Solution) as arsenic standard solutions. The area of the CRM surface to which arsenic ions have been implanted is measured by a method traceable to the specified secondary standard. The certified value, therefore, is traceable to the International System of Units (SI).

Expiration of Certification

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

Sample Form

This CRM is in the form of a solid piece 15 mm square and 0.8 mm thick. Each piece of this CRM is placed on a wafer tray packaged in a plastic container.

Homogeneity

The homogeneity of this CRM was determined by analyzing six wafer chips selected with the stratified random sampling method from the total of 161 wafer chips. Specifically, arsenic mass of the six wafer chips was measured by the ICP-MS. The homogeneity has been incorporated into the uncertainty of the certified value.

Instructions for Storage

This CRM should be stored in a clean atmosphere at a temperature between 5 °C and 40 °C and shielded from direct sunlight. It is recommended to store this CRM in an ambience of dry air or nitrogen gas.

Instructions for Use

- 1) The CRM is placed with the implanted side down in the wafer tray. As arsenic ions were implanted into one side of the CRM of which both sides were polished, it is difficult to distinguish the implanted side from unimplanted side.
- 2) Etching the CRM is prohibited because arsenic may be removed.
- 3) The certified value is determined for whole area of the chip. If the sampling spot is much smaller than the chip size, several points on the film surface must be picked up at the time of analysis and the average value of the analysis should be adopted.

Precautions for Handling

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

Preparation

The CRM was prepared by cutting a 300 mm p-type single-crystal silicon (100) wafer into 15 mm squares. In an ion implanter, ^{75}As ions were implanted to one side of the silicon wafer at a nominal energy of 10 keV. The arsenic ion implantation, the wafer cutting, and packaging of the wafer chips were performed by Advanced Soc Platform Corp., ATOCK Co., Ltd., and NTT Advanced Technology Corp., respectively.

Technical Information

- 1) The certified value for arsenic mass per unit area is equivalent to 3.07×10^{15} atoms/cm² when a value of 74.9216 g/mol is applied as the arsenic mass.
- 2) Figure 1 shows an example of ^{75}As atom depth distribution measured by the SIMS. In this measurement, Cs⁺ ions were bombarded as the primary ions with a bombardment energy of 1 keV at an incident angle of 60° against the normal direction of the wafer surface, and $^{75}\text{As}^{28}\text{Si}$ secondary ions were detected by a quadrupole mass spectrometer.

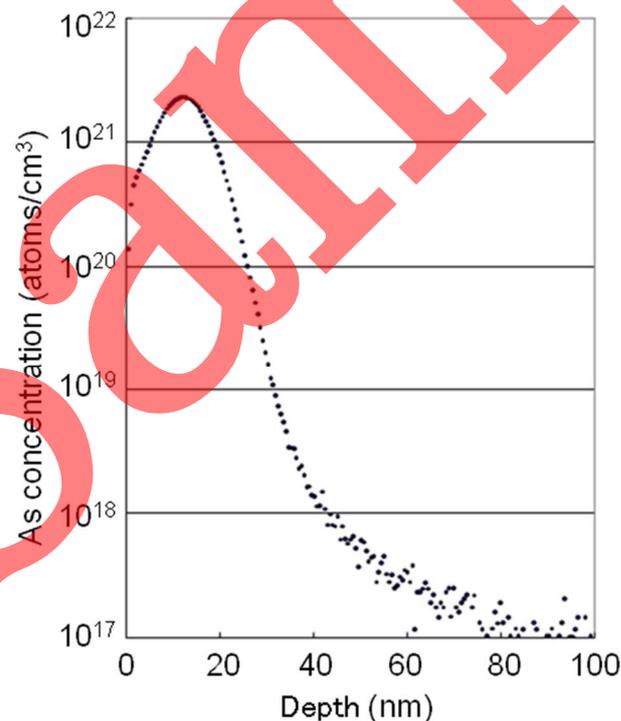


Figure 1 Example of ^{75}As atom depth distribution measured by SIMS

NMIJ Analysts

The technical manager is KOBAYASHI Y., the production manager is HIRATA K., and the analysts are TAKATSUKA T., and

KUROIWA T.

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.

Note

Determination of the arsenic mass by the INAA was based on the results of the AIST and Japan Atomic Energy Agency (JAEA) joint research.

April 1, 2020

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/>

Revision history

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

January 15, 2019: The description in “Expiration of Certification” was changed to “one year from the date of shipment.”