National Institute of Advanced Industrial Science and Technology

National Metrology Institute of Japan

Reference Material Certificate

NMIJ CRM 5604-a
No. +++

Low Energy Arsenic Implanted Silicon (Level: 6×10^{14} atoms/cm^2)

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 precision control and validation of a secondary ion mass spectrometry (SIMS) and a Rutherford backscattering spectrometry instrument both of which measure dose of arsenic ions implanted to silicon substrates with an average implantation depth of ca. 10nm.

Certified Value

This CRM is an arsenic ion implanted silicon substrate, and 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	78.6	2.1

Analysis

The certified value of this CRM was determined as arsenic mass per unit area of the CRM surface, to which arsenic ions had been implanted. The arsenic mass was determined by the graphite furnace atomic absorption spectrometry (GFAAS) and the instrumental neutron activation analysis (INAA), and the area was measured by the optical imaging.

Metrological Traceability

The certified value of this CRM is determined using the Japan Calibration Service System (JCSS) standard solution and a NIST SRM 3103a (Arsenic Standard Solution) as arsenic standard solutions. The area of CRM surface to which the arsenic ions have been implanted is measured by a method traceable to the standard scales for length calibrated by a frequency stabilized 633 nm He-Ne laser system. 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 this CRM is stored in accordance with the instructions given in this certificate.

Sample Form

This CRM is in the form of a chip 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 eight wafer chips selected with the stratified random sampling method from the total of 164 wafer chips. Specifically, arsenic mass per unit area of each wafer chip was measured by the INAA and the area measurement. 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 was performed by SEN Corp., and the wafer cutting and packaging of the wafer chips were performed by NTT Advanced Technology Corp.

Technical Information

1) The certified value for arsenic mass per unit area is equivalent to 6.32×10^{14} atoms/cm^2 when the values of 74.9216 g/mol and 6.022×10^{23} /mol are applied as the arsenic mass and Avogadro constant, respectively.
2) Figure 1 shows an example of ^{75}As atom depth distribution measured by the SIMS. In this measurement, Cs^+ ions with an energy of 1 keV were incident as the primary ions on the CRM surface at an incident angle of 60° to the normal direction of the surface, and $^{75}As^{28}Si^-$ secondary ions were detected by a quadrupole mass spectrometer. The depth (the horizontal axis in Fig. 1) was determined from the sputtering duration and the depth of the crater formed by the primary ion sputtering. The As concentration (the vertical one) was determined from the relative sensitivity factor, the measured intensity of $^{75}As^{28}Si^-$, and the above information 1). The relative sensitivity factor was calculated by the secondary ion intensities of $^{75}As^{28}Si^-$ and $^{28}Si^{30}Si^-$.

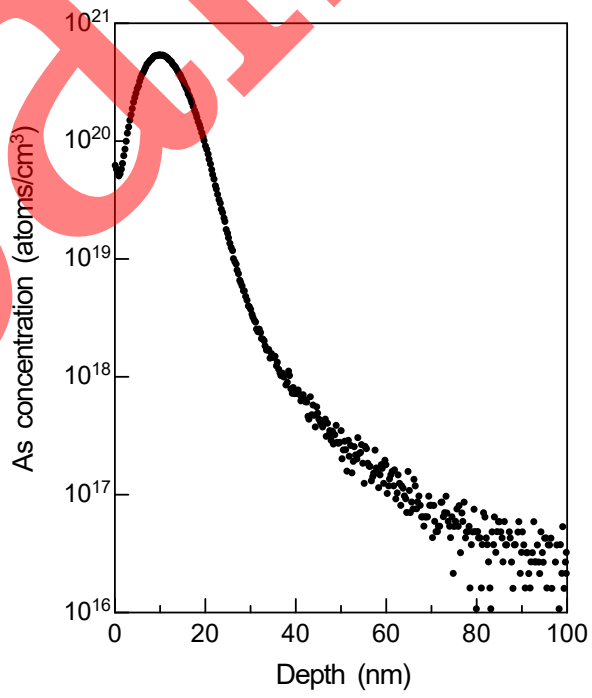

Figure 1 Example of ^{75}As atom depth distribution measured by SIMS.

NMIJ Analysts

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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 performed in the Common-Use Facility of Japan Atomic Energy Agency (JAEA).

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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Revision history
April 1, 2015: "Metrology Management Center" was renamed to "Center for Quality Management of Metrology."
January 14, 2020: The description in "Expiration of Certification" was changed to "one year from the date of shipment."