National Institute of Standards & Technology

Certificate

Standard Reference Material 1522

Set No.

Silicon Power Device Level Resistivity Standard

This Standard Reference Material (SRM) is intended primarily for use as a reference standard by both producers and consumers of semiconductor grade silicon when using the four-probe method of measuring semiconductor resistivity (ASTM F-84). However, the thickness of the slices in this SRM has been made compatible for additional use with contactless resistivity measurement equipment.

This SRM consists of three slices of silicon with nominal resistivities of 25, 75, and 180 ohm · centimeters, respectively. Each slice has been individually measured for resistivity at the National Institute of Standards & Technology. The measurements for the slices in the set designated above are as follows:

	(25 Ω · cm)	(75 Ω · cm)	(180 Ω · cm)
Slice Number	N25-______	N75-______	N180-______
Thickness	______ mm	______ mm	______ mm
Diameter	______ mm	______ mm	______ mm
Measuring Current (nominal)	______ mA	______ mA	______ mA
Voltage-Current Ratio[1]	______ Ω	______ Ω	______ Ω
Sheet Resistance[2]	______ Ω	______ Ω	______ Ω
Resistivity[3]	______ Ω · cm	______ Ω · cm	______ Ω · cm

[1]Measurement average, corrected to 23 °C for an ideal 1.59 mm (62.5 mil) probe.

[2]Measurement average, corrected for diameter and for temperature to 23 °C.

[3]Measurement average, corrected for diameter and thickness and for temperature to 23 °C.

The silicon crystals used for these standards are (111) orientation and were phosphorus doped by neutron transmutation of float-zone starting crystals. Resistivity measurements were carried out at the slice centers in accordance with ASTM Method F-84 with the exception that measurement current was chosen to maintain measured specimen voltage between 10 and 12 mV. Correction factors applied to the data are those of ASTM Method F-84. Due to resistivity nonuniformity for the silicon slices, the certified values are applicable only to the center of the slices.

Gaithersburg, MD 20899
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(Revision of Certificate dated 3-24-86)

William P. Reed, Chief
Standard Reference Materials Program

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Additional Information:

All certification measurements of slices in this SRM are performed by a single operator using a fixed set of instrumentation. At the inception of this SRM, a special experiment was performed to estimate possible systematic errors that might arise from the use of a single instrument-single operator procedure. Measurments were made on five slices at each of the resistivity levels in the SRM by each of two operators each using two different instrument sets (a total of four instrument-operator combinations, including the combination then being used for certification). Analysis indicated that the 95% confidence interval for the measurement averages derived from the instrument-operator combination used for normal certification were: ±0.11%, ±0.28% and ±0.38% for the 25, 75, and 180 ohm·cm levels, respectively. Less elaborate tests, both of the two operator-two instrument and of the control chart types, have been run periodically since then to maintain control of the measurement process.

Where the transferability of the resistivity scale between NIST and the laboratory using these SRMs is of interest, the 95% confidence interval obtained from multilaboratory tests is more appropriate. Such tests have been conducted to investigate the reproducibility of average resistivity values obtainable when using the instrumentation and procedures of ASTM Method F-84. These tests indicate that the 95% confidence intervals are: ±1.3% of the average value for specimens with resistivities up to 120 ohm·cm.and æ3.6% of the average value for specimens with resistivities between 120 and 500 ohm·cm.

The physical preparation of these specimens was performed by J. Fuller and J.M. Thomas. Resistivity measurements were performed by D. Ricks.

Technical measurement coordination and overall direction of the technical activities were performed by J.R. Ehrstein of the Semiconductor Electronics Division.

The support aspects involved in the original preparation, certification, and issuance of this Standard Reference Material were coordinated through the Standard Reference Materials Program by R.W. Seward.

The update of this certificate and issuance of this Standard Reference Material were coordinated through the Standard Reference Materials Program by N.M. Trahey.