# National Institute of Standards & Technology

# Certificate

## Standard Reference Material 1523

### Set No.

### Silicon Resistivity Standard for Eddy Current Testers

This Standard Reference Material (SRM) is intended primarily for use as a resistivity scale reference for semiconductor resistivity measurements made by instruments based on the eddy current principle (ASTM Method F-673) as well as those made by the four-probe method (ASTM Method F-84). This SRM consists of two slices of boron-doped silicon: both are from (100) orientation, Czochralski grown crystals. Each slice is individually certified for resistivity.

| | (0.01 Ω·cm) | (1. Ω·cm) |
|---|---|---|
| Slice Number | 0.01- | 1- |
| Thickness | mm | mm |
| Diameter | mm | mm |
| Measuring Current (nominal) | mA | mA |
| Voltage-Current Ratio[1] | Ω | Ω |
| Sheet Resistance[2] | Ω | Ω |
| Resistivity[3] | 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.

Specimen preparation and instrument verification were done in accordance with ASTM Method F-84. Measurements for certification of this SRM were made at the slice centers by the four-probe method, ASTM Method F-84, with two exceptions: only six independent pairs of voltage and current measurements (instead of the required ten pairs) were used to compute the average resistivity, and the measurement current for the nominal 1 Ω·cm slices was kept to a value that would give a measured specimen voltage between 10 and 12 mV. Due to resistivity nonuniformity of the silicon slices, the certified values are applicable only to the center of the slices.

The physical preparation of these specimens was done by R. Snurr and J.M. Thomas. Electrical and dimensional measurements were performed by D. Ricks. Technical coordination and overall direction of the technical activities were performed by J.R. Ehrstein of the NIST Semiconductor Electronics Division.

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William P. Reed, Chief
Standard Reference Materials Program

(over)

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 was coordinated through the Standard Reference Materials Program by N.M. Trahey.

The experimental error of electrical measurement was investigated using two operators on each of two different instrument systems (including different four-probe arrays) for four slices of each resistivity. No effect due to operator or instrument was found that was larger than the average slice measurement repeatability from any one combination of instrument and operator (less than 0.25%). An earlier multilaboratory round-robin test of ASTM Method F-84 indicates, with a confidence interval of 95%, that resistivity scales can be transferred using this SRM with a reproducibility of average resistivity of ±1.4%.

An experiment was conducted to test the longer term multilaboratory reproducibility of resistivity measurements using a previously issued SRM which consisted of 0.1 and 10 $\Omega \cdot$cm silicon slices. The experiment, more than a year in duration, involved five laboratories, and seven sets of the silicon resistivity standards, two of which were circulated among the laboratories, and the remaining five were used for stability tests by the individual laboratories.[1] The pooled results indicate that for either resistivity level in the SRM set, there is a 95% probability that the averages of 5 readings taken in two different laboratories will not differ by more than 1.7%. In addition, no detectable drift in the measured resistivity was found through the course of the experiment for any of the resistivity test specimens used. The results of that experiment are expected to apply to this SRM.

[1] Semiconductor Measurement Technology: Progress Report, January 1 to June 30, 1975, W. Murray Bullis, Editor, NBS Special Publication 400-19, pp. 7-9, (April 1976).