



Standard Test Method for Measuring Resistivity of Silicon Wafers With an In-Line Four-Point Probe¹

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1. Scope

1.1 This test method² covers the measurement of the resistivity of silicon wafers with a in-line four-point probe. The resistivity of a silicon crystal is an important materials acceptance requirement. This test method describes a procedure that will enable interlaboratory comparisons of the room temperature resistivity of silicon wafers. The precision that can be expected depends on both the resistivity of the wafer and on the homogeneity of the wafer. Round-robin tests have been conducted to establish the expected precision for measurements on *p*-type wafers with room temperature (23°C) resistivity between 0.0008 and 2000 Ω·cm and on *n*-type wafers with room-temperature (23°C) resistivity between 0.0008 and 6000 Ω·cm.

1.2 This test method is intended for use on single crystals of silicon in the form of circular wafers with a diameter greater than 16 mm (0.625 in.) and a thickness less than 1.6 mm (0.0625 in.). Geometrical correction factors required for these measurements are available in tabulated form.³

1.3 This test method is to be used as a referee method for determining the resistivity of single crystal silicon wafers in preference to Test Methods F 43.

NOTE 1—The test method is also applicable to other semiconductor materials but neither the appropriate conditions of measurement nor the expected precision have been experimentally determined. Other geometrics for which correction factors are not available can also be measured by this test method but only comparative measurements using similar geometrical conditions should be made in such situations.

NOTE 2—DIN 50431² is a similar, but not equivalent, method for determining resistivity. It is equivalent to Test Methods F 43.

¹ This test method is under the jurisdiction of ASTM Committee F-1 on Electronics and is the direct responsibility of Subcommittee F01.06 on Silicon Materials and Process Control.

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² DIN 50431 is a similar, but not equivalent, method. It is the responsibility of DIN Committee NMP 221, with which Committee F-1 maintains close liaison. DIN 50431, Testing of Inorganic Semiconductor Materials: Measurement of the Specific Electrical Resistance of Monocrystals of Silicon or Germanium by the Four-Point Direct-Current Technique with Linearly Arranged Probes, is available from Beuth Verlag GmbH Burggrafenstrasse 4-10, D-1000 Berlin 30, Federal Republic of Germany.

³ Smits, F. M., "Measurement of Sheet Resistivities with the Four-Point Probe" *Bell System Technical Journal*, BSTJA, Vol 37, 1958, p. 711; Swartzendruber, L. J., "Correction Factor Tables for Four-Point Probe Resistivity Measurements on Thin, Circular Semiconductor Samples," *Technical Note 199*, NBTNA, National Bureau of Standards, April 15, 1964.

1.4 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* Specific hazard statements are given in Section 8.

2. Referenced Documents

2.1 ASTM Standards:

D 1193 Specification for Reagent Water⁴

E 1 Specification for ASTM Thermometers⁵

E 177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods⁶

F 42 Test Methods for Conductivity Type of Extrinsic Semiconducting Materials⁷

F 43 Test Methods for Resistivity of Semiconductor Materials⁷

F 613 Test Method for Measuring Diameter of Semiconductor Wafers⁷

2.2 SEMI Standard:

C1 Specifications for Reagents⁸

3. Terminology

3.1 Definitions of Terms Specific to This Standard:

3.1.1 *four-point probe*—an electrical probe arrangement for determining the resistivity of a material in which separate pairs of contacts are used (1) for passing current through the specimen and (2) measuring the potential drop caused by the current.

3.1.2 *probe head, of a four-point probe*—the mounting that (1) fixes the positions of the four pins of the probe in a specific pattern such as an in-line (collinear) or square array and (2) contains the pin bearings and springs or other means for applying a load to the probe pins.

3.1.3 *probe pin, of a four-point probe*—one of the four

⁴ *Annual Book of ASTM Standards*, Vol 11.01.

⁵ *Annual Book of ASTM Standards*, Vol 14.03.

⁶ *Annual Book of ASTM Standards*, Vol 14.02.

⁷ *Annual Book of ASTM Standards*, Vol 10.05.

⁸ Available from the Semiconductor Equipment and Materials International, 805 East Middlefield Road, Mountain View, CA 94043.