

SEMI MF951-0305 (Reapproved 0222) TEST METHOD FOR DETERMINATION OF RADIAL INTERSTITIAL OXYGEN VARIATION IN SILICON WAFERS

This Standard was technically approved by the Silicon Wafer Global Technical Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on August 12, 2021. Available at www.semiviews.org and www.semi.org in February 2022; originally published by ASTM International as ASTM F951-85; previously published March 2016.

NOTICE: Paragraphs entitled ‘NOTE:’ are not an official part of this Standard or Safety Guideline and are not intended to modify or supersede the official Standard or Safety Guideline. These have been supplied by the global technical committee to enhance the usage of the Standard or Safety Guideline.

NOTICE: The section symbol (§) is used to reference a numbered section, paragraph, or header and all subordinate paragraphs, headers, and embedded material (i.e., EXCEPTIONs, lists) therein. The paragraph symbol (§) is used to reference a particular numbered paragraph and embedded material therein. When duplicated (i.e., §§ and §§) the symbols are used to reference more than one section or paragraph, respectively.

1 Purpose

1.1 The presence of oxygen can be beneficial to certain manufacturing operations by preventing the formation of process-induced defects. To the extent that this is true, it becomes important that the oxygen be uniformly distributed over the entire slice.

1.2 Multiple test plans are included to satisfy a variety of requirements. The characteristic shape and magnitude of oxygen concentration distributions in crystals are functions of the crystal growth process. Although the specified test plans are intended to cover oxygen concentration distributions which are typically found, other distributions may occur. In such cases, it may be necessary to use test positions other than those specified in order to adequately describe the distribution pattern.

1.3 This Test Method may be used for process control, research and development, and materials acceptance purposes. In the absence of an interlaboratory evaluation of the precision of this Test Method, its use for materials acceptance is not recommended unless the parties involved establish the degree of correlation which can be expected (refer to § 12).

2 Scope

2.1 This Test Method covers test site selection and data reduction procedures for radial variation of the interstitial oxygen concentration in silicon slices typically used in the manufacture of microelectronic semiconductor devices.

2.2 This Test Method is intended as both a referee and production test through selection of an appropriate test position plan.

2.3 The interstitial oxygen content may be measured in accordance with SEMI MF1188, SEMI MF1619, DIN 50438-1, JEITA EM-3504, or any other procedure agreed upon by the parties to the test.

NOTE 1: SEMI MF1366 is not based on infrared absorption measurement and it measures total oxygen content, not interstitial oxygen content. It is also a destructive technique. However, it can be used to determine the radial variation of the oxygen content if suitable modifications of the test procedure are made.

2.4 Acceptable thickness and surface finish for the test specimens are specified in the applicable test methods. This Test Method is suitable for use on chemically etched, single-side polished and double-side polished silicon wafers or slices with no surface defects that could adversely change infrared radiation transmission through the test specimen (subsequently called slice), provided that appropriate test methods for oxygen content are selected.

NOTICE: SEMI Standards and Safety Guidelines do not purport to address all safety issues associated with their use. It is the responsibility of the users of the Documents to establish appropriate safety and health practices, and determine the applicability of regulatory or other limitations prior to use.

3 Limitations

3.1 Variations of optical thickness can be caused by thickness or surface finish variations, or both.

3.2 Beam size differences from instrument to instrument can cause errors when the beam area is smaller than the aperture used in this Test Method.

4 Referenced Standards and Documents

4.1 SEMI Standards and Safety Guidelines

SEMI MF81 — Test Method for Measuring Radial Resistivity Variation on Silicon Wafers

SEMI MF533 — Test Method for Thickness and Thickness Variation of Silicon Wafers

SEMI MF1188 — Test Method for Interstitial Oxygen Content of Silicon by Infrared Absorption with Short Baseline

SEMI MF1366 — Test Method for Measuring Oxygen Concentration in Heavily Doped Silicon Substrates by Secondary Ion Mass Spectrometry

SEMI MF1619 — Test Method for Measurement of Interstitial Oxygen Content of Silicon Wafers by Infrared Absorption Spectroscopy with *p*-Polarized Radiation Incident at the Brewster Angle

4.2 ANSI Standards¹

ANSI/ASQ Z1.4-1993 — Sampling Procedures and Tables for Inspection by Attributes

4.3 DIN Standards²

DIN 50435 — Testing of Semiconductor Materials; Determination of the Radial Resistivity Variation of Silicon or Germanium Slices by Means of the Four-Point/Direct Current Method (Withdrawn)

DIN 50438-1 — Testing of Materials for Semiconductor Technology – Determination of Impurity Content in Silicon by Infrared Absorption – Part 1: Oxygen (Withdrawn)

DIN 50441-1 — Testing of Materials for Semiconductor Technology – Determination of Geometric Dimensions of Semiconductor Wafers – Part 1: Thickness and Thickness Variation (Withdrawn)

4.4 JEITA Standards³

JEITA EM-3504 — Standard Test Method for Interstitial Atomic Oxygen Content of Silicon by Infrared Absorption

NOTICE: Unless otherwise indicated, all documents cited shall be the latest published versions.

5 Summary of Test Method

5.1 Instruments are selected and qualified according to the test procedure chosen.

5.2 Measurements are made at the specified test locations and a relative oxygen variation is calculated by one of four available plans.

6 Apparatus

6.1 *Infrared Spectrophotometer* — As required by the test method for interstitial oxygen measurement.

6.2 *Thickness Measurement Equipment* — As required by the test method.

6.3 *Fixturing* — Capable of positioning test slices to the tolerances required in each plan, including a fixed 7.0 ± 0.5 mm circular aperture centered on the infrared beam.

7 Sampling

7.1 Sampling plans must be agreed upon by the participants.

¹ American National Standards Institute, 25 West 43rd Street, New York, NY 10036, USA; Telephone: +1.212.642.4900, Fax: +1.212.398.0023, <http://www.ansi.org>

² Deutsches Institut für Normung e.V., Available from Beuth Verlag GmbH, Burggrafenstrasse 6, D-10787 Berlin, Germany; Telephone: +49.30.2601.0; Fax: +49.30.2601.1260; <http://www.din.de>

³ Japan Electronics and Information Technology Industries Association, Ote Center Building, 1-1-3, Otemachi, Chiyoda-ku, Tokyo 100-0004, Japan; <http://www.jeita.or.jp>

7.2 For acceptance testing, ANSI/ASQ Z1.4-1993, normal level, must be used unless other agreements have been made.

8 Test Plans

8.1 Test Plan A

8.1.1 This test plan consists of measurements (1) at the center of the wafer, located within 3 mm of the intersection of any two diameters that are at least 45° apart, and (2) at one position 10.0 ± 1 mm from the sample periphery on one of the diameters parallel with or perpendicular to the major flat (or, for notched wafers, perpendicular to or parallel with the notch axis).

8.1.2 The positions of edge measurement sites are determined by the distance from the sample periphery to the center of the aperture.

8.1.3 The position A1 on the diameter perpendicular to the major flat (parallel with the notch axis) and at the side of the wafer opposite the major flat (or notch) is preferred (refer to Figure 1). Positions A2 and A3 on the diameter parallel with the major flat (perpendicular to the notch axis) may be selected to replace position A1 if agreed to by both customer and supplier. Specify Test Plan A1, Test Plan A2, or Test Plan A3 depending on the position selected.

8.1.4 When an interfering minor flat is present, locate the edge position as though the minor flat were not present.

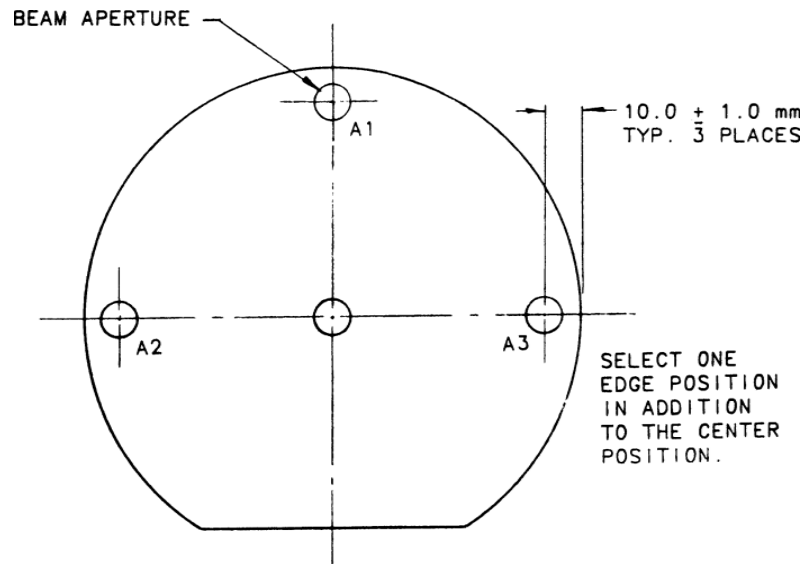


Figure 1
Test Plan A

8.2 Test Plan B

8.2.1 This test plan consists of measurements at the center of the wafer, located within 3 mm of the intersection of any two diameters that are at least 45° apart, and at two positions 10.0 ± 1 mm from the sample periphery on each end of the diameter parallel with the major flat (or, for notched wafers, perpendicular to the notch axis) (refer to Figure 2).

8.2.2 In addition, two optional measurements may be made at the half radius ($[R/2] \pm 1$ mm) positions on the same diameter of the wafer. If made, these optional measurements must be in addition to measurements at the center and two edge positions. Customer and supplier must agree on the use of measurements at R/2 positions. Specify Test Plan B1 when using all five positions.

8.2.3 When an interfering minor flat is present, locate the edge position as though the minor flat were not present.