



Designation: F 671 – 99

Standard Test Method for Measuring Flat Length on Wafers of Silicon and Other Electronic Materials¹

This standard is issued under the fixed designation F 671; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers techniques for determination of the length of the flattened portion of a wafer periphery.

1.2 This test method is intended primarily for use on electronic materials in the form of nominally circular edge-contoured wafers with flat lengths up to 65 mm. The precision of this test method has been established directly only for silicon wafers, but it is not expected to be material dependent.

1.3 This test method is suitable for referee measurement purposes and may be used for routine acceptance measurements when specified limits require test precision greater than can be obtained with hand held scale and unaided eye.

1.4 This test method is independent of surface finish.

1.5 For application to wafers of diameter 3 in. or smaller, the values stated in inch-pound units are to be regarded as the standard; the values stated in acceptable metric units are for information only. For application to wafers of diameter larger than 3 in., the values stated in acceptable metric units are to be regarded as the standard whether or not they appear in parentheses; the values stated in inch-pound units are for information only.

NOTE 1—DIN 50441, Part 4,² is a similar, but not equivalent method for determining flat length. In this method the flat length is calculated from a measurement of a flat depth. This method does not provide any correction for rounding at the ends of the flat.

1.6 *This standard does not purport to address 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.*

2. Referenced Documents

2.1 ASTM Standards:

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 50441, Part 4, Testing of Inorganic Semiconductor Materials: Measurement of the Geometric Dimensions of Semiconductor Wafers: Diameter and Flat Depth of Wafers is a similar, but not equivalent, method. It is the responsibility of DIN Committee NMP 221, with which Committee F-1 maintains close liaison. This document is available from Beuth Verlag GmbH, Burggrafenstrasse 4–10, D-1000, Berlin 30, Germany.

E 122 Practice for Choice of Sample Size to Estimate a Measure of Quality for a Lot or Process³

2.2 ANSI/ASQC Standard:

ANSI/ASQC Z1.4–1993 Sampling Procedures and Tables for Inspection by Attributes⁴

2.3 SEMI Standard:

Specifications M 1, for Polished Monocrystalline Silicon Wafers⁵

3. Terminology

3.1 Definitions:

3.1.1 *offset*—a perpendicular deviation at either end region of a flat from the horizontal reference line, used to define the flat boundaries (see Fig. 1).

3.1.2 *primary flat*—the flat of longest length that is commonly located with respect to a specific crystal plane; major flat.

3.1.3 *secondary flat*—the flat or flats of a length shorter than the primary flat, whose location with respect to the primary flat identifies the type and orientation of the wafer (see SEMI Specifications M 1); minor flat.

4. Summary of Test Method

4.1 The specimen is aligned on an optical comparator. One end of the projected image of the flat is positioned on a reference point on the viewing screen. The micrometer reading is recorded, and the stage is manipulated to scan to the opposite end of the flat where the micrometer reading is again recorded. Flat length is the difference between the first and second readings.

5. Significance and Use

5.1 The length of fiducial flats is an important materials characteristic for determining the suitability of material for use in semiconductor processing.

5.2 Automatic wafer handling equipment widely used in semiconductor device manufacturing processes relies on identification and orientation of the primary flat to obtain correct alignment.

³ *Annual Book of ASTM Standards*, Vol 14.02.

⁴ Available from American Society for Quality Control, 611 East Wisconsin Ave., Milwaukee, WI 53202

⁵ Available from Semiconductor Equipment and Materials International, 805 East Middlefield Rd., Mountain View, CA 94043.

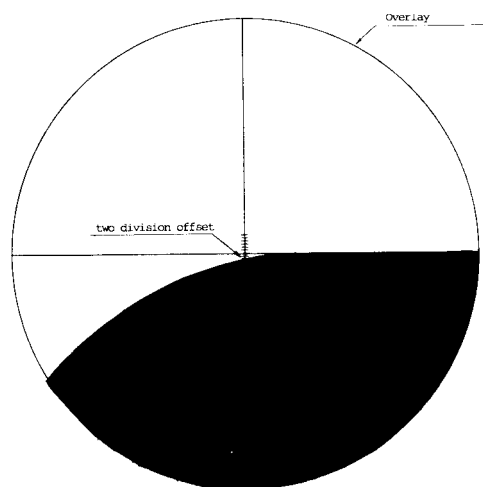


FIG. 1 Illustration of the Use of Offset

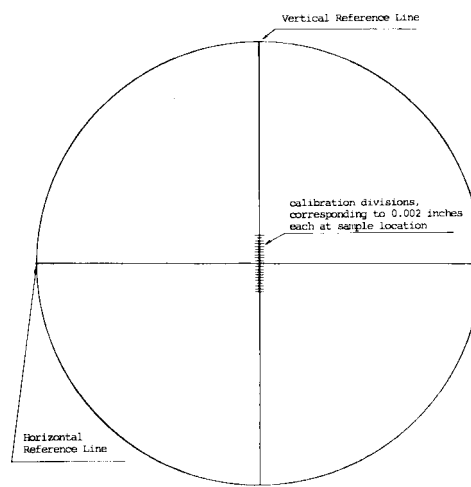


FIG. 2 Overlay

5.3 This test method is suitable for use in research, development, process control, quality assurance, and materials acceptance applications.

6. Interferences

6.1 Some operations performed after slicing, such as mechanical edge grinding and chemical etching, may reduce profile definition at the ends of the flattened area.

6.2 Backlash in the micrometer head assemblies may result in erroneous readings.

6.3 Failure to maintain sharp focus on the sample comparator screen image during measurement can introduce errors.

6.4 Comparator optics may sometimes incorporate image-reversal elements which result in image conditions opposite to those described by this test method.

7. Apparatus

7.1 *Shadowgraph Comparator*, equipped as follows:

7.1.1 20× optical system,

7.1.2 Viewing screen with minimum diameter of 10 in. (254 mm), and

7.1.3 Sample stage capable of minimum micrometer travel of 2 in. or 50 mm in the X direction and goniometer rotation in the X-Y plane.

7.1.3.1 Stage travel in the X direction shall move the projected image horizontally on the viewing screen. Travel in the Y direction shall move the projected image vertically on the viewing screen.

7.1.3.2 The X micrometer shall have graduations of 0.001 in. (25 μm) or less.

7.1.3.3 The Y direction stage travel must be enough to show the flattened regions of the largest wafer to be tested, or about three-fifths of the nominal diameter of the largest wafer to be tested.

7.1.4 An overlay, with reference lines perpendicular to each other intersecting at the center, and ten calibrated divisions on the vertical reference line above and below center, corresponding to 0.002 in. (50 μm) per division at the sample location. See Fig. 2.

NOTE 2—For a 20× overlay, the calibration divisions on the overlay itself will be 1 mm apart.

7.2 *Microscope Stage Micrometer* on clear glass or plastic, the scale to be at least 0.05 in. (1.3 mm) long with 0.001-in. (25-μm) divisions.

7.3 *Machinists' Steel Scale*, 6 in. (150 mm) minimum length, graduated in 0.02 in. (0.50 mm) or 0.01 in. (0.25 mm).

8. Sampling

8.1 Unless otherwise specified, Practice E 122 shall be used. When so specified, appropriate sample sizes shall be selected from each lot in accordance with ANSI/ASQC Z1.4-1993. Inspection levels shall be agreed upon between the supplier and purchaser.

9. Calibration

9.1 *Comparator Optical Magnification:*

9.1.1 Place the microscope stage micrometer on the comparator sample stage so that its projected image is at the center of the viewing screen.

9.1.2 With a steel scale on the viewing screen, count the number of 0.001-in. (25-μm) lines projected over a 1-in. (25-mm) distance. Divide the number into 1000 to obtain the actual magnification.

9.1.3 Magnification must be between 19.8 and 20.2 to be usable for this method.

9.2 *Comparator Micrometer Travel—X Direction:*

9.2.1 Set the X-travel micrometer to zero.

9.2.2 Align the projected image of the microscope stage micrometer such that the array of scale division lines is horizontal and the right most lines are all to one side of the vertical reference line on the viewing screen as in Fig. 3.

9.2.3 Using the X-travel micrometer, scan the image of the microscope stage micrometer until the array has been transposed to the opposite side of the vertical reference line in an analogous manner.

9.2.4 Read the X-travel micrometer scale. This value should agree with the full-range value of the microscope stage micrometer scale within 0.001 in. (25 μm). If the value does not agree, adjust or repair the micrometer.

10. Procedure

10.1 Mount the overlay (Fig. 2) on the viewing screen.