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AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Test Method for Dimensions of Notches on Silicon Wafers [1]

This standard is issued under the fixed designation F 1152; 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 a nondestructive procedure to determine whether or not the dimensions of fiducial notches on silicon wafers fall within specified limits.

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

1.3 *This standard does not purport to address all of the safety problems, 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:

E 122 Practice for Choice of Sample Size to Estimate a Measure of Quality of a Lot or Process [2]

2.2 Military Standard:

MIL-STD-105E Sampling Procedures and Tables for Inspection by Attributes [3]

2.3 SEMI Standard:

M 1 Specifications for Monocrystalline Silicon Wafers [4]

3. Summary of Test Method

3.1 The wafer is aligned in position on an optical comparator and the image of the notch is compared with a series of templates projected on the screen of the comparator.

3.2 First, the wafer is aligned so that the sides of the image of the notch contact the image of the alignment pin used to fix the position of the wafer in use. In this case, the image of the notch bottom must lie on or below the designated line on the notch form/depth template and the image of the wafer edge must lie on or above another designated line on the template.

3.3 The wafer is then aligned so that the image of the wafer edge coincides with the wafer periphery line on the template. In this case the image of the notch bottom must lie between maximum and minimum lines on the template.

3.4 The image of the notch sides are compared with a series of angles on the notch angle template and the angle that makes the best fit is chosen as the value of the notch angle.

3.5 No test is provided for the blend radius at the apex of the notch.

4. Significance and Use

4.1 Wafers must be accurately aligned in various processing equipment during integrated circuit manufacture.

4.2 A notch ground into the edge of the wafer at a specified orientation provides a positive method for such alignment. The accuracy of the critical dimensions of the notch controls the possible accuracy of the alignment.

4.3 This test method is specifically directed to the notch dimensions specified in SEMI Specifications M 1, but with suitable modifications, the principles of this test method may be applied to any desired notch dimensions.

4.4 This test method may be used for process control, quality control, and incoming or outgoing inspection.

4.5 Until an index of precision is determined based on an interlaboratory evaluation, this test method is not recommended for use in decisions between purchasers and suppliers.

5. Interferences

5.1 Any foreign material or rough spots on the notch edge in the light path may present a distorted image which can result in the determination of incorrect dimensions.

5.2 Alignment of the notch position with respect to the center of the wafer is important in achieving an accurate determination of the notch characteristics.

5.3 Wear of grinding tools and process variations may result in notch edges which are not exactly straight and a nonunique radius at the apex of the notch. Under these conditions, great care must be taken to align the image of the notch correctly against the appropriate portions of the template.

6. Apparatus

6.1 *Optical Comparator*, capable of 20 and 50× magnification with a viewing screen large enough to display an area 5 by 5 mm at 20× or 2 by 2 mm at 50×.

6.2 *Fixture*, for holding the wafer to be tested. The fixture must provide means for positioning the wafer such that the plane of the surface of the wafer is perpendicular to the viewing direction and that the wafer can be rotated about its center. The horizontal and vertical motions are parallel or

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[2] *Annual Book of ASTM Standards*, Vol 14.02.

[3] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

[4] Available from the Semiconductor Equipment and Materials Institute, 805 Middlefield Rd., Mountain View, CA 94043.

perpendicular to the diameter of the wafer that passes through the notch.

6.3 *Templates*, having lines which define the limits of the notch dimensions. Two templates are required.

6.3.1 The notch form and depth template has two sections that define (1) the locations of the notch bottom and wafer periphery relative to the center of the alignment pin, and (2) the location of the notch bottom relative to the wafer periphery. Separate templates are required for each wafer diameter to be tested. An example of a notch form and depth template is given in Fig. 1.

6.3.2 The notch angle template contains angles from 88 to 96° in 1° increments.

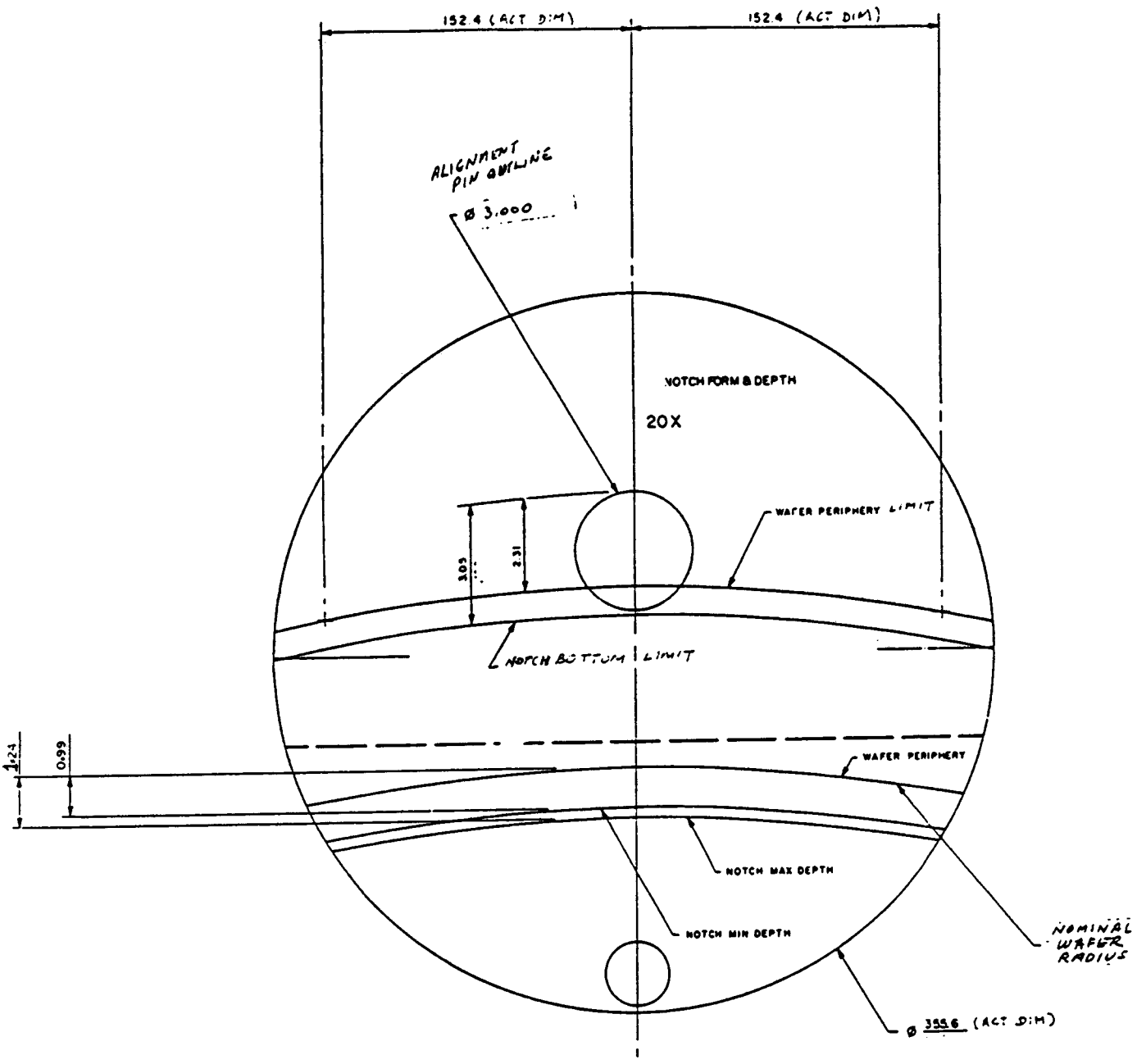
6.3.3 Instructions for constructing templates are given in Section 9.

6.4 *Gage Block or Precision Rod*, with dimensions approximately the same as the depth of the notch and accurately known for use in establishing the magnification of the apparatus.

6.5 *Rule*, 150 mm long with scale gradations of 0.5 mm or less.

7. Sampling

7.1 Unless otherwise specified, Practice E 122 shall be used to select sample sizes. When so specified, appropriate sample sizes shall be selected from each lot in accordance with



NOTE 1—In use the template is rotated 90° counterclockwise.

FIG. 1 Example of Notch Form and Depth Template

MIL-STD-105E. Inspection levels shall be agreed upon between the parties to the test.

8. Determination of Magnification Factor

8.1 Adjust the comparator to the desired magnification. Using the gage block or precision rod of accurately known dimensions, follow the manufacturer's instructions to establish the object-to-image magnification to three significant figures.

9. Preparation of Templates

9.1 Multiply each of the chosen or specified template dimensions by the magnification factor.

9.2 Prepare on transparent material a full scale template with the dimensions calculated in 9.1 and a projected image accuracy of ±0.5 mm or better.

9.3 Include horizontal and vertical axes and label the lines on the notch form and depth template as shown in Fig. 1.

10. Procedure

10.1 Set the magnification to 20×.

10.2 Align the fixture in the comparator so that the notch is at the nine o'clock position and the directions of horizontal and vertical motion of the fixture in the comparator are parallel with and perpendicular to, respectively, the diameter which passes through the notch.

10.3 Place the notch form and depth template on the comparator screen. Align the horizontal and vertical lines with the simulated pin outline in the nine o'clock position.

10.4 Place the first sample to be tested in the fixture, front surface up.

10.5 Align the fixture using only table crossfeed (horizontal) control and fixture rotation so that the simulated pin outline on the template makes contact with the sides of the notch image.

10.6 Verify that the image of the notch bottom falls on or below the NOTCH BOTTOM LIMIT line. If the image of the notch bottom falls above this line, record the sample as defective.

10.7 Verify that the image of the wafer edge falls on or above the WAFER PERIPHERY LIMIT line. If the image of the wafer edge falls above this line, record the sample as defective.

10.8 Move the fixture to the right until the image of the wafer edge falls on the line marked WAFER PERIPHERY using only the table crossfeed control.

10.9 Verify that the notch bottom falls between the NOTCH MAX DEPTH and NOTCH MIN DEPTH lines. If the image of the notch bottom falls outside these lines, record the sample as defective.

10.10 Repeat 10.4 through 10.9 for all remaining samples to be tested.

10.11 Remove the notch form and depth template and replace it with the notch angle template.

10.12 Set the magnification to 50×.

10.13 Place the first sample to be tested in the fixture, front surface up.

10.14 Align the image of the wafer notch sides with each angle on the template using the table crossfeed control and the fixture rotation. Define as the notch angle, the angle that provides the best fit to the image. If the notch angle is <89 or >95°, record the sample as defective.

10.15 Repeat 10.14 for all remaining samples to be tested.

10.16 On completion of the testing, return the magnification to 20×.

11. Report

11.1 Report as a minimum the following information:

11.1.1 Date of test,

11.1.2 Name of person conducting the test,

11.1.3 The lot number or other identification of the material,

11.1.4 The number of wafers in the lot,

11.1.5 The number of wafers tested, and

11.1.6 The number of defective wafers.

11.2 If desired, a table of the types of defects observed may be provided.

12. Precision and Bias

12.1 Interlaboratory evaluation of this test method is planned to verify its suitability and reliability. Until the results are established, use of this test method for commercial transactions is not recommended unless the parties to the test establish the degree of correlation that can be obtained.

12.2 A dimension of 0.1 mm in the object plane produces a screen image of 2.0 mm at 20× and of 5.0 mm at 50×. The smallest size details of the notch contour which can be inspected by this test method are of comparable dimensions.

13. Keywords

13.1 notch; notch dimension; optical comparator; silicon; wafer