

SEMI M68-0315

PRACTICE FOR DETERMINING WAFER NEAR-EDGE GEOMETRY FROM A MEASURED HEIGHT DATA ARRAY USING A CURVATURE METRIC, ZDD

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 November 11, 2014. Available at www.semiviews.org and www.semi.org in March 2015; originally published March 2007; previously published November 2009.

1 Purpose

- 1.1 Wafer near-edge geometry can significantly affect the yield of semiconductor device processing.
- 1.2 Knowledge of near-edge geometrical properties can help the producer and consumer determine if the dimensional characteristics of a specimen wafer satisfy given geometrical requirements.
- 1.3 The metric, ZDD, quantifies the near-edge curvature of wafers used in semiconductor device processing.
- 1.4 Consideration should be given to the use of this or other proposed near-edge geometry metrics as a process control tool rather than a material exchange specification.

2 Scope

- 2.1 This Practice covers calculation of near-edge curvature ZDD (radial double derivative of z [height]).
- 2.2 The metric calculated by this Practice is based on a height data array; either a single surface (front or back) or thickness.
- 2.3 This Practice is suitable for polished, epitaxial, SOI, or other layer condition.
- 2.4 The Practice is applicable to notched 200 and 300 mm diameter wafers having dimensions in accordance with wafer categories 1.9.2, 1.9.3, 1.15, and 1.15.1 of SEMI M1.
- 2.5 This Practice does not cover acquisition of the height data array. However, it gives the required characteristics of the height data array.

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 Deficiencies of data such as inadequate spatial resolution, mispositioning, noise, etc. in the height data array used to calculate the metrics may lead to erroneous results.
- 3.2 Noise of the ZDD calculation may be affected by the height data array spacing and the details of the sector averaging and the differentiation method for curvature.

4 Referenced Standards and Documents

4.1 SEMI Standards and Safety Guidelines

SEMI M1 — Specification for Polished Single Crystal Silicon Wafers

SEMI M20 — Practice for Establishing a Wafer Coordinate System

SEMI M59 — Terminology for Silicon Technology

SEMI M67 — Practice for Determining Wafer Near-Edge Geometry from a Measured Thickness Data Array Using the ESFQR, ESFQD and ESBIR Metrics

SEMI M70 — Practice for Determining Wafer-Near-Edge Geometry Using Partial Wafer Site Flatness

SEMI M77 — Practice for Determining Wafer Near-Edge Geometry Using Roll-Off Amount, ROA

SEMI MF1530 — Test Method for Measuring Flatness, Thickness, and Total Thickness Variation on Silicon Wafers by Automated Noncontact Scanning

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

5 Terminology

5.1 Acronyms, terms, and symbols used in silicon wafer technology, including those in this Practice, are given in SEMI M59.

6 Summary of Practice

6.1 Sectors for calculation of ZDD are defined by ZDD reporting radii and sector angular extent. Required exclusions are defined.

6.2 A height data array is acquired.

6.3 $ZDD(r)$ for each sector is calculated.

6.4 Recipe parameters are reported.

6.5 ZDD is reported at the reporting radii for each sector and surface(s) analyzed.

6.6 Statistical quantities for ZDD are also calculated and reported for each wafer.

7 Apparatus

7.1 *Measuring Equipment* — Suitable for acquiring the height data array and transferring it to the calculation equipment. A test method for acquiring the height data array is not covered in this Document.

7.1.1 The equipment shall perform all necessary calculations and corrections needed to produce the height data array internally and automatically, including instrument-dependent exclusion areas. The equipment shall be equipped with a means of detecting and either deleting or identifying invalid data (over-range signal).

7.1.2 Height resolution shall be 1 nm or smaller.

7.1.3 Height data array data point spacing shall be 0.5 mm or less in two orthogonal directions in the plane of the wafer.

7.1.4 The acquisition spatial resolution shall be appropriate for the height data array data point spacing and shall be agreed upon between the parties of the test.

7.1.5 The height data array must cover the wafer surface to allow calculation of ZDD at the reporting radii (except in exclusion areas) (see Note 1).

NOTE 1: Typical ZDD calculations require at least one data point radially either side of the calculated point.

7.1.6 *Calculation Software* — To perform the calculations of this Practice and to provide outputs of the results, including statistical parameters as agreed upon by the parties to the test.

8 Procedure

8.1 Define $r_1 \dots r_n$ as the radii for reporting of ZDD. The largest reporting radius r_n is typically $R_{NOM} - EE$ where EE is the specified nominal edge exclusion. A minimum value for EE is agreed upon by all parties to the practice (see Note 2).

8.2 Select the number of sectors, N , which defines a sector span, $\theta_s = 360/N$, where θ_s is in degrees. (Default $N=72$, $\theta_s=5$ degree.)

8.3 Determine statistics to be reported for each wafer. As a minimum, these shall include maximum, average, range, standard deviation, and 95th percentile. Note: for small numbers of sectors (e.g., less than 100) the 95th percentile may not be appropriate.

8.4 Acquire the height data array in accordance with a method agreed upon by all parties to the practice.