

SEMI M68-0307 (Preliminary)

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 global Silicon Wafer Committee. This edition was approved for publication by the global Audits and Reviews Subcommittee on January 18, 2007. It was available at www.semi.org in February 2007 and on CD-ROM in March 2007.

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 and 1.15 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: This standard does not purport to address safety issues, if any, associated with its use. It is the responsibility of the users of this standard 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

SEMI M1 — Specifications for Polished Monocrystalline Silicon Wafers

SEMI M20 — Practice for Establishing a Wafer Coordinate System

SEMI M59 — Terminology for Silicon Technology

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

5 Terminology

- 5.1 General terms, acronyms, and symbols used in silicon wafer technology are listed and defined in SEMI M59.

5.1.1 Other Definitions

5.1.2 *edge roll off (ERO)* — surface deviations of a large-diameter silicon wafer near the edge, but excluding effects due to wafer edge profiling.

5.1.3 *near-edge geometry* — the flatness of the top surface of a large diameter silicon wafer in the outer region of the fixed quality area (FQA).

6 Summary of Practice

- 6.1 Sectors for calculation of ZDD are defined by FQA radius and sector angular extent. Required exclusions are defined.
- 6.2 A height data array is acquired.
- 6.3 ZDD reporting radii are defined.
- 6.4 ZDD(r) for each sector is calculated.
- 6.5 Recipe parameters are reported.
- 6.6 ZDD is reported at the reporting radii for each sector and surface(s) analyzed.
- 6.7 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 including the entire FQA boundary (except in exclusion areas).
- 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 Select the fixed quality area (FQA) by specifying the nominal edge exclusion EE . The FQA radius, $R_{FQA} = R_{NOM} - EE$ where R_{NOM} is the nominal radius of the wafer (e.g., 100 or 150 mm).
- 8.2 Select the number of sectors, N , which defines a sector span, $\theta_s = 360/N$, where θ_s is in degrees.
- 8.3 Define $r_1 \dots r_n$ as the radii for reporting of ZDD.
- 8.4 Determine statistics to be reported for each wafer. As a minimum, these shall include maximum, average, range, standard deviation, and 95th percentile.
- 8.5 Acquire the height data array in accordance with a method agreed upon by all parties to the practice.

9 Calculations

NOTE 1: The following calculations are performed automatically within the equipment. An outline of the calculation structures is provided here to indicate the nature of the procedure.

NOTE 2: Alternative calculation of sector average profile from the height data array, giving comparable results, may be used. Data at sector boundaries is generated using interpolation techniques. This may result in use of height data outside the FQA boundary. Alternatively, for this boundary, an extrapolation technique may be used.

- 9.1 Divide the wafer surface into N sectors, S_1 to S_N as follows (see Figure 1):
 - 9.1.1 Place the outer boundary of the sectors at a radius $R_o = R_{FQA}$. (see 8.1.1).
 - 9.1.2 Place the counter-clockwise lateral boundary of a sector S_i is at $\theta_{CCi} = (i - 1)\theta_s + \theta_s/2$.
 - 9.1.3 Place the clockwise lateral boundary of a sector S_i is at $\theta_{Ci} = (i - 1)\theta_s - \theta_s/2$.
- 9.2 For each sector,
 - 9.2.1 Interpolate values from the height data array onto a polar grid having data point spacing consistent with ¶ 7.1.3 which includes the sector boundaries.
 - 9.2.2 Calculate a sector average radial profile from the polar grid by averaging all the data within the sector and on its boundaries at each radius.