# SEMI MF1810-1110 (Reapproved 1115)
# TEST METHOD FOR COUNTING PREFERENTIALLY ETCHED OR DECORATED SURFACE DEFECTS 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 31, 2015. Available at www.semiviews.org and www.semi.org in November 2015; originally published by ASTM International as ASTM F1810-97; previously published November 2010.

**NOTICE:** This Document was reapproved with minor editorial changes.

SUPERSEDED

## 1 Purpose

1.1 Defects on or in silicon wafers may adversely affect device performance and yield.

1.2 Crystal defect analysis is a useful technique in troubleshooting device process problems. The type, location, and density of defects counted by this Test Method may be related to the crystal growth process, surface preparation, contamination, or thermal history of the wafer.

1.3 This Test Method is suitable for acceptance testing when used with referenced standards.

## 2 Scope

2.1 This Test Method describes the technique to count the density of surface defects in silicon wafers by microscopic analysis.

NOTE 1: Practical use of a defect counting method requires an assumption be made that defects are randomly distributed on the surface. If this assumption is not met, the accuracy and precision of this Test Method will be diminished.

2.2 Application of this Test Method is limited to specimens that have discrete, identifiable artifacts on the surface of the silicon sample. Typical samples have been preferentially etched according to SEMI MF1809 or epitaxially deposited, forming defects in a silicon layer structure.

2.3 Wafer thickness and diameter for this Test Method is limited only by the range of microscope stage motions available.

2.4 This Test Method is applicable to silicon wafers with defect density between 0.01 and 10,000 defects per $cm^2$.

NOTE 2: The commercially significant defect density range is between 0.01 to 10 defects per $cm^2$, but this Test Method extends to higher defect levels due to the improved statistical sampling obtained with higher counts.

**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 Improper identification of defects is possible during the counting process.

3.1.1 Contamination not removed by cleaning procedures or deposited following cleaning, may become visible after preferential etching.

3.1.2 Insufficient agitation during the preferential etching process may cause artifacts that may be mistaken as crystallographic defects.

3.2 The accuracy of the defect density calculation is directly affected by calibration of the area of the microscope field of view.

3.3 The defect density determined by this Test Method requires an assumption be made that defects are randomly distributed on the surface. Nonuniform patterns of defects alter the defect density measurement by their size and location.

3.4 Multiple scan patterns intersect at the center of the wafer. If a defect is found at this single, common point, it is counted more than once and thus alters the accuracy of the count.



Documents Document Sharing Hub

Full document details: SEMI MF1810-1110-1115R

## 4 Referenced Standards and Documents

4.1 *SEMI Standards and Safety Guidelines*

SEMI M59 — Terminology of Silicon Technology

SEMI MF1725 — Practice for Analysis of Crystallographic Perfection of Silicon Ingots

SEMI MF1726 — Practice for Analysis of Crystallographic Perfection of Silicon Wafers

SEMI MF1727 — Practice for Detection of Oxidation Induced Defects in Polished Silicon Wafers

SEMI MF1809 — Guide for Selection and Use of Etching Solutions to Delineate Structural Defects in Silicon

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

## 5 Terminology

5.1 Acronyms, terms, and symbols related to silicon technology, including those used in this Test Method, are listed and defined in SEMI M59.

## 6 Summary of Test Method

6.1 Samples for this test are selected and prepared in accordance with SEMI MF1725, SEMI MF1726 or SEMI MF1727. As indicated in these practices, the defect to be analyzed is exposed using one of the specific etching solutions listed in SEMI MF1809.

6.2 The wafer is aligned on a microscope stage.

6.3 It is then inspected according to predefined inspection pattern.

6.3.1 The basic inspection pattern is a single scan along a wafer diameter. The starting and ending points of the scan pattern are 5 mm from the edges of the wafer. Figure 1 represents the characteristics of the basic pattern.

6.3.2 The complete inspection pattern of this Test Method is based upon the combination of four separate basic scans across different diameters.

6.4 Finally, specific defects distinguished by shape or size are counted.

## 7 Apparatus

7.1 *Nonmetallic Vacuum Pickup Tool* — Of suitable material such as quartz or TFE-fluorocarbon. The pickup tool shall be constructed so that no metal can contact the specimen wafer.

7.2 *Optical Microscope* — Equipped with interference contrast attachment.

NOTE 3: Nomarski differential interference contrast is an example of interference contrast.

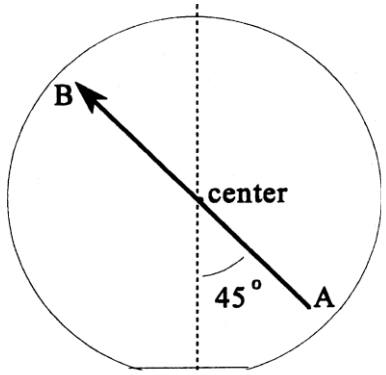
7.2.1 *Eyepiece and Objective Lens* — In combination shall give a magnification range of approximately 100× to 400× magnification of the specimen. The dimension of the field of view at each magnification option is calibrated to allow defect density calculations.

SUPERSEDED



Documents
Document Sharing Hub

Full document details: SEMI MF1810-1110-1115R




#1 Begin scan 5 mm from the edge.

**Figure 1**
**The Basic Microscopic Inspection Scan Pattern**

7.2.2 *Graduated Metric X-Y Microscope Stage* — Used for sample positioning.

## 8 Sampling

8.1 Specimens shall be selected to represent the lot to be tested as specified in producer-consumer agreements.

## 9 Procedure

9.1 *Four Scan Inspection Pattern*

9.1.1 Place the specimen wafer onto the microscope inspection stage. Handle wafers only with a clean nonmetallic vacuum pickup tool to avoid scratching or contaminating the surface.

9.1.2 Place the specimen such that a single linear motion of the stage (either *x* or *y*) allows counting of defects contained in the field of view along the path labeled *AB* in Figure 1. Points *A* and *B* are 5 mm from the wafer edge and the line *AB* is rotated 45° from the location of the major orientation flat or notch. Alternative edge exclusion positions are acceptable with the agreement of the parties involved.

9.1.3 Scan the path and record the classification and numbers of the defects observed during the scan. Refer to descriptions and pictures in SEMI MF1809.

9.1.4 Rotate the wafer by 45° clockwise on the microscope stage and repeat ¶ 9.1.3 for the second scan. Refer to Figure 2 for improved definition of the scan pattern.

9.1.5 Rotate the wafer by 45° clockwise on the microscope stage and repeat ¶ 9.1.3 for the third scan.

9.1.6 Rotate the wafer by 45° clockwise on the microscope stage and repeat ¶ 9.1.3 for the fourth scan.

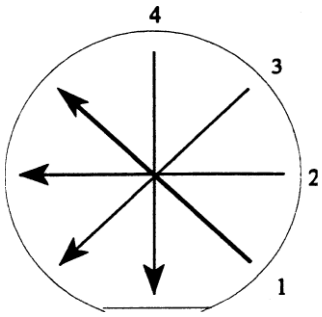



**Figure 2**
**Four Scan, Multiple Microscopic Inspection Pattern**

SUPERSEDED



Documents
Document Sharing Hub
Full document details: SEMI MF1810-1110-1115R