Designation: F 1725 – 02

Standard Guide for Analysis of Crystallographic Perfection of Silicon Ingots [1]

This standard is issued under the fixed designation F 1725; 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 practice covers the analysis of the crystallographic perfection in silicon ingots. The steps described are sample preparation, etching solution selection and use, defect identification, and defect counting.

1.2 This practice is suitable for use if evaluating silicon grown in either [111] or [100] direction and doped either *p* or *n* type with resistivity greater than 0.005 Ωcm.

1.3 *This standard does not purport to address all of 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:*

D 5127 Guide for Ultra Pure Water Used in the Electronics and Semiconductor Industry [2]
F 26 Test Method for Determining the Orientation of a Semiconductor Single Crystal [3]
F 523 Practice for Unaided Visual Inspection of Polished Silicon Wafers [3]
F 1241 Terminology of Silicon Technology [3]
F 1809 Guide for Selection and Use of Etching Solutions to Delineate Structural Defects in Silicon [3]
F 1810 Test Method for Counting Preferentially Etched or Decorated Surface Defects in Silicon Wafers [2]

2.2 *SEMI Standards:*

C18 Specification for Acetic Acid[4]
C28 Specifications and Guidelines for Hydrofluoric Acid[4]
C35 Specifications and Guidelines for Nitric Acid[4]

3. Terminology

3.1 Defect-related terminology may be found in Terminology F 1241.

4. Summary of Practice

4.1 The end portion of the silicon crystal, which solidified last, may contain dislocations or other defects such as slip. The portion containing the defects is removed by sawing the crystal. A specimen wafer from the end of the remaining ingot is obtained with a second cut.

4.2 This wafer is mechanically lapped, chemically polished, and then etched in a preferential defect etching solution.

4.3 The etched surface is examined under bright light illumination and examined microscopically to count and classify the imperfections highlighted by the preferential defect etching solution.

5. Significance and Use

5.1 The use of silicon wafers in many semiconductor devices requires a consistent atomic lattice structure. Crystal defects disturb local lattice energy conditions that are the basis for semiconductor behavior. These defects have distinct effects on essential semiconductor device-manufacturing processes such as alloying and diffusion.

5.2 This practice along with the referenced standards may be used for process control, research and development, and materials' acceptance purposes.

6. Apparatus

6.1 *Slicing Equipment*, suitable for removing wafers of varied thickness from ingots.

6.2 *Lapping or Grinding Equipment* (optional), suitable for removing saw damage.

6.3 *Laboratory Equipment*, suitable for use with hydrofluoric acid (fluorocarbon, polyethylene, or prolypropylene beakers, graduates, pipets, and nonmetallic wafer pickup tools).

6.4 *Acid Sink*, in a fume hood and facilities for disposing of acids and their vapors.

6.5 *Personnel Safety Equipment*, for handling acids, such as gloves, safety glasses, face shield, and gown.

7. Reagents and Materials

7.1 *Purity of Reagents*—All chemicals for which such specifications exist shall conform to the assay and impurity levels of Grade 1 SEMI Specifications.. Other grades may be used provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

---

[1] This guide is under the jurisdiction of ASTM Committee F01 on Electronics and is the direct responsibility of Subcommittee F01.06 on Silicon Materials and Process Control.

Current edition approved Dec. 10, 2002. Published February 2003. Originally approved in 1997. Last previous edition approved in 1997 as F 1725–97.

[2] *Annual Book of ASTM Standards*, Vol 11.01.

[3] *Annual Book of ASTM Standards*, Vol 10.05.

[4] Available from Semiconductor Equipment and Materials International, 3081 Zanker Road, San Jose, CA 95134 (www.semi.org).