

SEMI MF1049-0308 (Reapproved 0413) PRACTICE FOR SHALLOW ETCH PIT DETECTION ON SILICON WAFERS

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1 Purpose

1.1 High levels of etch pits are reported¹ to indicate metallic contamination that is detrimental to wafer processing. This can be deduced from the density of etch pits on the surface of the wafer.

1.2 This Practice is used to detect shallow etch pits that may be related to the level of metallic impurities near the surface of silicon epitaxial or polished wafers.

2 Scope

2.1 This Practice covers detection of high densities of shallow etch pits on silicon wafers doped either *p*- or *n*-type and with resistivities as low as 0.005 $\Omega\cdot\text{cm}$. This Practice is applicable for silicon wafers cut from crystals grown in either a (111) or (100) crystal orientation.

2.2 This Practice is not recommended for use in defect density evaluations, but as a subjective means of estimating defect densities and distributions on the surface of a polished or epitaxial wafer.

NOTE 1: For determination of shallow and other defect densities in wafer production environments, use of the sequence of procedures in SEMI MF1726, SEMI MF1727, SEMI MF1809, and SEMI MF1810 is recommended.

2.3 This Practice utilizes a thermal oxidation process followed by a chemical preferential etchant to create and then delineate shallow etch pits.

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 Etch artifacts are the primary cause of difficulty in identifying shallow etch pits. Etch artifacts are generated in various ways such as gas bubble formation during etching, improperly cleaned surface prior to etching, or insufficient etch solution volume.

3.2 Excessive silicon staining (very dark color) during the preferential etching may obscure or prevent the development of shallow etch pits on heavily doped *p*-type silicon material ($<0.2 \Omega\cdot\text{cm}$).²

NOTE 2: Light staining will not affect subsequent defect etch results. However, heavy stains are undesirable.

4 Referenced Standards and Documents

4.1 SEMI Standards and Safety Guidelines

SEMI C28 — Specifications for Hydrofluoric Acid

SEMI C54 — Specifications and Guidelines for Oxygen

SEMI C59 — Specifications and Guidelines for Nitrogen

SEMI M17 — Guide for a Universal Wafer Grid

¹ Pearce, C. W., and McMahon, R. G., "Role of Metallic Contamination in the Formation of 'Saucer' Pit Defects in Epitaxial Silicon." *J. Vac. Sci. Tech.*, **14** (1977) p. 40.

² Schimmel, D. G., and Elkind, M. J., "An Examination of the Chemical Staining of Silicon." *J. Electrochem. Soc.*, **125** (1978) p. 152.

SEMI M59 — Terminology for Silicon Technology

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

SEMI MF1810 — Test Method for Counting Preferentially Etched or Decorated Surface Defects in Silicon Wafers

4.2 *ASTM Standard*³

ASTM D5127 — Guide for Ultra-Pure Water Used in the Electronics and Semiconductor Industries

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

5 Terminology

5.1 General terms, acronyms, and symbols associated with silicon technology and used in this Standard are listed and defined in SEMI M59.

6 Summary of Practice

6.1 Silicon wafers, either epitaxial or polished, are thermally oxidized and preferential etched to reveal small etch pits, shallow in depth, when observed through an interference contrast microscope.

6.2 The distribution of the etch pits on the surface of the wafer is determined and recorded on a diagram.

7 Apparatus

7.1 *High-Intensity, Narrow-Beam Light Source* — Tungsten filament with a concentrated beam intensity greater than 16 klx (1500 fc) and a beam diameter of 20 to 40 mm (0.8 to 1.6 in.) at a position 100 mm (4 in.) from the light-source housing. The light beam shall not be collimated and shall be capable of forming an image of the bulb filament at the lamp focus length.

NOTE 3: Some standard microscope illuminators meet these requirements.

7.2 *Hydrofluoric Acid-Proof Chemical Laboratory Apparatus* — Fluorocarbon, polyethylene, or polypropylene beakers, graduates, tweezers, eye protection, apron, gloves, and protective sleeves.

7.3 *Wafer Holders* — HF acid-proof wafer carriers which hold wafers. These are required if more than one wafer is to be etched at a time.

7.4 *Optical Microscope* — Equipped with interference contrast attachment. The eyepiece and objective lens in combination shall give 200× to 1000× magnification.

NOTE 4: Nomarski differential interference contrast is an example of interference contrast.

7.4.1 *Stage Micrometer* — With divisions of 0.002 mm or finer, if an estimate of the shallow etch pit density is to be made.

7.5 *Acid Sink* — A fume hood and facilities for disposing of acids and their vapors.

7.6 *Spin Dryer* — Used to dry the wafers. Although this item is not required, it is useful to provide a surface free of residue artifacts.

8 Reagents and Materials

8.1 *Purity of Reagents* — Reagents for which SEMI Specifications have not been developed shall conform to the specifications of the Committee of Analytical Reagents of the American Chemical Society.⁴ Other grades may be used

³ ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA; Telephone: +1.610.832.9585, Fax: +1.610.832.9555, <http://www.astm.org>

⁴ Reagent Chemicals, *American Chemical Society Specifications*, American Chemical Society, Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see *Analar Standards for Laboratory Chemicals*, BDH Ltd., Poole, Dorset, U.K., and the *United States Pharmacopeia and National Formulary*, U.S. Pharmacopeial Convention, Inc. (USPC), Rockville, MD.