SEMI MF674-0705 (Reapproved 0611)
PRACTICES FOR PREPARING SILICON FOR SPREADING RESISTANCE MEASUREMENTS

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NOTICE: This document was reapproved with minor editorial changes.

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1 Purpose

1.1 Resistivity is probably the single most important parameter for the characterization of silicon starting material for semiconductor device fabrication. Spreading resistance measurements are used to measure resistivity variations in raw silicon crystals and completed semiconductor devices. The reproducibility of spreading resistance measurements on silicon specimens is known to depend on the manner of specimen preparation. The interpretation of spreading resistance measurements depends in turn on the reproducibility of test specimen measurements and on the reproducibility of calibration specimen measurements.

1.2 The procedures given are intended to confer a high degree of reproducibility to spreading resistance measurements, and offer improvement over other preparation techniques.[1]

2 Scope

2.1 These practices cover the surface preparation of silicon samples using diamond polishing prior to measurement of resistivity variations by the spreading resistance technique.

NOTE 1: Benefits derived from diamond polishing are (1) stability and reproducibility of spreading resistance values on large area or beveled specimens, and (2) acuity of beveled surface geometry. The benefits of stability and reproducibility are likely to apply to both conductivity types and all resistivity values; however, they have been demonstrated extensively only for (111) *n*-type above 1 Ω·cm. Enhanced bevel acuity is independent of conductivity-type or resistivity value.

2.2 Separate practices are given for preparation of large-area specimens for measurement of lateral resistivity variations and for preparation of bevel-sectioned specimens (usually small chips) for measurement of vertical variations of resistivity (depth profiling).

2.3 The two practices are covered as follows:

- *Front-Surface Diamond Polishing* — § 7.1 through § 7.3.
- *Diamond Bevel Polishing* — § 8.1 through § 8.3.

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 Polishing of silicon with diamond causes light but controllable and uniform scratch damage to the silicon surface. Nevertheless, such uniform damage is compatible with spreading resistance measurement data having very low scatter. Contamination of the polishing medium with hard foreign particles can cause random heavy scratch damage to a specimen. If encountered by the spreading resistance probes, heavily scratch-damaged regions may yield erratic measurement results.

3.2 Contamination of the specimen with water subsequent to polishing may adversely affect the reproducibility of spreading resistance measurements.

[1] Ehrstein, J. R., Ricks, D. R. and Robinson, L. A., "Spreading Resistance Measurements, Measurement Techniques for High Power Semiconductor Materials and Devices," Annual Report, Oct. 1, 1977 to Sept. 30, 1978, NBSIR 79-1756, F.F. Oettinger, ed.

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4 Referenced Standards and Documents

4.1 *SEMI Standards and Safety Guidelines*

SEMI M59 — Terminology for Silicon Technology

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

5 Terminology

5.1 *Definitions*

5.1.1 Terms relating to silicon technology are defined in SEMI M59.

6 Summary of Practices

6.1 Silicon specimens are polished using fine-grain diamond compound in a non-aqueous fluid. Polishing of silicon wafers or other large-area specimens is done against a nonwoven polishing cloth; bevel polishing of small specimens is done against a frosted lapped glass surface. When polishing is complete, residual polishing compound is removed by an organic solvent.

7 Front-Surface Diamond Polishing

7.1 *Apparatus*

7.1.1 *Polishing Machine* — Oscillating-tub polisher or other similar small laboratory-scale polishing machine capable of providing randomized motion of the silicon specimen over the polishing pad.

7.1.2 *Mounting Block and Fixture* — To support and apply vertical load to the silicon specimen during polishing.

7.1.3 *Polishing Pad* — Nonwoven cloth pad of a texture specified as being compatible with the grain size of diamond used during polishing. The polishing pad should be adhesive-backed for attaching to a support plate.

NOTE 2: The preferred material is of a type identified as a "chemotextile."

7.1.4 *Support Plate* — Of glass or other similar hard material compatible with the chosen polishing machine and capable of providing a flat support for the polishing pad during polishing.

7.1.5 *Microscope* — Optical microscope having a total magnification of at least 30× and provision for oblique illumination of the specimen.

7.1.6 *Hot Plate* — Capable of heating the sample mounting block and wax to 150°C.

7.2 *Reagents and Materials*

7.2.1 *Diamond Slurry* — Synthetic or natural diamond with grain size in the range 0.5 to 3 µm, inclusive, suspended in a nonaqueous liquid or paste carrier.

NOTE 3: The predominant causes of variation in the surface finish of the silicon specimen are expected to result from (1) the uniformity of particle size in the diamond grit, (2) the inclusion of a large fraction of needle-shaped grains (fines) in addition to the preferred symmetric grains (blocky diamond), and (3) in the case of diamond suspended in paste, the uniformity of the diamond distribution in the paste. For a fixed diamond grain size, whether the diamond is natural, single-crystal synthetic, or polycrystalline synthetic should make little difference in the resulting surface finish. However, the abrasive breakdown mechanisms differ somewhat for the different types of diamond. Consequently, the size and type of diamond should be chosen to give an acceptable cutting rate for the specimen and machine conditions that are used.

NOTE 4: For use with large-area specimens, the appropriate size diamond grain and, in part, the type of diamond to be used should be compatible with (1) the starting surface texture of the silicon, which may range from as-sawn to prepolished, and (2) the load that is applied during polishing.

7.2.2 *Solvent* — Suitable nonaqueous solvent for removing diamond slurry subsequent to polishing.

NOTE 5: The choice of solvent is governed in part by the composition of the carrier liquid or paste. The supplier of the diamond slurry should be consulted regarding the appropriate solvent. Acetone [$(CH_3)_2CO$] and methanol (CH_3OH) are known to work well for removing many commercial diamond compounds.

7.2.3 *Wax* — Glycol phthalate or other similar wax having a melting temperature of less than 150°C.

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