



SEMI M24-1296

SPECIFICATION FOR POLISHED MONOCRYSTALLINE SILICON PREMIUM WAFERS

1 Purpose

This document specifies requirements for virgin silicon premium wafers with nominal diameter from 100 mm to 200 mm used for particle counting, ion contamination monitoring, and measuring pattern resolution in the photolithography process in semiconductor manufacturing.

2 Scope

2.1 This specification is directed mainly to silicon wafers with one polished surface. Wafers polished on both sides are also covered for super flat wafers. Purchasers of such wafers may find this specification to be a useful guide in defining their requirements.

2.2 This specification classifies premium wafers according to surface condition and dimensional tolerances. Premium wafer classifications are summarized in Table 1.

2.3 Dimensional and crystallographic orientation characteristics and limits on surface defects and minority carrier lifetime are the only standardized properties included in this specification.

2.4 Metallic concentration and 0.1 μm particle measurement are specified as guidelines because these measurement methods have not been established.

2.5 For referee purposes, SI (System International) units shall be used.

3 Applicable Documents

3.1 SEMI Specifications

SEMI M1 — Specifications for Polished Monocrystalline Silicon Wafers

SEMI M18 — Format for Silicon Wafer Specification Form for Order Entry

3.2 ASTM Standards¹

E 122 — Practice for Choice of Sample Size to Estimate the Average Quality of a Lot or Process

F 26 — Test Methods for Determining the Orientation of a Semiconductive Single Crystal

F 42 — Test Methods for Conductivity Type of Extrinsic Semiconducting Materials

F 47 — Test Method for Crystallographic Perfection of Silicon by Preferential Etch Techniques

F 81 — Test Method for Measuring Radial Resistivity Variation on Silicon Slices

F 84 — Test Method for Measuring Resistivity of Silicon Slices with a Colinear Four-Probe Array

F 154 — Practices and Nomenclature for Identification of Structures and Contaminants Seen on Specular Silicon Surfaces

F 523 — Practice for Unaided Visual Inspection of Polished Silicon Slices

F 533 — Test Method for Thickness and Thickness of Variation of Silicon Slices

F 612 — Practice for Cleaning Surfaces of Polished Silicon Slices

F 613 — Test Method for Measuring Diameter of Silicon Slices and Wafers

F 671 — Test Method for Measuring Flat Length on Slices of Electronic Material

F 673 — Test Methods for Measuring Resistivity of Semiconductor Slices with a Noncontact Eddy-Current Gage

F 847 — Test Methods for Crystallographic Orientation of Flats on Single Crystal Silicon Slices and Wafers by X-Ray Techniques

F 928 — Test Methods for Edge Contour of Silicon Wafers

F 1241 — Terminology of Silicon Technology

3.3 DIN Standards²

¹ American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959

² Deutsches Institut für Normung e.v., available from Beuth Verlag GmbH, Burggrafenstrasse 4-10, D-1000 Berlin 30, Federal Republic of Germany



50431 — Measurement of the Electrical Resistivity of Silicon or Germanium Single Crystals by Means of the Four-Point-Probe Direct Current Method with Collinear Four-Probe Array

50432 — Determination of the Conductivity Type of Silicon or Germanium by Means of Rectification Test or Hot-Probe

50433/1 — Determination of the Orientation of Single Crystals by Means of X-Ray Diffraction

50433/2 — Determination of the Orientation of Single Crystals by Means of Optical Reflection Figure

50433/3 — Determination of the Orientation of Single Crystals by Means of Laue Back Scattering

50434 — Determination of Crystal Perfection of Monocrystalline Silicon Samples on Etched (111)-Surfaces

50435 — Determination of the Radial Resistivity Variation of Silicon or Germanium Slices by Means of a Four-Point-DC-Probe

50441/1 — Measurement of the Geometric Dimensions of Semiconductor Slices: Measurement of Thickness

50441/2 — Measurement of the Geometric Dimensions of Semiconductor Slices: Testing of Edge Rounding

3.4 JIS Standard³

H 0611 — Methods of Measurement of Thickness, Taper, and Bow of Silicon Wafers

3.5 Other Standard⁴

ANSI/ASQC Z1.4-1993 — Sampling Procedures and Tables for Inspection by Attributes

4 Definitions

4.1 Definitions of terms related to silicon wafer technology are given in ASTM Terminology F 1241.

4.2 Definitions for some additional terms are given in SEMI M1.

4.3 The following definitions apply in the context of this specification:

hand scribe mark — any marking, usually on the back surface of a wafer, scratched manually into the silicon surface, as with a diamond-tipped scribe, for purposes of wafer identification.

premium wafer — a silicon wafer suitable for particle counting, ion contamination monitoring, and measuring pattern resolution in the photolithography process.

5 Ordering Information

5.1 Purchase orders for silicon premium wafers furnished to this specification shall include the items from the appropriate specification groups listed in Table 1.

Table 1. Wafer Classifications

Classification	Application
Super clean 1	Particle counting
Super clean 2	Particle counting and ion contamination monitoring
Super flat	Measurement of pattern resolution in photolithography

5.2 Items which may be specified when ordering silicon wafers are listed in Table 2. Not all of these items are required for ordering premium wafers.

5.3 The following must be specified on the purchase order for all classes of premium wafers:

5.3.1 Wafer classification.

5.3.2 Nominal diameter, surface orientation, and, if required by the application, edge profile (see Section 6).

5.3.3 Growth method (see Section 7).

5.3.4 Lot acceptance procedures (see Section 9).

5.3.5 Certification (if required) (see Section 12).

5.3.6 Packing and marking (see Section 13).

5.4 For super clean premium wafers that require controlled surface characteristics (see Section 11), the following must be specified in addition to the items listed in 5.3:

5.4.1 Light levels of visual inspection of wafers if different from those specified in 10.9.

6 Dimensions and Permissible Variations

The material shall conform to the dimensions and dimensional tolerances in Table 2.

³ Japanese Standards Association, 1-24, Akasaka 4 Chome, Minato-ku, Tokyo 107, Japan

⁴ American Society for Quality Control, 611 East Wisconsin Avenue, Milwaukee, WI 53202



7 Materials and Manufacture

The material shall consist of wafers from crystals grown by the process specified in the purchase order or contract.

8 Physical Requirements

The material shall conform to the details specified in the purchase order.

9 Sampling

Unless otherwise specified, ASTM Practice E 122 shall be used. When so specified, appropriate sample sizes shall be selected from each lot in accordance with ANSI/ASQC Z1.4-1993. Each quality characteristic shall be assigned an acceptable quality level (AQL) and lot total percent defective (LTPD) value in accordance with ANSI/ASQC Z1.4-1993 definitions for critical, major, and minor classifications. If desired and so specified in the contract or order, each of these classifications may alternatively be assigned cumulative AQL and LTPD values. Inspection levels shall be agreed upon between the supplier and the purchaser.

10 Test Methods

NOTE 1 — Silicon wafer are extremely fragile. While the mechanical dimensions of a wafer can be measured by use of tools such as micrometer calipers and other conventional techniques, the wafer may be damaged physically in ways that are not immediately evident. Special care must, therefore, be used in the selection and execution of measurement methods.

10.1 *Diameter* — Determine in accordance with ASTM Test Method F 613 or DIN 50441/4.

10.2 *Thickness, Center Point* — Determine in accordance with ASTM Test Method F 533 or DIN 50441/1.

10.3 *Flat Length* — Determine in accordance with ASTM Test Method F 671.

10.3.1 If flat diameter is specified instead of flat length, determine in accordance with Paragraph 5.2.1 of DIN 50441/4 or by a dial gauge method (see NOTE 9) as agreed upon between supplier and purchaser.

10.4 *Bow and Warp* — Determine bow in accordance with ASTM Test Method F 534 and warp in accordance with ASTM Test Method F 1390 or Test Method F 657.

NOTE 2 — ASTM has standardized two methods for measuring warp. ASTM Test Method F 1390 is an automated, noncontact method which provides for correction of the wafer deflection due to gravitational effects. The scan pattern covers the entire fixed quality area. ASTM Test Method F 657 is a manual, noncontact method which has a continuous, prescribed scan pattern which covers only a portion of the wafer surface. There is no provision for correction of the wafer deflection due to gravitational effects. As noted in Appendix 2, different reference planes are used for the two methods. Because Test Method F 657 employs a back surface reference plane, the measured warp may include contributions from thickness variation of the wafer. Test Method F 1390 employs a median surface reference plane and is not susceptible to interferences from thickness variations. In general, Test Method F 1390 is preferred, especially for wafers 150 mm in diameter and larger.

10.4.1 *Sori* — If sori is specified in lieu of bow or warp or both, determine by a method agreed upon between the supplier and the purchaser.

NOTE 3 — Because sori is a property of the top surface of an unclamped wafer, it may be measured on many types of flatness measuring instruments.

10.5 *Total Thickness Variation* — Determine in accordance with ASTM Test Method F 533, ASTM Test Method F 657, DIN 50441/1, and JIS H 0611.

NOTE 4 — ASTM Test Method F 533, DIN 50441/1, and JIS H 0611 are all 5-point methods, while Test Method F 657 involves a continuous scan pattern. JIS H 0611 differs from ASTM Test Method F 533 and DIN 50441/1 in that the measurements in JIS H 0611 are taken at the center and at 5 mm from the edge on diameters parallel and perpendicular to the major flat, while the measurements in the latter two test methods are taken at the center and at the same radial distance (R nominal — 6 mm) on diameters 30 degrees and 120 degrees counterclockwise from the bisector to the primary flat or notch (with the wafer facing front surface up).

10.6 *Flat Orientation* — Determine in accordance with ASTM Test Method F 847.

10.7 *Surface Orientation* — Determine in accordance with ASTM Test Method F 26 or DIN 50433.