SLOVENSKI STANDARD
SIST EN 50513:2009

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Solarne rezine - Tehniļ ni podatki in informacije o kristalnih silicijevih rezinah za izdelavo sonļ nih celic

Solar wafers - Data sheet and product information for crystalline silicon wafers for solar cell manufacturing

Solarscheiben - Datenblattangaben und Produktinformation für kristalline Silizium-Scheiben zur Solarzellenherstellung

Tranches de silicium solaires - Fiche technique et information produit sur les tranches au silicium cristallin pour la fabrication de cellules solaires

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English version

Solar wafers - Data sheet and product information for crystalline silicon wafers for solar cell manufacturing

Tranches de silicium solaires - Fiche technique et information produit sur les tranches au silicium cristallin pour la fabrication de cellules solaires

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CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

This European Standard was prepared by the Technical Committee CENELEC TC 82, Solar photovoltaic energy systems.

The text of the draft was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 50513 on 2008-12-01.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2009-12-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2011-12-01

Contents

Figures

Table

1 Scope

This document describes data sheet and product information for crystalline silicon (Si) – solar wafers and measurement methods for wafer properties.

The document intends to provide the minimum information required for an optimal use of crystalline silicon wafers in solar cell manufacturing. Clauses 5 to 7 describe the data sheet information with technical specifications of the silicon solar wafer with all essential characteristics.

The product information concerns packaging, labelling and storage, and implies the commitment to inform about major changes of the product and in the manufacturing process. This data is needed for the processing of silicon solar wafers to solar cells. Clauses 8 to 16 describe measurement methods for the characteristic properties specified in the data sheet.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 50461, Solar cells – Datasheet information and product data for crystalline silicon solar cells

EN ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025)

DIN 5043-2, Radioactive luminescent pigments – Method of measurement and designation

DIN 50431, Testing of semiconductor materials – Measurement of the resistivity of silicon or germanium single crystals by means of the four-probe/direct current method with collinear array

DIN 50432, Testing semi-conducting inorganic materials – Determining conduction type for silicon or germanium using a standard test or thermosonde probe (withdrawn)

DIN 50434, Testing of materials for semiconductor technology – Detection of crystal defects in mono-crystalline silicon using etching techniques on [111] and [100] surfaces (ASTM F 47)

DIN 50438-1, Testing of materials for semiconductor technology – Determination of impurity content in silicon by infrared absorption – Part 1: Oxygen

DIN 50438-2, Testing of materials for semiconductor technology – Determination of impurity content in silicon by infrared absorption – Part 2: Carbon

DIN 50441-1, Testing of materials for semiconductor technology – Determination of the geometric dimensions of semiconductor wafers – Part 1: Thickness and thickness variation

DIN 50441-5, Testing of materials for semiconductor technology – Determination of the geometric dimensions of semiconductor wafers – Part 5: Terms of shape and flatness deviation

DIN 4760, Form deviations – Concepts – Classification system

DIN 4768, Identification of roughness characteristics R_a, R_z, R_{max} with electrical testing machines – terms, conditions of measurement

DIN 879-1, Verification of geometrical parameters – Dial indicator for linear measurement – Part 1: With mechanical indication

DIN 4774, Measurement of wave depth with electrical contact stylus instruments

3 Terms, definitions and acronyms

For the purposes of this document, the following terms and definitions apply.

3.1
ingot
the largest connected silicon piece after the crystallisation process

3.2
brick, column, block
the semi-finished silicon product after squaring with area equal to the area of the later wafer

3.3
wafer
the final product of silicon processing which is the input product for solar cell production

3.4
batch size
the smallest unit of wafers for which traceability is guaranteed

3.5
thickness variation Δd (Total Thickness Variation, TTV)
the largest difference from several thickness measurement values

3.6
Etch Pit Density (EPD)
the number of etch pits per unit area

4 Crystallisation process

The crystallisation process has to be specified e.g. ingot casting, Bridgman.

5 Product characteristics

5.1 Size

See Annex A.

Shape:	Rectangular, square, round, pseudo square
Dimensions:	Dimensions as nominal values with tolerances, declared in mm
Area:	Declaration of nominal area in mm^2
Thickness:	Average thickness with tolerances in µm (according to Clause 8)
TTV:	Maximum value (according to Clause 9)
Information on rectangularity (where applicable):	Maximum tolerance from 90° angle in degrees

NOTE 1 The actual wafer edge may be approximated by a line determined by least squares fitting.

Information on the type of angle:

- Flat chamfer: Length of hypotenuses as chamfer width (*H*) and angle between the wafer edge and hypotenuses (*α*) (see Figure A.1)
- Round chamfer: Length of a leg of a right triangle (*D*) and diameter of the round crystal (*E*) (see Figure A.2)

Information about waviness and warping: (According to Clause 10)

NOTE 2 All measurements are to be carried out at standard measurement temperature (25 ± 2) °C.

5.2 Electrical characteristics

Information on the dopant (*B*, *P*, *Ga* …) and the conductivity type (*p* or *n*).

Resistivity according to Clause 15 with tolerances in Ωcm.

Minimum value of average effective minority carrier lifetime measured (for multi-crystalline material on the wafer, for mono-crystalline material on the face of the ingot) with µ-PCD or QSSPC according to Clause 13 or 14.

5.3 Surface and edge characteristics

Information about the maximum allowable defects on the wafer, e.g. chipping on the surface or at the edge, pinholes, saw marks, cracks, edge swelling (see Figures A.3 to A.5).

Table 1 – Surface and edge characteristics

Term	Description	Specification
Surface chipping	Chipping on the wafer surface	Maximum permissible length, width and number (and exclusion of positions if required)
Cracks	Technically detectable cracks	Maximum permissible length and number
Holes	Permeating and non-permeating holes of all sizes (e.g. by air inclusions during the drawing process)	Maximum permissible length, width and number (and exclusion of positions if required)
Inclusions	Inclusions in the silicon matrix visible to the naked eye which affect the electrical, chemical or optical characteristics of the wafer	Maximal permissible number (and dimensions if required)
Visible contaminations	Contaminations visible to the naked eye	Type and maximum permissible size if any contamination is allowed
Not visible contaminations	For an assessment, the etching rate can be specified according to Clause 12	Type and maximal permissible size
Saw mark	Grooves which typically result from failures in the slicing process; measurement according to Clause 11	Maximum permissible depth and number (per area unit)
Step type saw mark	Steps which typically result from failures in the slicing process; measurement according to Clause 11	Maximal permissible depth and number (per area unit)
Edge chips, chipping	Chipping at the wafer edge which is not visible by backlight illumination (see Figure A.3)	Maximum permissible length, width and number (and exclusion of positions if required)
Local thickness fluctuations (LATF)	A localised swelling of the wafer edge which is not detected by measurement of TTV_{PV} in accordance with Clause 9 (see Figure A.4)	Distance a and limits for parameters b and c

Table 1 – Surface and edge characteristics *(continued)*

Term	Description	Specification
V-Chips, indents (v-type), nicks	V-shaped indents/chips visible in backlight (corner radius < 0,3 mm) and wafer edge (see Figure A.3 b))	Maximum permissible length, width and number
Edge breakage, indents (not including v-type)	Non V-shaped indents/chips visible in backlight (corner radius < 0,3 mm) and wafer edge (see Figure A.3 c))	Maximum permissible length, width and number
Edge deviation	Deviation from the ideal edge approximated by a line determined by least squares fitting (see Figure A.5)	Maximum deviation from the fitted line and minimal wavelength
NOTE In case of alternative terms, the preferred term is marked by underlining.		

5.4 Chemical characteristics

Specification of oxygen and carbon content determined according to Clause 16.

5.5 Crystal characteristics

NOTE The following information refers only for mono crystalline material.

Etch pitch density (EPD), with units of cm^{-2} determined in accordance with DIN 50434 or SEMI MF1725-1103, SEMI MF1809-0704, SEMI MF1810-0304

– Information about crystal orientation

– Information on the crystallographic orientation relative to the wafer edge

All information shall be provided with tolerances.

6 Packaging, marking and storage

6.1 Packaging

– Packaging unit

– Kind of packaging

6.2 Marking

The smallest packaging unit has to be labelled with the following information:

– Product type

– Lot number

– Quantity

6.3 Storage

– Data on stack ability

– Conditions during storage

7 Major changes of product and processes

All relevant changes of the product or the manufacturing process, which could affect the solar cell process or the solar cell product, have to be communicated.

8 Wafer thickness

8.1 Scope

This procedure describes the measurement to determine the thickness of crystalline silicon wafers by using non-contact or contact thickness measuring equipment.

8.2 Normative references

This measurement is based on part of DIN 50441-1 and contains specifications from other publications in the form of dated and undated references. These normative references are cited at the relevant points in the text and the publications are: EN ISO/IEC 17025, DIN 4760, DIN 4768 and DIN 879-1 (see also Clause 2).

In the case of dated references, subsequent modifications or revisions of the publications only form part of the standards if they have been incorporated as modifications or revisions. In the case of undated references, the last edition of the publication referred to is valid.

8.3 Definitions

8.3.1 Thickness

The locally variable distance between the actual surface of the front and back sides of the wafer whereby the actual surface is the surface identified with measuring technology in accordance to DIN 4760.

NOTE The centre thickness (thickness d_5 in the middle of the wafer at measuring point 5 according to Figure 1) is often described simply as thickness.

8.3.2 Average thickness d_m

The average value of the 5 measuring values d_1, d_5, d_8, d_{11} and d_{15} at the measuring points 1, 5, 8, 11 and 15 according to Figure 1:

$$d_m = \frac{d_1 + d_2 + d_3 + d_4 + d_5}{5} \quad (1)$$

The average thickness can also be calculated from weighing the wafer, taking into account the wafer area and density of silicon.

8.3.3 Centre thickness

The thickness d_8 at the centre of the wafer at measuring point 8 according to Figure 1:

$$d = d_8 \quad (2)$$

8.4 Units

All measured variables specified in 8.3.1 to 8.3.3 are indicated in micrometers.