

Single crystal wafers for surface acoustic wave (SAW) device applications — Specifications and measuring methods

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ICS 31.140

National foreword

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 34, an inside back cover and a back cover.

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Amendments issued since publication

Amd. No.	Date	Comments

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 14 February 2006

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**Single crystal wafers
for surface acoustic wave (SAW) device applications -
Specifications and measuring methods
(IEC 62276:2005)**

Tranches monocristallines pour
applications utilisant des dispositifs
à ondes acoustiques de surface -
Spécifications et méthodes de mesure
(CEI 62276:2005)

Einkristall-Wafer für Oberflächenwellen-
(OFW-)Bauelemente -
Festlegungen und Messverfahren
(IEC 62276:2005)

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

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of document 49/720/FDIS, future edition 1 of IEC 62276, prepared by IEC TC 49, Piezoelectric and dielectric devices for frequency control and selection, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 62276 on 2005-11-01.

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) | 2006-08-01 |
| – latest date by which the national standards conflicting
with the EN have to be withdrawn | (dow) | 2008-11-01 |

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 62276:2005 was approved by CENELEC as a European Standard without any modification.

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INTRODUCTION

A variety of piezoelectric materials are used for surface acoustic wave (SAW) filter and resonator applications. Prior to the 1996 Rotterdam IEC TC 49 meeting, wafer specifications were typically negotiated between users and suppliers. During the meeting a proposal was announced to address wafer standardization. This document has been prepared in order to provide industry standard technical specifications for manufacturing piezoelectric single crystal wafers to be used in surface acoustic wave devices.

SINGLE CRYSTAL WAFERS FOR SURFACE ACOUSTIC WAVE (SAW) DEVICE APPLICATIONS – SPECIFICATIONS AND MEASURING METHODS

1 Scope

This International Standard applies to the manufacture of synthetic quartz, lithium niobate (LN), lithium tantalate (LT), lithium tetraborate (LBO), and lanthanum gallium silicate (LGS) single crystal wafers intended for use as substrates in the manufacture of surface acoustic wave (SAW) filters and resonators.

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.

IEC 60758, *Synthetic quartz crystal – Specifications and guide to the use*

IEC 60410, *Sampling plans and procedures inspection by attributes*

ISO 4287, *Geometrical Product Specifications (GPS) – Surface texture: Profile method – Terms, definitions and surface texture parameters*

3 Terms and definitions

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

3.1

Single crystals for SAW wafer

3.1.1

as-grown synthetic quartz crystal

right-handed or left-handed single crystal quartz is grown hydrothermally. The term “as-grown” indicates a state prior to mechanical fabrication

NOTE See IEC 60758 for further information concerning crystalline quartz.

3.1.2

lithium niobate

LN

single crystals approximately described by chemical formula LiNbO_3 , grown by Czochralski (crystal pulling from melt) or other growing methods

3.1.3

lithium tantalate

LT

single crystals approximately described by chemical formula LiTaO_3 , grown by Czochralski (crystal pulling from melt) or other growing methods

3.1.4

lithium tetraborate

LBO

single crystals described by the chemical formula to $\text{Li}_2\text{B}_4\text{O}_7$, grown by Czochralski (crystal pulling from melt), vertical Bridgman, or other growing methods

3.1.5

lanthanum gallium silicate

LGS

single crystals described by the chemical formula to $\text{La}_3\text{Ga}_5\text{SiO}_{14}$, grown by Czochralski (crystal pulling from melt) or other growing methods

3.2

manufacturing lot

established by agreement between customer and supplier

3.3 Terms and definitions related to LN and LT crystals

3.3.1

Curie temperature

T_c

phase transition temperature between ferroelectric and paraelectric phases measured by differential thermal analysis (DTA) or dielectric measurement

3.3.2

single domain

ferroelectric crystal with uniform electrical polarization throughout (for LN and LT)

3.3.3

polarization (or poling) process

electrical process used to establish a single domain crystal

3.4 Terms and definitions related to all crystals

3.4.1

lattice constant

length of unit cell along a major crystallographic axis measured by X-ray using the Bond method

3.4.2

congruent composition

chemical composition of a single crystal in a thermodynamic equilibrium with a molten solution of the same composition during the growth process

3.4.3

twin

crystallographic defect occurring in a single crystal.

NOTE The twin is separated from the rest of the material by a boundary, generally aligned along a crystal plane. The lattices on either side of the boundary are crystallographic mirror images of one another.

3.5

orientation flat

OF

flat portion of wafer perimeter indicating the crystal orientation. Generally, the orientation flat corresponds to the SAW propagation direction. It is also referred to as the “primary flat” (see Figure 1)

3.6**secondary flat****SF**

flat portion of wafer perimeter shorter than the OF. When present, the SF indicates wafer polarity and can serve to distinguish different wafer cuts. It is also referred to as the “sub-orientation flat” (see Figure 1)

3.7**Flatness****3.7.1****fixed quality area****FQA**

central area of a wafer surface, defined by a nominal edge exclusion, X , over which the specified values of a parameter apply

NOTE The boundary of the FQA is at all points (e.g. along wafer flats) the distance X away from the perimeter of the wafer of nominal dimensions.

3.7.2**reference plane**

depends on the flatness measurement and needs to be specified. It can be any of the following:

- for clamped measurements, the flat chuck surface that contacts the back surface of the wafer;
- three points at specified locations on the front surface within the FQA;
- the least-squares fit to the front surface using all measured points within the FQA;
- the least squares fit to the front surface using all measured points within one site.

3.7.3**site**

square area on the front surface of the wafer with one side parallel to the OF. Flatness parameters are assessed either globally for the FQA, or for each site individually

3.7.4**TV5 (thickness variation for five points)**

TV5 is a measure of wafer thickness variation and is defined as the maximum difference between five thickness measurements. Thickness is measured at the centre of the wafer and at four peripheral points shown in Figure 1

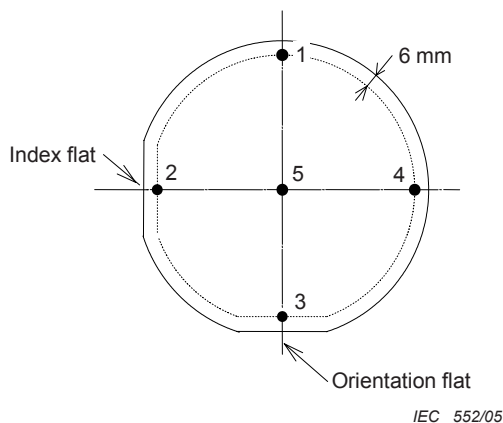


Figure 1 – Wafer sketch and measurement points for TV5 determination

3.7.5

total thickness variation (TTV)

measurement of TTV is performed under clamped conditions with the reference plane as defined in 3.7.2 a). TTV is the difference between maximum thickness (A) and the minimum thickness (B) as shown in Figure 2

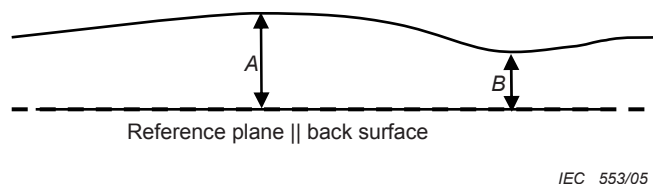


Figure 2 – Schematic diagram of TTV

3.7.6

warp

warp describes the deformation of an unclamped wafer and is defined as the maximum difference between a point on the front surface and a reference plane, as shown in Figure 3. The reference plane is defined by 3-points as described in 3.7.2 b). Warp is a bulk property of a wafer and not of the exposed surface alone

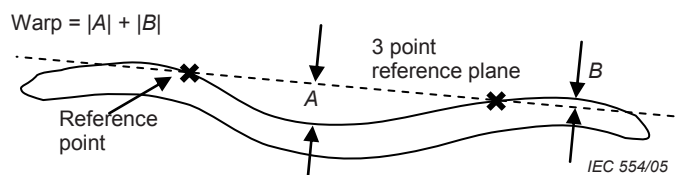


Figure 3 – Schematic diagram of warp

3.7.7

sori

describes the deformation of an unclamped wafer and is defined as the maximum difference between a point on the front surface and a reference plane. In contrast to warp, in this case the reference plane is defined by a least-squares fit to the front surface (3.7.2 c))

3.7.8

local thickness variation (LTV)

determined by a measurement of a matrix of sites with defined edge dimensions (e.g. 5 mm × 5 mm). Measurement is performed on a clamped wafer with the reference plane as defined in 3.7.2 a). A site map example is shown in Figure 4. The value is always a positive number and is defined for each site as the difference between the highest and lowest points within each site, as shown in Figure 5. For a wafer to meet an LTV specification, all sites must have LTV values less than the specified value

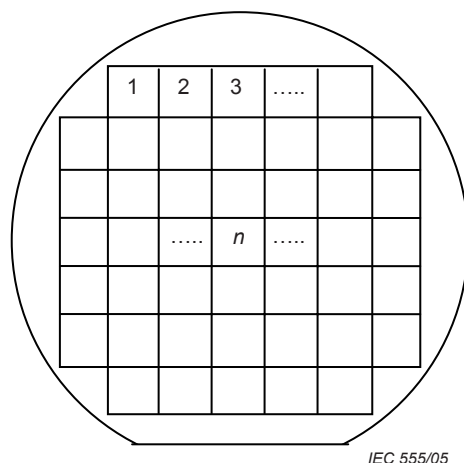


**Figure 4 – Example of site distribution for LTV measurement.
All sites have their centres within the FQA**

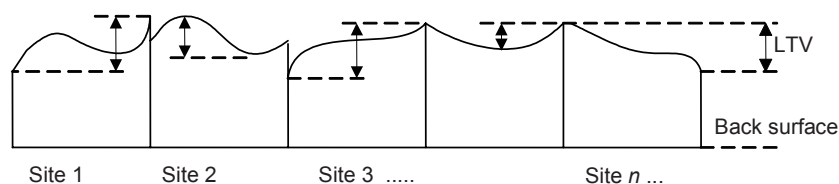


Figure 5 – LTV is a positive number and is measured at each site

3.7.9

percent local thickness variation

PLTV

the percentage of sites that fall within the specified values for LTV. As with the LTV measurement, this is a clamped measurement

3.7.10

focal plane deviation

FPD

measured relative to the 3-point reference plane as defined in 3.7.2 b). The value indicates the maximum distance between a point on the wafer surface (within the FQA) and the focal plane. If that point is above the reference, the FPD is positive. If that point is below the reference plane, the FPD is negative

3.8

back surface roughness

definitions of R_a are given in ISO 4287

3.9

surface orientation

crystallographic orientation of the axis perpendicular to the surface of wafer

3.10

description of orientation and SAW propagation

indicating the surface orientation and the SAW propagation direction, separated by the symbol “-”. Specification of a 0° orientation is normally omitted. Typical examples for these expressions are shown in Table 1.