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INTERNATIONAL STANDARD

NORME INTERNATIONALE

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

Tranches monocristallines pour applications utilisant des dispositifs à ondes acoustiques de surface (OAS) – Spécifications et méthodes de mesure

IEC 62276:2016-10(en-fr)

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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

FOREWORD

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International Standard IEC 62276 has been prepared by IEC technical committee 49: Piezoelectric, dielectric and electrostatic devices and associated materials for frequency control, selection and detection.

This bilingual version (2018-01) corresponds to the monolingual English version, published in 2016-10.

This third edition cancels and replaces the second edition of IEC 62276 published in 2012. It constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

– Corrections of Euler angle indications in Table 1 and axis directions in Figure 3.
– Definition of "twin" is not explained clearly enough in 3.3.3. Therefore it is revised by a more detailed definition.

– Etch channels maximum number at quartz wafer of seed which do not pass through from surface to back surface are classified for three grades in 4.2.13 a). Users use seed portions of quartz wafers for devices. They request quartz wafers with less etch channels in seeds to reduce defects of devices. The classification of etch channels in seed may prompt a rise in quartz wafer quality.

The text of this standard is based on the following documents:

CDV	Report on voting
49/1144/CDV	49/1170/RVC

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

INTRODUCTION

A variety of piezoelectric materials are used for surface acoustic wave (SAW) filter and resonator applications. Prior to an IEC meeting in 1996 in Rotterdam, wafer specifications were typically negotiated between users and suppliers. During this meeting, a proposal was announced to address wafer standardization. This standard 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 document 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 documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 60758:2016, *Synthetic quartz crystal – Specifications and guidelines for use*

ISO 2859-1: 1999, *Sampling procedures for inspection by attributes – Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1 Single crystals for SAW wafer

3.1.1
as-grown synthetic quartz crystal
right-handed or left-handed single crystal quartz grown hydrothermally

Note 1 to entry: The term “as-grown” indicates a state prior to mechanical fabrication.

Note 2 to entry: 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 $Li_2B_4O_7$, 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 $La_3Ga_5SiO_{14}$, grown by Czochralski (crystal pulling from melt) or other growing methods

3.2 Terms and definitions related to LN and LT crystals

3.2.1
Curie temperature
T_c
phase transition temperature between ferroelectric and paraelectric phases measured by differential thermal analysis (DTA) or dielectric measurement

3.2.2
single domain
ferroelectric crystal with uniform electrical polarization throughout (for LN and LT)

3.2.3
polarization process
electrical process used to establish a single domain crystal

Note 1 to entry: The polarization process is also referred to as "poling".

3.2.4
reduction process
REDOX reaction to increase conductivity to reduce the harmful effects of pyroelectricity

3.2.5
reduced LN
LN treated with a reduction process

Note 1 to entry: Reduced LN is sometimes referred to as "black LN".

3.2.6
reduced LT
LT treated with a reduction process

Note 1 to entry: Reduced LT is sometimes referred to as "black LT".

3.3 Terms and definitions related to all crystals

3.3.1
lattice constant
length of unit cell along a major crystallographic axis measured by X-ray using the Bond method

3.3.2
congruent composition
chemical composition of a single crystal in a thermodynamic equilibrium with a molten solution of the same composition during the growth process

3.3.3
twin
two or more same single crystals which are combined together by the law of symmetrical plane or axis

Note 1 to entry: Twins exhibit symmetry that may be classified as reflection across a mirror plane (twin plane), rotation around an axis (twin axis), or inversion through a point (twin center).

Note 2 to entry: Optical twins（growth twins） and electrical twins（transformation twins） are the most relevant to SAW wafers. Optical twins arise from defects related to growth. Electrical twins may result from extreme conditions (temperature and pressure, for example) during processing.

3.4 Flatness

3.4.1
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 1 to entry: 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.

3.4.2
reference plane
plane depending on the flatness measurement and which can be any of the following:

a) for clamped measurements, the flat chuck surface that contacts the back surface of the wafer;

b) for without clamped measurememts, three points at specified locations on the front surface within the FQA;

for without clamped measurememts, the least-squares fit to the front surface using all measured points within the FQA;

3.4.3
site
square area on the front surface of the wafer with one side parallel to the OF

Note 1 to entry: Flatness parameters are assessed either globally for the FQA, or for each site individually.

3.4.4
thickness variation for five points
TV5
measure of wafer thickness variation defined as the maximum difference between five thickness measurements

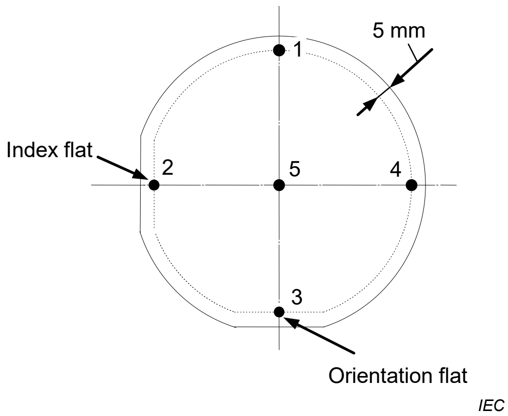


Figure 1 – Wafer sketch and measurement points for TV5 determination

Note 1 to entry: Thickness is measured at the centre of the wafer and at four peripheral points shown in Figure 1.

3.4.5
total thickness variation
TTV
difference between the maximum thickness and the minimum thickness

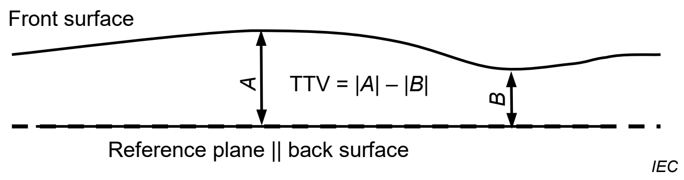


Figure 2 – Schematic diagram of TTV

Note 1 to entry: The maximum thickness is represented by the letter A and the minimum thickness is represented by the letter B in Figure 2.

Note 2 to entry: Measurement of TTV is performed under clamped conditions with the reference plane as defined in 3.4.2 a).

3.4.6
warp
maximum difference between a point on the front surface and a reference plane

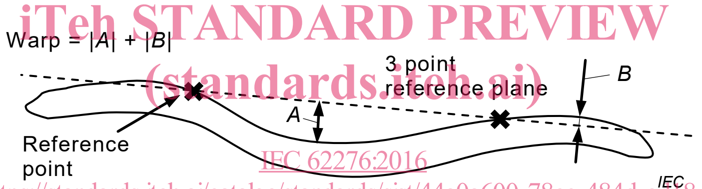


Figure 3 – Schematic diagram of warp

Note 1 to entry: Warp (shown in Figure 3) describes the deformation of an unclamped wafer.

Note 2 to entry: The reference plane is defined by 3-points as described in 3.4.2 b). Warp is a bulk property of a wafer and not of the exposed surface alone.

3.4.7
Sori
maximum difference between a point on the front surface and a reference plane

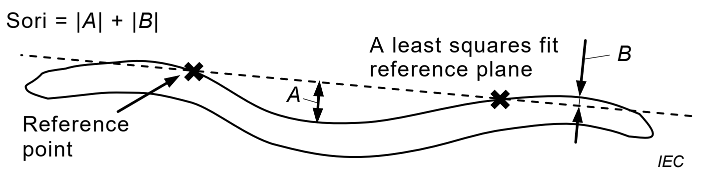
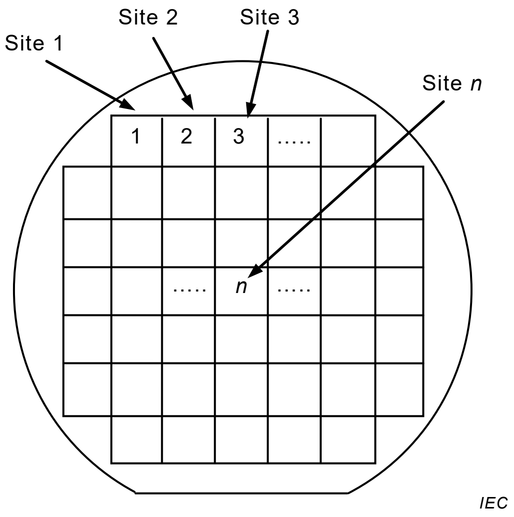


Figure 4 – Schematic diagram of Sori

Note 1 to entry: Sori describes the deformation of an unclamped wafer, as shown in Figure 4.

Note 2 to entry: In contrast to warp, in this case the reference plane is defined by a least-squares fit to the front surface (3.4.2 c)).

3.4.8
local thickness variation
LTV
variation determined by a measurement of a matrix of sites with defined edge dimensions



Note 1 to entry: All sites have their centres within the FQA.

Figure 5 – Example of site distribution for LTV measurement

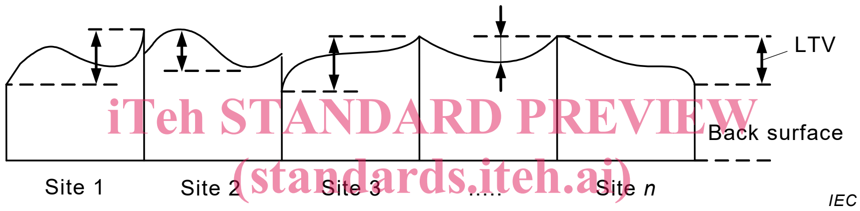


Figure 6 – LTV value of each site

Note 2 to entry: Measurement is performed on a clamped wafer with the reference plane as defined in 3.4.2 a). A site map example is shown in Figure 5. 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 6. For a wafer to meet an LTV specification, all sites shall have LTV values less than the specified value.

3.4.9
percent local thickness variation
PLTV
percentage of sites that fall within the specified values for LTV

Note 1 to entry: As with the LTV measurement, this is a clamped measurement.

3.4.10
focal plane deviation
FPD
deviation measured relative to the 3-point reference plane

Note 1 to entry: The 3-point reference plane is defined in 3.4.2 b).

Note 2 to entry: The value obtained 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.

3.5 Definitions of appearance defects

3.5.1
contamination
foreign matter on a surface of wafer which cannot be removed after cleaning

3.5.2
crack
fracture that extends to the surface and may or may not penetrate the entire thickness of the wafer

3.5.3
scratch
shallow groove or cut below the established plane of the surface, with a length to width ratio greater than 5:1

3.5.4
chip
region where material has been removed from the surface or edge of the wafer

Note 1 to entry: The size can be expressed by its maximum radial depth and peripheral chord length.

3.5.5
dimple
smooth surface depression larger than 3 mm diameter

3.5.6
pit
non-removable surface anomaly

EXAMPLE A hollow, typically resulting from a bulk defect or faulty manufacturing process.

3.5.7
orange peel
large featured, roughened surface visible to the unaided eye under diffuse illumination

Note 1 to entry: This is also called pear skin.

3.6 Other terms and definitions

3.6.1
manufacturing lot
lot established by agreement between the customer and the supplier

3.6.2
orientation flat
OF
flat portion of wafer perimeter indicating the crystal orientation

Note 1 to entry: Generally, the orientation flat corresponds to the SAW propagation direction.

Note 2 to entry: Orientation flat is also referred to as the “primary flat” (see Figure 1).

3.6.3
secondary flat
SF
flat portion of wafer perimeter shorter than the OF

Note 1 to entry: When present, the SF indicates wafer polarity and can serve to distinguish different wafer cuts.

Note 2 to entry: Secondary flat is also referred to as the “suborientation flat” (see Figure 1).

3.6.4
back surface roughness
roughness which scatters and suppresses bulk wave spurious at back surface