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Piezoelectric and dielectric devices for frequency control and selection – Glossary – Part 4-4: Materials – Materials for surface acoustic wave (SAW) devices

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PIEZOELECTRIC AND DIELECTRIC DEVICES FOR FREQUENCY CONTROL AND SELECTION – GLOSSARY –

Part 4-4: Materials – Materials for surface acoustic wave (SAW) devices

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 61994-4-4, which is a technical specification, has been prepared by IEC technical committee 49: Piezoelectric and dielectric devices for frequency control and selection.

This second edition of IEC 61994-4-4 cancels and replaces the first edition published in 2005.

This edition constitutes a technical revision.

The main changes with respect to the previous edition are listed below:

– Terms and definitions are rearranged in accordance with the order of the alphabet.
– ”reduced LN” is appended to terms and definitions.
– ”reduced LT” is appended to terms and definitions.
– reduction process is appended to terms and definitions.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
49/890/DTS	49/901/RVC

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

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

A list of all parts of IEC 61994 series, published under the general title *Piezoelectric and dielectric devices for frequency control and selection – Glossary* can be found on the IEC website.

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

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

PIEZOELECTRIC AND DIELECTRIC DEVICES FOR FREQUENCY CONTROL AND SELECTION – GLOSSARY –

Part 4-4: Materials – Materials for surface acoustic wave (SAW) devices

1 Scope

This part of IEC 61994 specifies the terms and definitions for single crystal wafers applied for surface acoustic wave (SAW) devices representing the state of the art, which are intended for use in the standards and documents of IEC technical committee 49.

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.

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
acceptable quality level
AQL
AQL is the maximum percent defective (or the maximum number of defects per hundred units) that, for purposes of sampling inspections, can be considered satisfactory as a process average

[IEC 60410:1973, 4.2]

3.2
as-grown synthetic quartz crystal
single-crystal quartz grown hydrothermally. “As-grown” refers to the state of processing and indicates a state prior to mechanical fabrication

[IEC 61994-4-1:2007, 3.4]

3.3
back surface roughness
definitions of R_a are given in ISO 4287

[IEC 62276:2005, 3.8]

3.4
bevel
slope or rounding of the wafer perimeter. This is also referred to as “edge profile”. The process of creating a bevel is called “bevelling” or “edge rounding”. The profile and its tolerances should be specified by the supplier

[IEC 62276:2005, 3.13]

3.5
chip
region where material has been removed from the surface or edge of the wafer. The size of chip can be expressed by its maximum radial depth and peripheral chord length

[IEC 62276:2005, 3.16.4]

3.6
congruent composition
chemical composition of single crystal in thermodynamic equilibrium with molten solution of the same composition during the growth process

[IEC 62276:2005, 3.4.2]

3.7
contamination
the first is defined as area and the second as particulate. The first is caused by surface contaminants that cannot be removed by cleaning or are stained after cleaning. Those may be foreign matter on the surface of, for example a localized area that is smudged, stained, discoloured, mottled, etc., or large areas exhibiting a hazy or cloudy appearance resulting from a film of foreign materials

[IEC 62276:2005, 3.16.1]

3.8
crack
fracture that extends the surface and may or may not penetrate the entire thickness of the wafer

[IEC 62276:2005, 3.16.2]

3.9
curie temperature
T_c
phase transition temperature between ferroelectric and paraelectric phases measured by differential thermal analysis (DTA) or dielectric measurement

[IEC 62276:2005, 3.3.1]

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

Table 1 – Description of orientation

Material	LN	LT	Quartz crystal	LBO	LGS
Expression	128 ° Y-X Y-Z 64 ° Y-X	X-112 ° Y 36 ° Y-X	ST-X	45 ° X-Z	yxlt/48, 5 °/26, 6 °

[IEC 62276:2005, 3.10]

3.11
diameter of wafer
diameter of circular portion of wafer excluding the OF and SF regions

[IEC 62276:2005, 3.14]

3.12
dimple
smooth surface depression larger than 3 mm in diameter

[IEC 62276:2005, 3.16.5]

3.13
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

[IEC 62276:2005, 3.7.1]

3.14
focal plane deviation
FPD
measured relative to the three point reference plane as defined in 3.30b). 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

[IEC 62276:2005, 3.7.10]

3.15
lattice constant
length of one unit cell along major crystallographic axis measured by X-ray using the Bond method

[IEC 62276:2005, 3.4.1]

3.16
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

[IEC 62276:2005, 3.1.5]

3.17
lithium niobate
LN
single crystals approximately described by chemical formula $LiNbO_3$, grown by Czochralski (crystal pulling from melt) or other growing methods

[IEC 62276:2005, 3.1.2]

3.18
lithium tantalate
LT
single crystals approximately described by chemical formula $LiTaO_3$, grown by Czochralski (crystal pulling from melt) or other growing methods

[IEC 62276:2005, 3.1.3]

3.19
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

[IEC 62276:2005, 3.1.4]

3.20
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 3.30a). A site map example is shown in Figure 1. 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 2. For a wafer to meet an LTV specification, all sites must have LTV values less than the specified value

[IEC 62276:2005, 3.7.8]

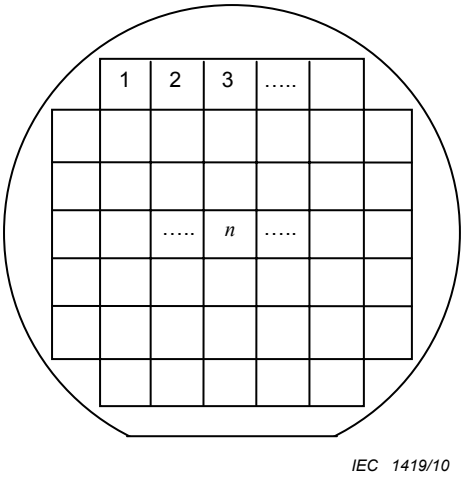

Figure 1 – Example of site distribution for LTV measurement. All sites have their centres within the FQA

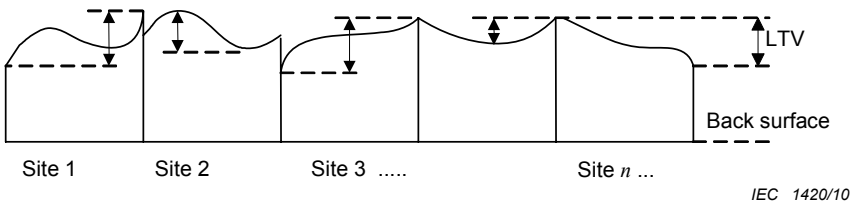

Figure 2 – LTV is a positive number and is measured at each site

3.21
manufacturing lot
manufacturing lot is established by agreement between customer and supplier

[IEC 62276:2005, 3.2]

3.22
orange peel
large featured, roughened surface visible to the unaided eye under diffuse illumination

[IEC 62276:2005, 3.16.7]

3.23
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 3)

[IEC 62276:2005, 3.5]

3.24
percent local thickness variation
PLTV
percentage of sites that fall within the specified values for LTV. As with the LTV measurement, this is a clamped measurement

[IEC 62276:2005, 3.7.9]

3.25
pit
non-removable surface anomaly such as a hollow, typically resulting from a bulk defect or faulty manufacturing process

[IEC 62276:2005, 3.16.6]

3.26
polarization (or poling) process
electrical process used to establish a single domain crystal

[IEC 62276:2005, 3.3.3]

3.27
reduced LN
LN treated with a reduction process, sometimes referred to as “black LN”

[IEC 62276:2005, 3.3.4.1]

3.28
reduced LT
LT treated with a reduction process, sometimes referred to as “black LT”

[IEC 62276:2005, 3.3.4.2]

3.29
reduction process
REDOX reaction to increase conductivity to reduce the harmful effects of pyroelectricity

[IEC 62276:2005, 3.3.4]

3.30
reference plane
depends on the flatness measurement and needs to be specified. It can be any of the following:

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

b) three points at specified locations on the front surface within the FQA;

c) the least-squares fit to the front surface using all measured points within the FQA;

d) the least squares fit to the front surface using all measured points within one site

[IEC 62276:2005, 3.7.2]

3.31
scratch
shallow groove or cut below the established plane of the surface, with a length to width ratio greater than 5:1

[IEC 62276:2005, 3.16.3]

3.32
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 3)

[IEC 62276:2005, 3.6]

3.33
single domain
ferroelectric crystal with uniform electrical polarization throughout (for LN and LT)

[IEC 62276:2005, 3.3.2]

3.34
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

[IEC 62276:2005, 3.7.3]

3.35
sori
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

[IEC 62276:2005, 3.7.7]

3.36
ST-cut
although the original definition is 42,75 º rotated Y-cut and X-propagation, the actual cut angle can range from 20 º to 42,75 º in order to achieve a zero temperature coefficient

[IEC 62276:2005, 3.11]

3.37
surface orientation
crystallographical orientation of the axis perpendicular to the surface of the wafer

[IEC 62276:2005, 3.9]

3.38
tolerance of surface orientation
acceptable difference between specified surface orientation and measured orientation, measured by X-ray diffraction

[IEC 62276:2005, 3.12]

3.39
thickness variation for five points
TV5
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 3

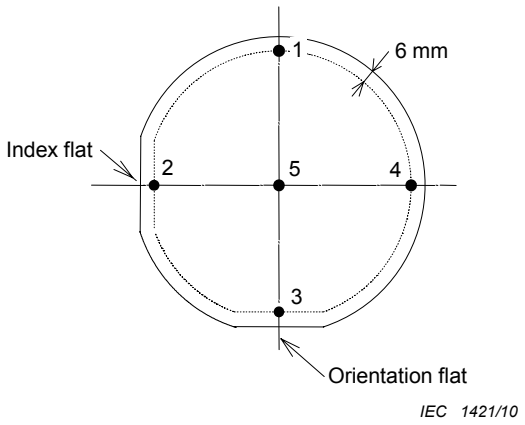

Figure 3 – Wafer indication and measurement points for TV5

[IEC 62276:2005, 3.7.4]

3.40
total thickness variation
TTV
measurement of TTV is performed under clamped conditions with the reference plane as defined in 3.30a). TTV is the difference between maximum thickness (A) and the minimum thickness (B) as shown in Figure 4

[IEC 62276:2005, 3.7.5]

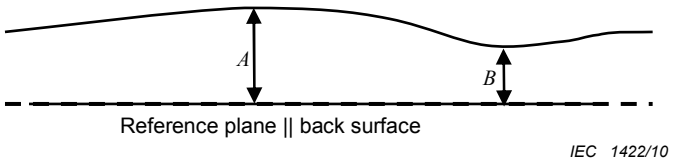

Figure 4 – Schematic diagram of TTV

3.41
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.

[IEC 62276:2005, 3.4.3]

3.42
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 5. The reference plane is defined by three points as described in 3.30b). Warp is a bulk property of a wafer and not of the exposed surface alone

[IEC 62276:2005, 3.7.6]

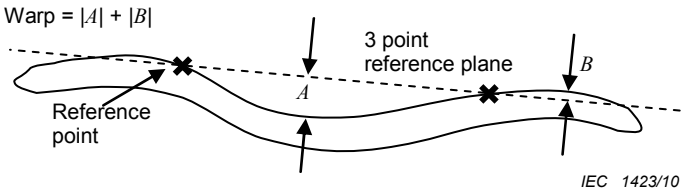

Figure 5 – Schematic diagram of warp

3.43
wafer thickness
thickness measured at the centre of the wafer

[IEC 62276:2005, 3.15]

Bibliography

IEC 60050-561:1991, *International Electrotechnical Vocabulary (IEV) – Chapter 561: Piezoelectric devices for frequency control and selection*
Amendment 1 (1995)
Amendment 2 (1997)

IEC 60410:1973, *Sampling plans and procedures for inspection by attributes*

IEC 61994-4-1:2007*, Piezoelectric and dielectric devices for frequency control and selection – Glossary – Part 4-1: Piezoelectric materials – Synthetic quartz crystal*

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

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