

# TECHNICAL SPECIFICATION

**Piezoelectric, dielectric and electrostatic devices and associated materials for frequency control, selection and detection – Glossary –  
Part 4-4: Piezoelectric materials – Single crystal wafers for surface acoustic wave (SAW) devices**

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INTERNATIONAL  
ELECTROTECHNICAL  
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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**PIEZOELECTRIC, DIELECTRIC AND ELECTROSTATIC DEVICES  
AND ASSOCIATED MATERIALS FOR FREQUENCY CONTROL, SELECTION  
AND DETECTION – GLOSSARY –****Part 4-4: Piezoelectric materials – Single crystal wafers  
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 TS 61944-4-4, which is a technical specification, has been prepared by IEC technical committee 49: Piezoelectric, dielectric and electrostatic devices and associated materials for frequency control, selection and detection.

This third edition of IEC 61994-4-4 cancels and replaces the second edition published in 2010. This edition constitutes a technical revision.

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

- a) the new terms and definitions given in IEC 62276:2016 have been taken into account;
- b) the general title has been changed according to the change in the title of TC 49 in 2009.
- c) the part title has been changed according to the title of IEC 62276:2016.

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

Enquiry draft	Report on voting
49/1283/DTS	49/1287/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 document has been drafted in accordance with the ISO/IEC Directives, Part 2.

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

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

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

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- withdrawn,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

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

# PIEZOELECTRIC, DIELECTRIC AND ELECTROSTATIC DEVICES AND ASSOCIATED MATERIALS FOR FREQUENCY CONTROL, SELECTION AND DETECTION – GLOSSARY –

## Part 4-4: Piezoelectric materials – Single crystal wafers for surface acoustic wave (SAW) devices

### 1 Scope

This part of IEC 61994 gives the terms and definition for single crystal wafers for surface acoustic wave (SAW) devices representing the state of the art.

### 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.

There are no normative references in this document.

### 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

[SOURCE: IEC 62276:2016, 3.1.1, modified – Notes 1 and 2 to entry have been removed.]

##### 3.1.2

##### **lanthanum gallium silicate**

##### **LGS**

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

[SOURCE: IEC 62276:2016, 3.1.5]

##### 3.1.3

##### **lithium niobate**

##### **LN**

single crystals approximately described by chemical formula  $\text{LiNbO}_3$ , grown by Czochralski (crystal pulling from melt) or other growing methods

[SOURCE: IEC 62276:2016, 3.1.2]

#### 3.1.4

##### **lithium tantalate**

##### **LT**

single crystals approximately described by chemical formula  $\text{LiTaO}_3$ , grown by Czochralski (crystal pulling from melt) or other growing methods

[SOURCE: IEC 62276:2016, 3.1.3]

#### 3.1.5

##### **lithium tetraborate**

##### **LBO**

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

[SOURCE: IEC 62276:2016, 3.1.4]

### 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

[SOURCE: IEC 62276:2016, 3.2.1]

#### 3.2.2

##### **polarization process**

electrical process used to establish a single domain crystal

[SOURCE: IEC 62276:2016, 3.2.3]

#### 3.2.3

##### **reduction process**

REDOX reaction to increase conductivity to reduce the harmful effects of pyroelectricity

[SOURCE: IEC 62276:2016, 3.2.4]

#### 3.2.4

##### **reduced LN**

LN treated with a reduction process

[SOURCE: IEC 62276:2016, 3.2.5, modified – Note 1 to entry has been removed.]

#### 3.2.5

##### **reduced LT**

LT treated with a reduction process

[SOURCE: IEC 62276:2016, 3.2.6, modified – Note 1 to entry has been removed.]

#### 3.2.6

##### **single domain**

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

[SOURCE: IEC 62276:2016, 3.2.2]

### 3.3 Terms and definitions related to all crystals

#### 3.3.1

##### **congruent composition**

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

[SOURCE: IEC 62276:2016, 3.3.2]

#### 3.3.2

##### **lattice constant**

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

[SOURCE: IEC 62276:2016, 3.3.1]

#### 3.3.3

##### **twin**

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

[SOURCE: IEC 62276:2016, 3.3.3, modified – Notes 1 and 2 to entry have been removed.]

### 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

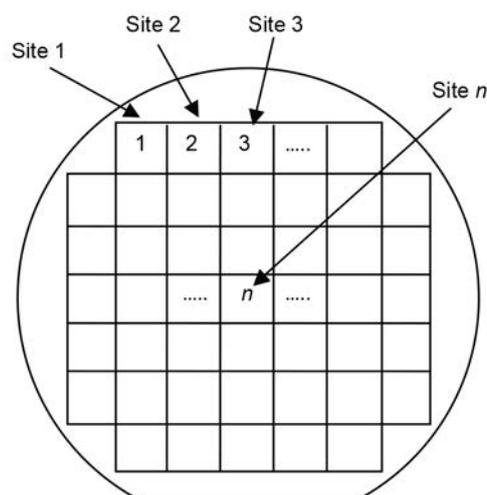
[SOURCE: IEC 62276:2016, 3.4.1, modified – Note 1 to entry has been removed.]

#### 3.4.2

##### **local thickness variation**

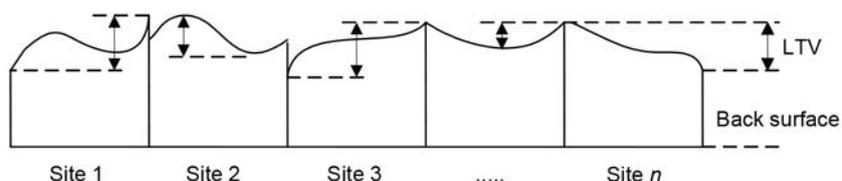
##### **LTV**

variation determined by a measurement of a matrix of sites with defined edge dimensions



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Figure 1 – Example of site distribution for LTV measurement



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**Figure 2 – LTV value of each site**

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

Note 2 to entry: Measurement is performed on a clamped wafer with the reference plane as defined in 3.4.5 a). 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 shall have LTV values less than the specified value.

[SOURCE: IEC 62276:2016, 3.4.8]

### 3.4.3

#### **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 3.4.5 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.

[SOURCE: IEC 62276:2016, 3.4.10]

### 3.4.4

#### **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.

[SOURCE: IEC 62276:2016, 3.4.9]

### 3.4.5

#### **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 measurements, three points at specified locations on the front surface within the FQA;
- c) for without clamped measurements, the least-squares fit to the front surface using all measured points within the FQA

[SOURCE: IEC 62276:2016, 3.4.2]

### 3.4.6

#### **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.

[SOURCE: IEC 62276:2016, 3.4.3]

### 3.4.7

#### Sori

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

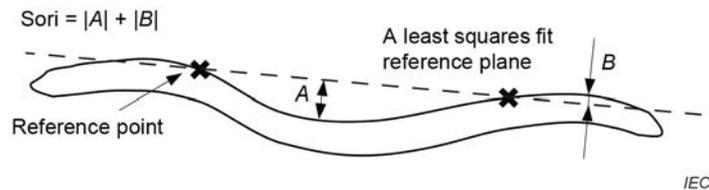


Figure 3 – Schematic diagram of Sori

Note 1 to entry: Sori describes the deformation of an unclamped wafer, as shown in Figure 3.

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 (3.4.5 c).

[SOURCE: IEC 62276:2016, 3.4.7]

### 3.4.8

#### thickness variation for five points

#### TV5

measure of wafer thickness variation defined as the maximum difference between five thickness measurements

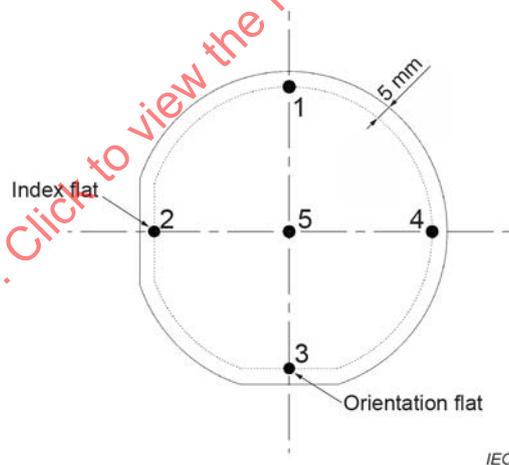


Figure 4 – Wafer sketch and measurement points for TV5 determination

Note 1 to entry: Thickness is measured at the centre of the wafer and at four peripheral points shown in Figure 4.

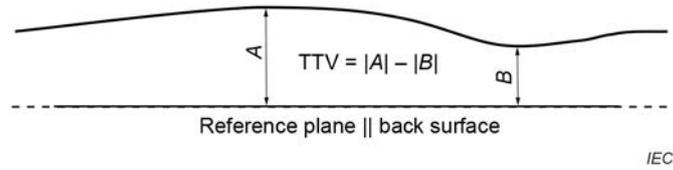
[SOURCE: IEC 62276:2016, 3.4.4]

### 3.4.9

#### total thickness variation

#### TTV

difference between the maximum thickness and the minimum thickness



**Figure 5 – Schematic diagram of TTV**

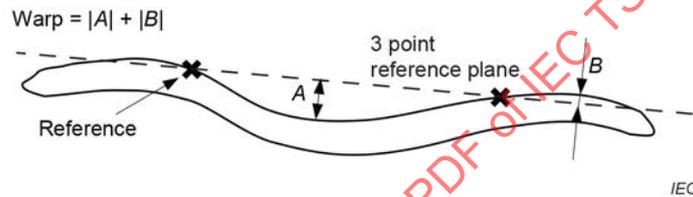
Note 1 to entry: The maximum thickness is represented by the letter A and the minimum thickness is represented by the letter B in Figure 5.

Note 2 to entry: Measurement of TTV is performed under clamped conditions with the reference plane as defined in 3.4.5 a).

[SOURCE: IEC 62276:2016, 3.4.5]

**3.4.10  
warp**

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



**Figure 6 – Schematic diagram of warp**

Note 1 to entry: Warp (shown in Figure 6) describes the deformation of an unclamped wafer.

Note 2 to entry: The reference plane is defined by 3-points as described in 3.4.5 b). Warp is a bulk property of a wafer and not of the exposed surface alone.

[SOURCE: IEC 62276:2016, 3.4.6]

**3.5 Definitions of appearance defects**

**3.5.1  
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.

[SOURCE: IEC 62276:2016, 3.5.4]

**3.5.2  
contamination**

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

[SOURCE: IEC 62276:2016, 3.5.1]

**3.5.3  
crack**

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

[SOURCE: IEC 62276:2016, 3.5.2]

**3.5.4****dimple**

smooth surface depression larger than 3 mm in diameter

[SOURCE: IEC 62276:2016, 3.5.5]

**3.5.5****orange peel**

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

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

[SOURCE: IEC 62276:2016, 3.5.7]

**3.5.6****pit**

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

[SOURCE: IEC 62276:2016, 3.5.6, modified – The example has been included into the definition.]

**3.5.7****scratch**

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

[SOURCE: IEC 62276:2016, 3.5.3]

**3.6 Other terms and definitions****3.6.1****back surface roughness**

roughness which scatters and suppresses bulk wave spurious at back surface

[SOURCE: IEC 62276:2016, 3.6.4]

**3.6.2****bevel**

slope or rounding of the wafer perimeter

Note 1 to entry: Bevel is also referred to as “edge profile”.

Note 2 to entry: The process of creating a bevel is called “bevelling” or “edge rounding”.

Note 3 to entry: The profile and its tolerances should be specified by the supplier.

[SOURCE: IEC 62276:2016, 3.6.9]

**3.6.3****description of orientation and SAW propagation**

indication of the surface orientation and the SAW propagation direction, separated by the symbol “-“

Note 1 to entry: Specification of a 0° orientation is normally omitted.

Note 2 to entry: Typical examples for these expressions are shown in Table 1.

Note 3 to entry: Description of wafer orientation rule is shown in Annex A of IEC 62276:2016.

**Table 1 – Description of wafer orientations**

Material LT Quartz	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	yxt/48,5°/26,6°

[SOURCE: IEC 62276:2016, 3.6.6]

**3.6.4**

**diameter of wafer**

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

[SOURCE: IEC 62276:2016, 3.6.10]

**3.6.5**

**manufacturing lot**

lot established by agreement between the customer and the supplier

[SOURCE: IEC 62276:2016, 3.6.1]

**3.6.6**

**orientation flat**

**OF**

flat portion of wafer perimeter indicating the crystal orientation

[SOURCE: IEC 62276:2016, 3.6.2, modified – Notes 1 and 2 to entry have been removed.]

**3.6.7**

**secondary flat**

**SF**

flat portion of wafer perimeter shorter than the OF

[SOURCE: IEC 62276:2016, 3.6.3, modified – Notes 1 and 2 to entry have been removed.]

**3.6.8**

**ST-cut**

cut direction of quartz to achieve zero temperature coefficient of frequency

[SOURCE: IEC 62276:2016, 3.6.7, modified – The words "of frequency" have been added at the end of the definition.]

**3.6.9**

**surface orientation**

crystallographic orientation of the axis perpendicular to the polished surface of wafer

[SOURCE: IEC 62276:2016, 3.6.5]

**3.6.10**

**tolerance of surface orientation**

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