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

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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 and dielectric devices for frequency control and selection.

This standard cancels and replaces IEC/PAS 62276 published in 2001. This first edition constitutes a technical revision.

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

FDIS	Report on voting
49/720/FDIS	49/724/RVD

Full information on the voting for the approval of this standard 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.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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

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- withdrawn,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

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

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 $Li_2B_4O_7$, 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
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:

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.

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

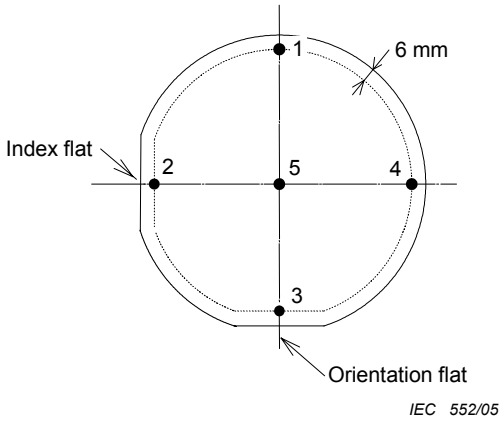

Figure 1 – Wafer sketch and measurement points for TV5 determination