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Semiconductor devices - Micro-electromechanical devices - Part 26: Description and measurement methods for micro trench and needle structures

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(IEC 62047-26:2016)

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European foreword

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The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2016-11-11
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Dispositifs à semiconducteurs – Dispositifs microélectromécaniques – Partie 26: Description et méthodes de mesure pour structures de microtranchées et de microaiguille

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**SEMICONDUCTOR DEVICES –
MICRO-ELECTROMECHANICAL DEVICES –**

**Part 26: Description and measurement methods for
micro trench and needle structures**

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International Standard IEC 62047-26 has been prepared by subcommittee 47F: Microelectromechanical systems, of IEC technical committee 47: Semiconductor devices.

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

FDIS	Report on voting
47F/233/FDIS	47F/239/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.

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A list of all parts in the IEC 62047 series, published under the general title *Semiconductor devices – Micro-electromechanical devices*, 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 website under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
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SEMICONDUCTOR DEVICES – MICRO-ELECTROMECHANICAL DEVICES –

Part 26: Description and measurement methods for micro trench and needle structures

1 Scope

This part of IEC 62047 specifies descriptions of trench structure and needle structure in a micrometer scale. In addition, it provides examples of measurement for the geometry of both structures. For trench structures, this standard applies to structures with a depth of 1 μm to 100 μm; walls and trenches with respective widths of 5 μm to 150 μm; and aspect ratio of 0,006 7 to 20. For needle structures, the standard applies to structures with three or four faces with a height, horizontal width and vertical width of 2 μm or larger, and with dimensions that fit inside a cube with sides of 100 μm.

This standard is applicable to the structural design of MEMS and geometrical evaluation after MEMS processes.

2 Normative references

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The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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None.

3 Terms and definitions

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

3.1
trench structure
one or more rectangular structures engraved in a planar substrate, with a constant trapezoidal cross section profile

3.2
needle structure
projecting structures with a pointed tip formed of three or more faces, formed on a planar substrate with the plane of symmetry in the vertical plane

3.3
wall and trench
two or more of the trench structures arranged in parallel at regular intervals

3.4
scallop
irregularity formed cyclically in the side walls after a deep-reactive ion etching (DRIE) process with repeated deposition and selective etching of polymeric passivation layer and then etching of a silicon substrate

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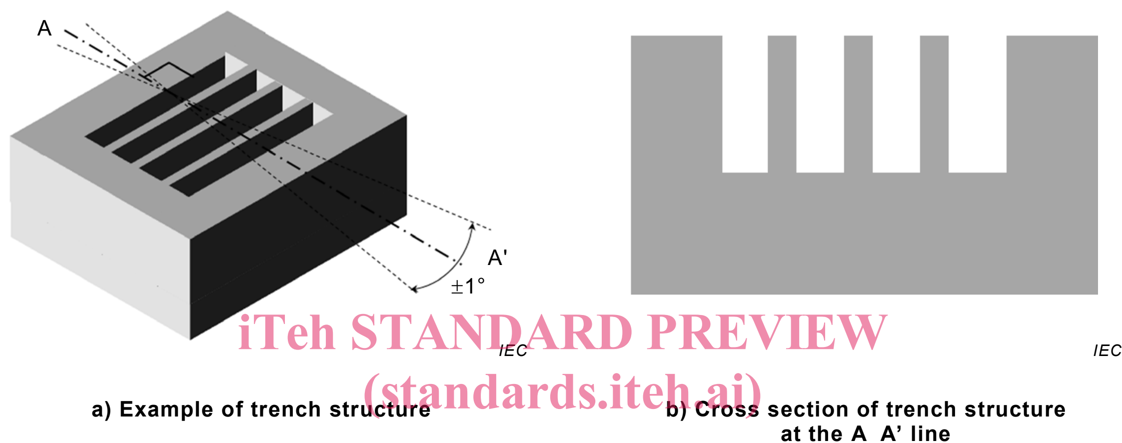
4 Description of trench structures in a micrometer scale

4.1 General

This standard specified the method of indicating the cross-sectional geometry of trench structures with micrometer scale dimensions. Figure 1 is a diagram of the cross section required for indicating the cross-sectional geometry of trench structures in this standard. The cross-sectional geometry of trench structures is the cross-sectional shape at a line longitudinally intersecting the trench structure at right angles as viewed from the upper surface of the substrate, with an error of ±1° or less.

See Clause 6 and Annex A for the method of measuring the cross-sectional dimensions of trench structures.



a) Example of trench structure b) Cross section of trench structure at the A_A' line

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Figure 1 – Schematic of example for trench structure in a micrometer scale and its cross section

4.2 Symbols and designations

The cross section of a typical trench structure is shown in Figure 2, and the symbols, designations and units used for indicating the cross section of the trench structures are listed in Table 1.

The horizontal datum line for indicating the cross section in Figure 2 is a straight line approximating the upper surface of the planar substrate. The vertical datum line is defined as a line intersecting the horizontal datum line at right angles. The trench side wall is indicated by its straight line approximation. The bottom of trench is expressed as its approximate straight or curved line. On the upper surface of the trench structure, the wall is defined as the area that is considered same as the horizontal datum line without etching, and the trench is defined as the etched area. According to these definitions, the widths of the wall and trench at the upper surface are expressed as shown in Figure 2. The trench side wall angle is defined as the angle between the horizontal datum line and approximate line of the side wall, and it is indicated with a value measured clockwise from the horizontal datum line positioned on the top of the wall to the trench side wall by the shortest distance, as shown in Figure 2. The widths of the wall and trench at the bottom of the trench are expressed by distances between intersection points with the approximate line of the side wall and approximate straight or curved line at the bottom of the trench. The depth of the trench is defined as the shortest distance from the horizontal datum line at the middle of the trench to the bottom surface of the trench.

When the trench structure is fabricated by the DRIE process with repeated deposition and selective etching of polymeric passivation layer and then etching of a silicon substrate, scallops are formed in the trench side walls after etching. Figure 3 shows a cross section of a trench structure with inverse taper side walls prepared with the DRIE etching process, including symbols for the geometry.

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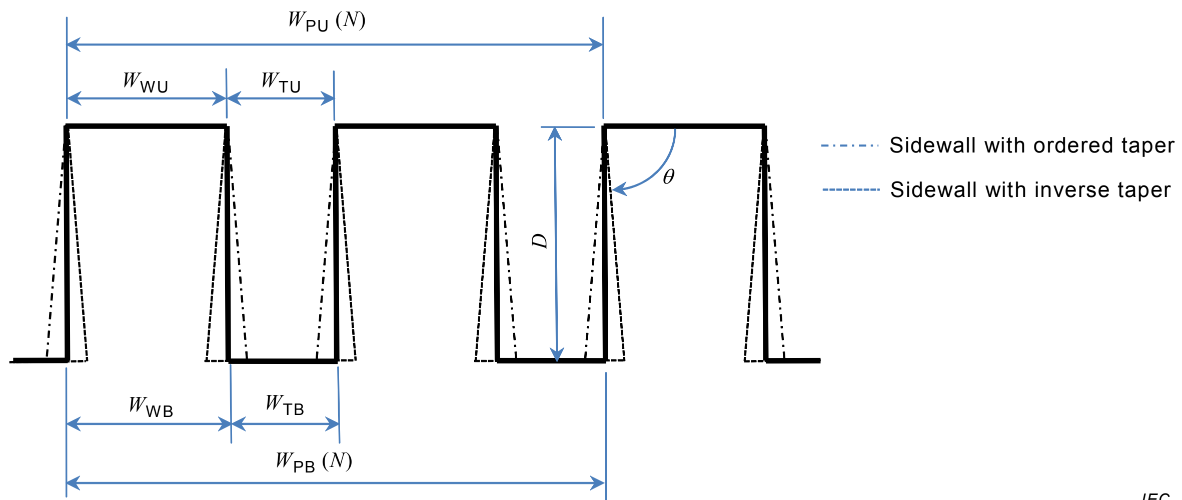

Figure 2 – Cross section of trench structure in a micrometer scale

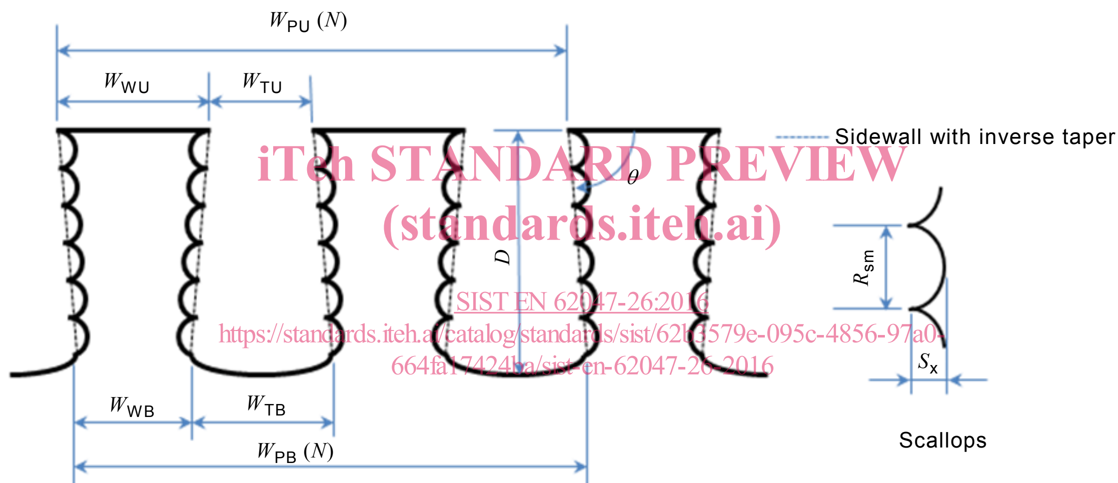

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Figure 3 – Cross section of trench structure in a micrometer scale fabricated by a deep-reactive ion etching process with repeated deposition and etching of silicon

Table 1 – Symbols and designations of trench structure in a micrometer scale

Symbol	Unit	Designation
W_{WU}	µm	Width of wall part at the upper surface
W_{TU}	µm	Width of trench part at the upper surface
W_{WB}	µm	Width of wall part at the bottom of trench
W_{TB}	µm	Width of trench part at the bottom of trench
$W_{PU}(N)$	µm	Distance of N pitches of Wall and Trench at the upper surface
$W_{PB}(N)$	µm	Distance of N pitches of Wall and Trench at the bottom of trench
N	–	Number of pitches
D	µm	Depth of trench at the center of trench
θ	Deg	Sidewall angle
S_x	µm	Horizontal distance of scallop
Rs_m	µm	Mean vertical distance of scallop