

INTERNATIONAL STANDARD

**Semiconductor devices - Non-destructive recognition criteria of defects in
silicon carbide homoepitaxial wafer for power devices -
Part 5: Test method for defects using X-ray topography**

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CONTENTS

FOREWORD	3
INTRODUCTION	5
1 Scope	6
2 Normative references	6
3 Terms and definitions	6
4 X-ray topography method	10
4.1 General	10
4.2 Principle	11
4.3 Requirements	11
4.3.1 Measuring equipment	11
4.3.2 Wafer positioning	13
4.3.3 Uniformity and constancy	13
4.3.4 Image capturing	13
4.3.5 Image processing	14
4.3.6 Image analysis	14
4.3.7 Image evaluation	14
4.3.8 Documentation	14
4.4 Parameter settings	14
4.4.1 General	14
4.4.2 Parameter setting process	14
4.5 Procedure	15
4.6 Evaluation	15
4.6.1 General	15
4.6.2 Mean width of planar and volume defects	15
4.6.3 Evaluation process	15
4.7 Precision	15
4.8 Test report	16
4.8.1 Mandatory elements	16
4.8.2 Optional elements	16
Annex A (informative) X-ray topography images of defects	17
A.1 General	17
A.2 Micropipe	17
A.3 TSD	19
A.4 TED	21
A.5 BPD	22
A.6 Scratch trace	24
A.7 Stacking fault	26
A.8 Polytype inclusion	28
Bibliography	31
Figure 1 – Schematic diagram of laboratory XRT imaging system	12
Figure A.1 – Example 1 of micropipe	18
Figure A.2 – Example 2 of Micropipe	19
Figure A.3 – Example 1 of TSD	20
Figure A.4 – Example 2 of TSD	21

Figure A.5 – Example of TED.....	22
Figure A.6 – Example 1 of BPD.....	23
Figure A.7 – Example 2 of BPD.....	24
Figure A.8 – Example 1 of scratch trace.....	25
Figure A.9 – Example 2 of scratch trace.....	26
Figure A.10 – Example 1 of stacking fault	27
Figure A.11 – Example 2 of Stacking fault.....	28
Figure A.12 – Example 1 of Polytype inclusion.....	29
Figure A.13 – Example 2 of polytype inclusion	30

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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in silicon carbide homoepitaxial wafer for power devices -
Part 5: Test method for defects using X-ray topography**

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The text of this International Standard is based on the following documents:

Draft	Report on voting
47/2915/CDV	47/2985/RVC

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

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 63068 series, published under the general title *Semiconductor devices - Non-destructive recognition criteria of defects in silicon carbide homoepitaxial wafer for power devices*, can be found on the IEC website.

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

- reconfirmed,
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INTRODUCTION

Results of evaluating defects on silicon carbide homoepitaxial wafer by test methods using optical inspection and/or photoluminescence often depend on wafer conditions, such as surface morphology and spatial variations in impurity concentration, and therefore often require visual confirmation after equipment-based inspection. In particular, micropipes, TSDs, TEDs and particle inclusions belong to different defect classes but exhibit similar visual features. Accurate classification of these defects relies on test methods that provide complementary information, including X-ray topography.

This part of IEC 63068 provides definitions and guidance in use of X-ray topography in detecting defects in silicon carbide (SiC) homoepitaxial wafers.

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1 Scope

This part of IEC 63068 provides definitions and guidance in use of X-ray topography inspection system for detecting defects in silicon carbide (SiC) homoepitaxial wafers. Additionally, this document exemplifies X-ray topographic images to enable the detection and categorization of defects in SiC homoepitaxial wafers.

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 63068-1, *Semiconductor devices - Non-destructive recognition criteria of defects in silicon carbide homoepitaxial wafer for power devices - Part 1: Classification of defects*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 63068-1 and the following apply.

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

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

3.1

silicon carbide

SiC

semiconductor crystal composed of silicon and carbon, which exhibits a large number of polytypes such as 3C, 4H, and 6H

Note 1 to entry: A symbol like 4H gives the number of periodic stacking layers (2, 3, 4,...) and the crystal symmetry (H = hexagonal, C = cubic) of each polytype.

[SOURCE: IEC 63068-1:2019, 3.1]

3.2

4H-SiC

SiC crystal showing a hexagonal symmetry, in which four Si-C layers are periodically arranged along the crystallographic c-axis

Note 1 to entry: The crystal structure of 4H-SiC is similar to wurtzite with a unit cell having four periodical occupied sites along the <0001> direction.

[SOURCE: IEC 63068-1:2019, 3.3]

3.3**X-ray topography****XRT**

method of assessing extended defects in a crystal, where a two-dimensional intensity profile of an X-ray beam diffracted by a crystal lattice is recorded

Note 1 to entry: The diffraction condition in X-ray topography is characterized by a diffraction vector $\mathbf{g}$.

Note 2 to entry: XRT is also known as X-ray diffraction imaging (XRDI).

[SOURCE: IEC 63068-1:2019, 3.47, modified – “x-rays diffracted by a crystal” has been replaced with “X-ray beam diffracted by a crystal lattice” and Note 2 has been added.]

3.4**XRT imaging**

technique for capturing, processing and analysing diffraction images of a crystal using an X-ray source, X-ray optics, a goniometer system, an optical image sensor and computer systems

3.5**diffraction condition**

geometrical condition how an X-ray beam is reflected by a crystal, denoted as (hkl) reflection, defined by the periodic three-dimensional arrangement of atoms in the crystal

Note 1 to entry: Scattering vector of the X-ray beam is perpendicular to the $(h/n \ k/n \ l/n)$ plane, where n is the greatest common divisor of h , k , and l .

Note 2 to entry: In 4H-SiC showing a hexagonal symmetry, four-digit indices, $hkil$, are frequently used, where $h + k + i = 0$.

3.6**X-ray source**

system which generates and emits X-rays, comprising a high-voltage power supply unit and an X-ray tube consisting of a vacuum cavity containing a target material and a filament

Note 1 to entry: The X-ray source for a laboratory system uses simple substance such as copper as a target material.

3.7**characteristic X-ray beam**

X-ray beam showing the line spectrum of wavelengths unique to the constituent elements of the target material

3.8**X-ray optics**

optical components which shape and filter an X-ray beam that travels to a test wafer

3.9**crystal monochromator**

X-ray optic to select a defined wavelength of the X-ray beam for further purpose on a dedicated instrument

3.10**multilayer collimating mirror**

X-ray optic having a multilayer structure that filters wavelength of X-rays and collimates the beam

3.11**slit**

X-ray optic with a very narrow opening to limit the size of an X-ray beam