



IEC 63068-2

Edition 1.0 2019-01

INTERNATIONAL STANDARD

**Semiconductor devices – Non-destructive recognition criteria of defects in
silicon carbide homoepitaxial wafer for power devices –
Part 2: Test method for defects using optical inspection**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 31.080.99

ISBN 978-2-8322-6480-5

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	4
INTRODUCTION.....	6
1 Scope.....	7
2 Normative references	7
3 Terms and definitions	7
4 Optical inspection method	11
4.1 General.....	11
4.2 Principle	12
4.3 Requirements	12
4.3.1 Illumination.....	12
4.3.2 Wafer positioning and focusing	13
4.3.3 Image capturing.....	13
4.3.4 Image processing	13
4.3.5 Image analysis	13
4.3.6 Image evaluation	13
4.3.7 Documentation	13
4.4 Parameter settings.....	14
4.4.1 General	14
4.4.2 Parameter setting process	14
4.5 Procedure	14
4.6 Evaluation.....	14
4.6.1 General	14
4.6.2 Mean width of planar and volume defects	14
4.6.3 Evaluation process	15
4.7 Precision.....	15
4.8 Test report	15
Annex A (informative) Optical inspection images of defects	16
A.1 General.....	16
A.2 Micropipe	16
A.3 TSD	17
A.4 TED	17
A.5 BPD.....	18
A.6 Scratch trace	18
A.7 Stacking fault.....	19
A.8 Propagated stacking fault.....	19
A.9 Stacking fault complex	20
A.10 Polytype inclusion	21
A.11 Particle inclusion.....	23
A.12 Bunched-step segment	23
Bibliography.....	25
Figure A.1 – Micropipe	16
Figure A.2 – TSD	17
Figure A.3 – TED	18
Figure A.4 – Scratch trace	18
Figure A.5 – Stacking fault.....	19

Figure A.6 – Propagated stacking fault	20
Figure A.7 – Stacking fault complex	21
Figure A.8 – Polytype inclusion	22
Figure A.9 – Particle inclusion	23
Figure A.10 – Bunched-step segment	24

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**SEMICONDUCTOR DEVICES –
NON-DESTRUCTIVE RECOGNITION CRITERIA OF DEFECTS IN SILICON
CARBIDE HOMOEPITAXIAL WAFER FOR POWER DEVICES –**

Part 2: Test method for defects using optical inspection

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 63068-2 has been prepared by IEC technical committee 47: Semiconductor devices.

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

CDV	Report on voting
47/2475/CDV	47/2522A/RVC

Full information on the voting for the approval of this International Standard 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 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 "<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.

INTRODUCTION

Silicon carbide (SiC) is widely used as a semiconductor material for next-generation power semiconductor devices. SiC, as compared with silicon (Si), has superior physical properties such as a higher breakdown electric field, higher thermal conductivity, lower thermal generation rate, higher saturated electron drift velocity, and lower intrinsic carrier concentration. These attributes realize SiC-based power semiconductor devices with faster switching speeds, lower losses, higher blocking voltages, and higher temperature operation relative to standard Si-based power semiconductor devices.

SiC-based power semiconductor devices are not fully realized due to some issues including high costs, low yield, and low long-term reliability. In particular, one of the serious issues lies in the defects existing in SiC homoepitaxial wafers. Although efforts of decreasing defects in SiC homoepitaxial wafers are actively implemented, there are a number of defects in commercially available SiC homoepitaxial wafers. Therefore, it is indispensable to establish an international standard regarding the quality assessment of SiC homoepitaxial wafers.

The IEC 63068 series of standards is planned to comprise Part 1, Part 2, and Part 3, as detailed below. This document provides definitions and guidance in use of optical inspection for detecting defects in commercially available silicon carbide (SiC) homoepitaxial wafers.

Part 1: Classification of defects

Part 2: Test method for defects using optical inspection

Part 3: Test method for defects using photoluminescence

SEMICONDUCTOR DEVICES – NON-DESTRUCTIVE RECOGNITION CRITERIA OF DEFECTS IN SILICON CARBIDE HOMOEPITAXIAL WAFER FOR POWER DEVICES –

Part 2: Test method for defects using optical inspection

1 Scope

This part of IEC 63068 provides definitions and guidance in use of optical inspection for detecting as-grown defects in commercially available 4H-SiC (Silicon Carbide) epitaxial wafers. Additionally, this document exemplifies optical images to enable the detection and categorization of the defects for SiC homoepitaxial wafers.

This document deals with a non-destructive test method for the defects so that destructive methods such as preferential etching are out of scope in this document.

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.