BS IEC 63229:2021



BSI Standards Publication

Semiconductor devices — Classification of defects in gallium nitride epitaxial film on silicon carbide substrate

bsi.

Documents
Document Sharing Hub

Full document details: BS IEC 63229:2021

National foreword

This British Standard is the UK implementation of IEC 63229:2021.

The UK participation in its preparation was entrusted to Technical Committee EPL/47, Semiconductors.

A list of organizations represented on this committee can be obtained on request to its committee manager.

Contractual and legal considerations

This publication has been prepared in good faith, however no representation, warranty, assurance or undertaking (express or implied) is or will be made, and no responsibility or liability is or will be accepted by BSI in relation to the adequacy, accuracy, completeness or reasonableness of this publication. All and any such responsibility and liability is expressly disclaimed to the full extent permitted by the law.

This publication is provided as is, and is to be used at the recipient's own risk.

The recipient is advised to consider seeking professional guidance with respect to its use of this publication.

This publication is not intended to constitute a contract. Users are responsible for its correct application.

© The British Standards Institution 2023
Published by BSI Standards Limited 2023

ISBN 978 0 539 02920 8

ICS 31.080; 31.080.01; 31.080.99

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 August 2023.

Amendments/corrigenda issued since publication

Date	Text affected

Documents
Document Sharing Hub

Full document details: BS IEC 63229:2021

IEC 63229

Edition 1.0 2021-04

INTERNATIONAL STANDARD

colour inside

Semiconductor devices – Classification of defects in gallium nitride epitaxial film on silicon carbide substrate

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 31.080.99

ISBN 978-2-8322-9669-1

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

® Registered trademark of the International Electrotechnical Commission

Documents
Document Sharing Hub

Full document details: BS IEC 63229:2021

CONTENTS

FOREWORD 3
INTRODUCTION 5
1 Scope 6
2 Normative references 6
3 Terms and definitions 6
4 Classification of defects 9
4.1 General 9
4.2 Description of the defect classes 9
4.2.1 General 9
4.2.2 Vacancy 9
4.2.3 Interstitial 10
4.2.4 Substitutional defect 11
4.2.5 Point defect complex 12
4.2.6 Threading dislocation 13
4.2.7 Crack 14
4.2.8 Inclusion 15
4.2.9 Hillock 16
4.2.10 Pit 18
4.2.11 Scratch 20
4.2.12 Others 21

Figure 1 – Vacancy 10
Figure 2 – Interstitial 11
Figure 3 – Substitutional defect 12
Figure 4 – Point defect complex 13
Figure 5 – Threading dislocation 14
Figure 6 – Crack 15
Figure 7 – Inclusion 16
Figure 8 – Hillock 18
Figure 9 – Pit 20
Figure 10 – Scratch 21

Table 1 – Classification of defects in GaN epitaxial film on SiC substrate 9

Documents
Document Sharing Hub

Full document details: BS IEC 63229:2021

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

SEMICONDUCTOR DEVICES – CLASSIFICATION OF DEFECTS IN GALLIUM NITRIDE EPITAXIAL FILM ON SILICON CARBIDE SUBSTRATE

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 63229 has been prepared by IEC technical committee 47: Semiconductor devices. It is an International Standard.

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

FDIS	Report on voting
47/2687/FDIS	47/2693/RVD

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.

Documents
Document Sharing Hub

Full document details: BS IEC 63229:2021

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/standardsdev/publications.

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

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

Documents
Document Sharing Hub

Full document details: BS IEC 63229:2021

INTRODUCTION

Gallium nitride (GaN) as a representative of the wide band gap semiconductors has outstanding properties, such as wide band gap, high critical electric field, high electron saturation drift velocity, and good resistance to corrosion and radiation. Owing to these properties, GaN can bring significant improvements to electronic devices, such as high-voltage, high-frequency, and high-power, which will be widely used in wireless communication base stations, radars, automotive electronics, aerospace, the nuclear industry, and military electronics.

To date, the development of GaN epitaxial film and related devices is hindered by high cost, low yield, and poor reliability. Among them, the defects in GaN epitaxial film, which closely related to device reliability, are especially serious.

There are various defects found in GaN epitaxial film on silicon carbide (SiC) substrate. In addition, global researchers have not established a uniform definition and classification criterion for defects in GaN epitaxial film yet. Thus, it is essential to establish a set of international standards for GaN epitaxial film on SiC substrate, which will benefit the development of GaN epitaxial film and related devices.

To define and classify defects in GaN epitaxial film on SiC substrate, a new international standard is proposed. The main contents of this document are listing and illustrating the definition and classification of defects in GaN epitaxial film on SiC substrate, providing reference for future GaN-related research and device manufacture.

AVA Documents
Document Sharing Hub

Full document details: BS IEC 63229:2021

SEMICONDUCTOR DEVICES – CLASSIFICATION OF DEFECTS IN GALLIUM NITRIDE EPITAXIAL FILM ON SILICON CARBIDE SUBSTRATE

1 Scope

This International Standard gives guidelines for the definition and classification of defects in GaN epitaxial film grown on SiC substrate. They are identified and described on the basis of examples, mainly by schematic illustrations, optical microscope images, and transmission electron microscope images for these defects. This document covers only defects in as-grown GaN epitaxial film on SiC substrate and does not include defects caused by subsequent processes.

2 Normative references

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
Gallium nitride
GaN
compound semiconductor crystal composed of gallium and nitrogen

3.2
substrate
material on which epitaxial layer is deposited

[SOURCE: IEC 63068-1:2019, 3.9, modified – "Homoepitaxial" has been replaced by "epitaxial".]

3.3
Silicon carbide
SiC
semiconductor crystal composed of silicon and carbon, which exhibits a large number of polytypes such as 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) of each polytype.

[SOURCE: IEC 63068-1:2019, 3.1, modified – Polytype of 3C has been deleted.]

AVA Documents Document Sharing Hub

Full document details: BS IEC 63229:2021