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Part 1: Classification of defects

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Introduction

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For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

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- All comments should be submitted online at <https://standardsdevelopment.bsigroup.com/>. You will need to register in order to comment.

Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	



47/2865/CD

COMMITTEE DRAFT (CD)

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2024-08-16

CLOSING DATE FOR COMMENTS:

2024-10-11

SUPERSEDES DOCUMENTS:

47/2816/NP, 47/2849/RVN

IEC TC 47 : SEMICONDUCTOR DEVICES

SECRETARIAT:

Korea, Republic of

SECRETARY:

Mr Cheolung Cha

OF INTEREST TO THE FOLLOWING COMMITTEES:

HORIZONTAL FUNCTION(S):

ASPECTS CONCERNED:

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TITLE:

Semiconductor devices - The recognition criteria of defects in polished indium phosphide wafers - Part 1: Classification of defects

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

SEMICONDUCTOR DEVICE–

THE RECOGNITION CRITERIA OF DEFECTS IN INDIUM PHOSPHIDE
WAFERS

Part 1: Classification of defects in InP polished wafers

FOREWORD

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

Draft	Report on voting
XX/XX/FDIS	XX/XX/RVD

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

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

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

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

- 107 • reconfirmed,
- 108 • withdrawn,
- 109 • replaced by a revised edition, or
- 110 • amended.

111

112

INTRODUCTION

113 Indium phosphide (InP) have high electron mobility, low dielectric constant, and direct
114 bandgap. InP is in perfect accordance with the optimum operating range for fiber-optic
115 transmission (1300 and 1550 nm). Owing to the properties, InP can bring significant
116 improvements to microelectronic and optoelectronic devices, such as HEMTs, HBTs,
117 photodetectors and lasers, which will be widely applied in optical communication, RF
118 application, Automotive Lidar, 5G communication, THz security check, Solar battery and so on.

119 The development of InP and related devices is hindered by high cost, low yield and poor
120 reliability. There are various defects in InP polished wafers. In addition, global researchers
121 have not established a uniform definition and classification criteria for the InP defects yet.
122 Thus, it is essential to establish international standards on the defects of InP polished wafers,
123 which will benefit the development of InP materials and related devices.

124 The IEC 63581 series of planned to comprise Part 1, Part 2, Part 3 and Part 4, as detailed
125 below. The outline of this Part 1 is to list and illustrate the definition and classification of
126 defects in InP polished wafers, providing reference for future InP-related research and device
127 manufacture.

128

129 Part 1: Classification of defects in InP polished wafers

130

131 Part 2: Classification of defects in InP epitaxial wafers

132

133 Part 3: Test method for defects using optical inspection

134

135 Part 4: Test method for defects using scanning electron microscopy

136

137

SEMICONDUCTOR DEVICE– THE RECOGNITION CRITERIA OF DEFECTS IN INDIUM PHOSPHIDE WAFERS

Part 1: Classification of defects in InP polished wafers

1 Scope

This document specifies the definitions and classification of defects in InP polished wafers. They are identified and described on the basis of examples, mainly by schematic illustrations, optical microscope images, scanning electron microscope images. It is necessary to choose testing methods based on the characteristic and size of defects. This document covers only defects in InP polished wafers 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 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 indium phosphide

InP
compound semiconductor crystal composed of indium and phosphorus

3.2 crystal monocrystalline material

[SOURCE: IEC 63068-1:2019, 3.4].

3.3 crystal direction

direction, denoted $[uvw]$, representing a vector direction in multiples of the basis vectors describing the a -, b - and c -axis

[SOURCE: IEC 63068-1:2019, 3.6]

3.4 lattice

specific form of atomic arrangement within the crystal

[SOURCE: IEC 63068-1:2019, 3.8]

176 **3.5**
177 **defect**
178 interruption of crystallinity.

179 Note 1 to entry: Defect in InP wafers including point defect, linear defect, planar defect, volume defect, surface
180 defect and the others.

181 [SOURCE: IEC 63229:2021, 3.10, modified – added the planar defect]

182 **3.6**
183 **point defect**
184 crystal defect that occurs at or around a single lattice site

185 Note 1 to entry: Point defect in InP wafers including vacancy, interstitial and substitutional.

186 Note 2 to entry: Intentionally doped is realized by using point defects for the purpose of modulating its electrical,
187 optical and structural properties.

188 [SOURCE: IEC 63229:2021, 3.11 modified –Deleted the content of “such as vacancy,
189 interstitial, substitutional defect and point defect complex”, and added Note 1 to entry and
190 Note 2 to entry.]

191 **3.7**
192 **linear defect**
193 lattice defects that occur in the inner structure of the crystal within the surrounding area of a
194 certain line

195 Note 1 to entry: Linear defects in InP wafers including dislocation, dislocation array and dislocation cluster.

196 Note 2 to entry: In InP based photodetectors, linear defect is the source for the large current leakage. It will
197 reduce the yield of photoelectric devices.

198 **3.8**
199 **planar defect**
200 crystal surface defects between crystal boundaries

201 Note 1 to entry: Planar defect in InP wafers include twin and twin lamella.

202 Note 2 to entry: InP has a small stacking fault energy so planar defect occurs very easily. These defects will
203 change the orientation of InP wafer.

204 **3.9**
205 **volume defect**
206 three-dimensional aggregates of atoms or vacancies in crystal

207 Note 1 to entry: Volume defects in InP wafers include inclusion, hole, crack and cavity.

208 Note 2 to entry: Volume defects will affect the crystal perfection of the crystal. These defects will reduce the rate
209 of finished products.

210 **3.10**
211 **surface defect**
212 area of partial physical or chemical inhomogeneity of the surface of crystal

213 Note 1 to entry: Surface defects in InP wafers include local light scatterer, pit, scratch.

214 Note 2 to entry: Surface defects will be enlarged during epitaxial growth. Such as the scratch on the substrate
215 surface will cause the dense rows of dislocation on epitaxial wafer.

216 **3.11**
217 **Schottky defect**
218 vacancy created at the original site when an atom escapes from its lattice site to the surface
219 of the crystal

220 [SOURCE: IEC 63229:2021, 3.13]

221 **3.12**

222 **Frankel defect**

223 vacancy created at the original site when an atom delivers from its lattice site to an interstitial
224 site of the crystal

225 [SOURCE: IEC 63229:2021, 3.14]

226 **3.13**

227 **dislocation**

228 linear crystallographic defect in monocrystalline material

229 [SOURCE: IEC 63068-1:2019, 3.22]

230 **3.14**

231 **Burgers circuit**

232 a closed circuit in the crystal, from atom to atom, in a region of crystal surrounding the
233 dislocation cone, proceeding in a clockwise or right-hand direction

234 **3.15**

235 **dislocation etch pit**

236 pit generated by a preferential etch where a dislocation meets the surface of a wafer

237 **3.16**

238 **second-phase particle**

239 small and dispersed particles in the crystal that have a different composition or structure,
240 such as indium oxide

241 **3.17**

242 **Optical microscopy**

243 OM

244 technique employed to observe morphological features of wafer surface through the
245 magnification by lenses with visible light

246 [SOURCE: IEC 63068-1:2019, 3.45]

247 **3.18**

248 **Scanning electron microscopy**

249 SEM

250 electron microscope in which a beam of focused electrons moves across the object with the
251 secondary electrons produced by the object and the electrons scattered by the object being
252 collected to form a three-dimensional image on a display screen

253

254 **4 Classification of defects**

255 **4.1 General**

256 The classification of defects in InP polished wafers in this document is based on
257 crystallographic type and dimension of the defects. Defects in InP polished wafers shall be
258 categorised into 14 patterns as given in table 1.