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Collection of metallographs on defects in silicon carbide crystal materials

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Foreword

This document complies with the provisions of GB/T 1:1-2020 "Standardization Work Guidelines Part 1: Structure and Drafting Rules of Standardization Documents" Drafting: Please note that some content in this document may be subject to patents: The publication structure of this document assumes no responsibility for identifying patents: This document is jointly developed by the National Semiconductor Equipment and Materials Standardization Technical Committee (SAC/TC203) and the National Semiconductor Equipment and Materials Standards It was jointly proposed and coordinated by the Materials Sub-Technical Committee of the Chemistry Technical Committee (SAC/TC203/SC2): This document was drafted by: Guangdong Tianyu Semiconductor Co:, Ltd:, Nonferrous Metals Technology and Economic Research Institute Co:, Ltd:, Beijing No: Third Generation Semiconductor Industry Technology Innovation Strategic Alliance, Shandong Tianyue Advanced Technology Co:, Ltd:, Hebei Tongguang Semiconductor Co:, Ltd:, Peking University Dongguan Institute of Optoelectronics, Shanxi Shuoke Crystal Co:, Ltd:, Hebei Puxing Electronic Technology Co:, Ltd:, Beijing Tianke Heda Half Conductor Co:, Ltd:, China Electronics Technology Group Corporation Thirteenth Research Institute, Institute of Semiconductors, Chinese Academy of Sciences, Huzhou Tony Semiconductor Technology Co:, Ltd:, China Electronics Technology Group Corporation No:

46 Research Institute, China Electronics Compound Semiconductor Co:, Ltd:, Nanjing Guosheng Electronics Co:, Ltd: Co:, Ltd:, Harbin Keyou Semiconductor Industry Equipment and Technology Research Institute Co:, Ltd:, New Micron (Suzhou) Semiconductor Technology Co:, Ltd:, Jiangsu Zhuoyuan Semiconductor Co:, Ltd: The main drafters of this document: Ding Xiongjie, Liu Wei, Han Jingrui, He Dongjiang, Li Suqing, Ding Xiaomin, Zhang Hong, Li Huanting, Zhang Hongyan, Yang Kun, Li Bin, Yin Haotian, Gao Wei, Lu Yajuan, She Zongjing, Wang Yang, Niu Yingxi, Yan Yang, Yao Kang, Jin Xiangjun, Wu Dianrui, Li Guopeng, Zhang Xinfeng, Zhao Lili, Zhang Shengtao, Xia Qiuliang, Li Guoping: Silicon carbide crystal material defect map

1 Scope

GB/T 43612-2023 is an atlas rather than a test method: images of the defects found in silicon carbide crystals, with what each looks like and what caused it. Silicon carbide is the material behind efficient high-voltage power electronics - electric vehicle inverters, fast chargers, grid converters - and its economics turn almost entirely on crystal quality. Micropipes, dislocations, stacking faults, polytype inclusions and basal plane defects each degrade a device differently, and some kill it outright, so a wafer's value depends on which defects it carries and how many. Identifying them is a matter of recognition, learned from examples, and until those examples are published each fab and each customer classifies them by its own private convention - which makes a defect specification in a purchase contract unenforceable. This document specifies the morphological characteristics, the causes and the defect maps for defects in conductive 4H silicon carbide (4H-SiC) crystal material. It applies to the research and development, production, testing and analysis of silicon carbide ingots and the material derived from them. Under ICS 29.045 and CCS H80, it is written for crystal growers, wafer suppliers, device manufacturers and their incoming inspection laboratories.

This document specifies the morphological characteristics, causes and defect maps of conductive 4H silicon carbide (4H-SiC) crystal material defects: This document is applicable to the research and development, production, testing and analysis of silicon carbide (ingots, substrate wafers, epitaxial wafers and subsequent processes) in the semiconductor industry: link:

2 Normative reference documents

The contents of the following documents constitute essential provisions of this document through normative references in the text: Among them, the dated quotations For undated referenced documents, only the version corresponding to that date applies to this document; for undated referenced documents, the latest version (including all amendments) applies to this document:

GB/T 14264 Semiconductor material terminology

3 Terms and definitions

The terms and definitions defined in GB/T 14264 and the following apply to this document: 3:

1 Ingot defect ingotdefect During the growth process of the 4H-SiC crystal ingot due to the extension of defects in the seed crystal itself, deviation from the stoichiometric ratio, internal stress of the crystal ingot, and impurities, resulting defects: 3:2 substratedefectsubstratedefect Crystal defects or structural defects in the 4H-SiC substrate

as well as defects left on the surface of the 4H-SiC substrate after cutting, grinding, and polishing: 3:3 epitaxialdefect epitaxialdefect Crystal defects in the 4H-SiC epitaxial layer and the surface of the 4H-SiC epitaxial layer caused by the step flow controlled epitaxial growth method birth defects: 3:

4 Deep energy level centers or extrinsic crystalline defects introduced into 4H-SiC crystals during device manufacturing or material modification processes: 3:5 crystallographic defectcrystalinedefect Point, line, surface and volume defects in 4H-SiC crystal:

Note: Including point, line, surface and volume defects in 4H-SiC ingot and substrate, as well as point, line and surface defects in 4H-SiC epitaxial layer: 3:

6 Due to the presence of foreign particles, substrate crystal defects, substrate surface polishing scratches, sub-damage layers, and epitaxial growth on the surface of the monocrystalline 4H-SiC substrate, Regular or irregular shapes are formed on the surface of the 4H-SiC epitaxial layer under the step flow controlled growth mechanism due to long condition deviation and other reasons: