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**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 44558-2024

**Test method for dislocation imaging in III-nitride semiconductor
materials - Transmission electron microscopy**

III族氮化物半导体材料中位错成像的测试 透射电子显微镜法

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Foreword

This document is in accordance with the provisions of GB/T 1.1-2020 "Guidelines for standardization work Part

1. Structure and drafting rules for standardization documents" Drafting. Please note that some of the contents of this document may involve patents. The issuing organization of this document does not assume the responsibility for identifying patents. This document was jointly issued by the National Technical Committee on Semiconductor Equipment and Materials Standardization (SAC/TC203) and the National Technical Committee on Semiconductor Equipment and Materials Standardization (SAC/TC203). It was jointly proposed and coordinated by the Materials Sub-Technical Committee of the Chemical Technical Committee (SAC/TC203/SC2). This document was drafted by: Suzhou Institute of Nano-Tech and Nano-Bionics, Chinese Academy of Sciences, Suzhou Navi Technology Co., Ltd., Jiangsu Third Semiconductor Research Institute Co., Ltd., Suzhou University of Science and Technology, Peking University, National Center for Nanoscience and Technology, Peking University Dongguan Institute of Optoelectronics, Dongguan Zhongjia Semiconductor Technology Co., Ltd., TCL Huanxin Semiconductor (Tianjin) Co., Ltd., Soochow University, Shandong Inspur Huaguang Optoelectronics Co., Ltd. Co., Ltd. and Beijing Guoji Kehang Third Generation Semiconductor Testing Technology Co., Ltd. The main drafters of this document are. Zeng Xionghui, Dong Xiaoming, Su Xujun, Niu Mutong, Wang Jianfeng, Xu Ke, Wang Xiaodan, Xu Jun, Guo Yanjun, Chen Jiafan, Wang Xinqiang, Yan Jianfeng, Ao Songquan, Tang Minghua, Yan Baohua, and Li Yanming. Testing of dislocation imaging in III-nitride semiconductor materials Transmission electron microscopy

1 Scope

GB/T 44558-2024 gives the Chinese TEM method for imaging dislocations in III-nitride semiconductor materials. Gallium nitride and its alloys are grown on mismatched substrates and therefore carry threading dislocations at densities that would be fatal in silicon; those dislocations determine the efficiency of an LED and the reliability of a power or RF device, so measuring them is a routine and consequential characterisation. The standard sets the

principle, the specimen preparation, which for a hard, chemically resistant nitride film is itself the hardest part of the method, whether by mechanical thinning and ion milling or by focused ion beam, the microscope and its imaging conditions, the two-beam and weak-beam diffraction conditions and the $g \cdot b$ analysis by which the dislocation type is identified, the imaging of plan-view and cross-section specimens, the counting and the calculation of the dislocation density with its statistics, the sources of error and the report. It takes effect on 1 April 2025.

This document describes a method for imaging dislocations in group III nitride semiconductor materials using transmission electron microscopy. This document applies to the testing of dislocation imaging in thin films or bulk single crystals of hexagonal III-nitride semiconductors.

2 Normative references

The contents of the following documents constitute essential clauses of this document through normative references in this document. For referenced documents without a date, only the version corresponding to that date applies to this document; for referenced documents without a date, the latest version (including all amendments) applies to This document.

GB/T 14264 Terminology of Semiconductor Materials

3 Terms and definitions

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

3.1 Burgers vector Burgers vector The characteristic vectors of the magnitude and direction of the lattice distortion caused by a dislocation.

3.2 a-type dislocation Dislocation with a Burgers vector of $\frac{1}{3} \langle 1120 \rangle$.

3.3 c-type dislocation Dislocation with Burgers vector $\langle 0001 \rangle$.

3.4 ac type dislocation a c type dislocation Dislocation with a Burgers vector of $\frac{1}{3} \langle 1123 \rangle$.

3.5 diffraction vector The coordinate vector from the center spot 0000 (origin) to the diffraction spot (hkil) in the diffraction spectrum.

Note. Under dual-beam imaging conditions, it specifically refers to the diffraction vector of strong reflection that satisfies the Bragg condition.

4 Principles of the method

The diffraction contrast image of the dislocation is determined by the dot product of the diffraction vector (g) and the Burgers vector (b), that is, the value of $g \cdot b$. When $g \cdot b$ equals 0