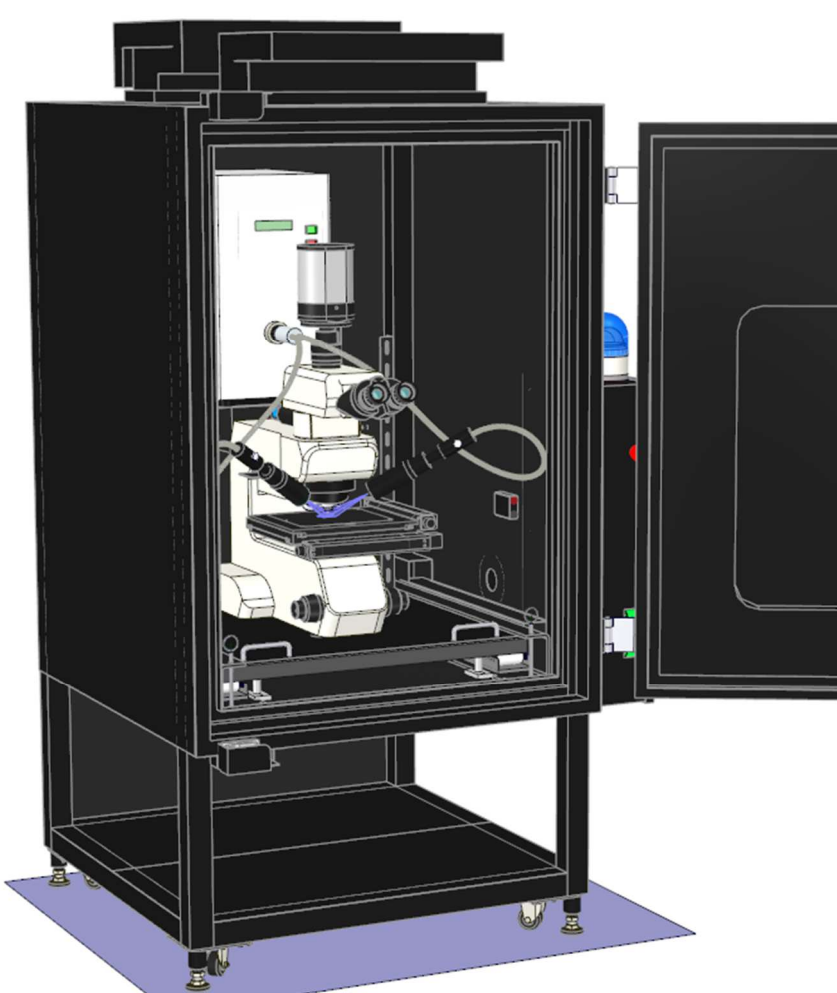


TEM Observation of PL Emission Sites in SiC

Basal plane dislocations (BPDs) present in SiC substrates are known to expand under forward bias conditions, leading to degradation of device characteristics. In this study, minute BPDs were identified by photoluminescence (PL) analysis, and the luminescent regions were subsequently examined using transmission electron microscopy (TEM).

Apparatus Overview

Photoluminescence (PL)



In-house developed PL imaging system

Excitation light source: Ultra-high-pressure mercury lamp UV source (285-350 nm)

The observation wavelength can be chosen according to the type of defect of interest.

Observation wavelength	Defect of interest
700 nm or longer	Basal Plane Dislocation (Triangular defect, Micropipe)
500 nm	Stacking Fault (Double Shockley-type defect)
420 nm	Stacking Fault (Single Shockley-type defect)
380 nm	Basal Plane Dislocation (Drift Layer, Buffer Layer) Stacking Fault

Transmission Electron Microscopy



Instrumentation :
JEOL JEM-4000FX
Accelerating Voltage :
400kV

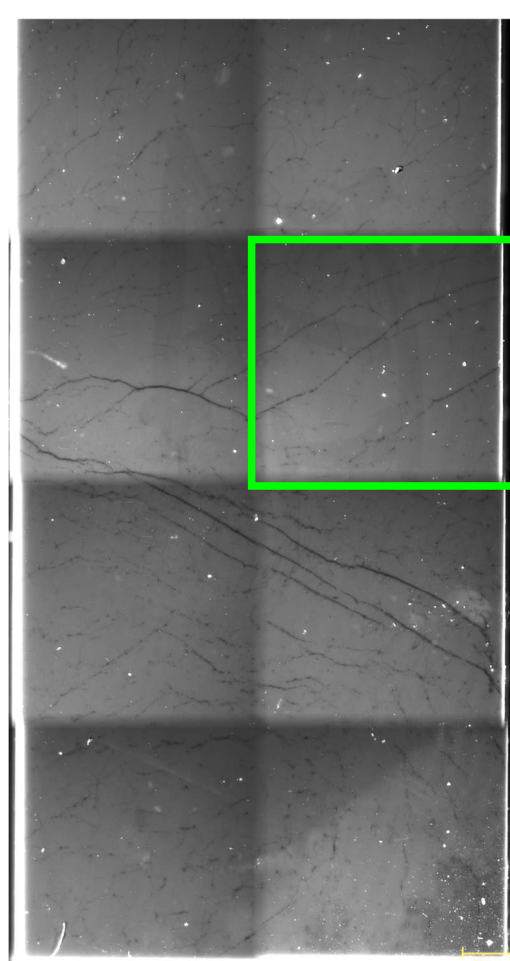
A high-energy electron beam accelerated by a high voltage is irradiated onto the specimen, and the transmitted electrons are used to form an image, producing a magnified view.

By leveraging our proprietary positioning technology, even extremely small defects that cannot be identified in optical images can be visualized with a high success rate using SEM and TEM.

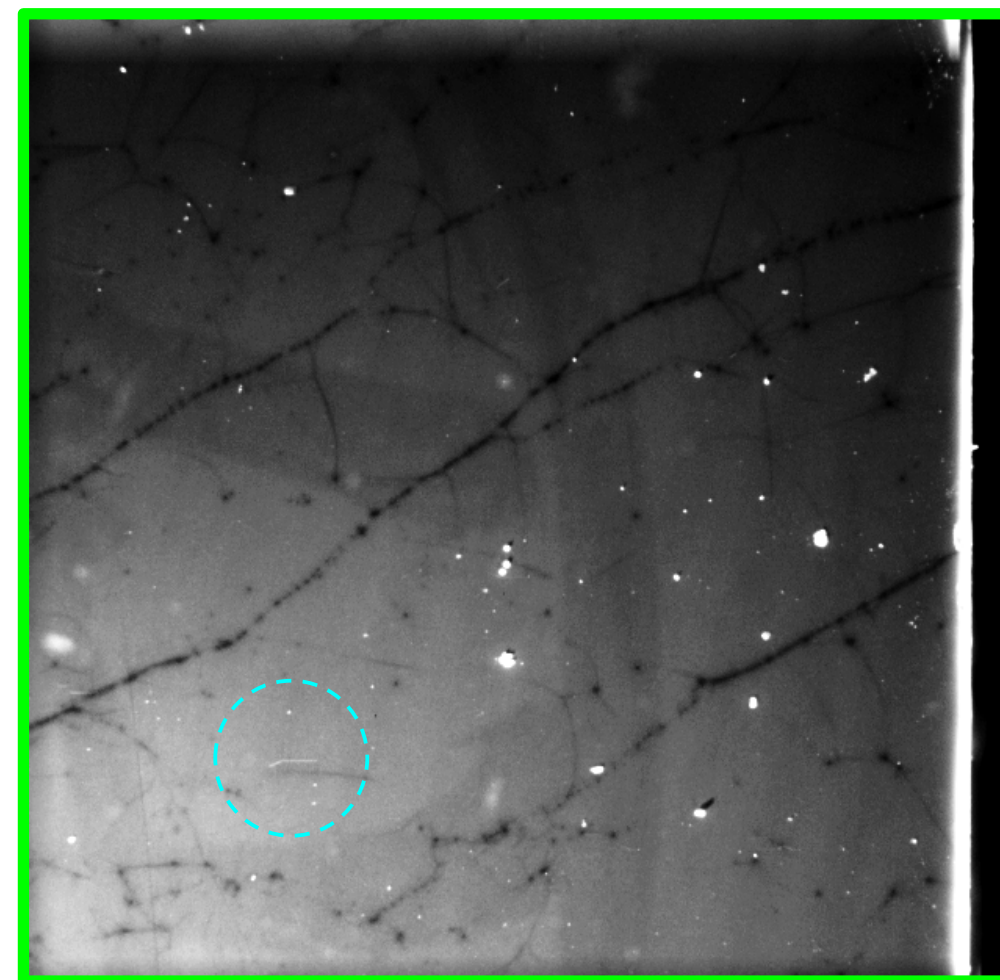
Example of PL-to-TEM Observation Using an SiC Substrate

Photoluminescence (PL)

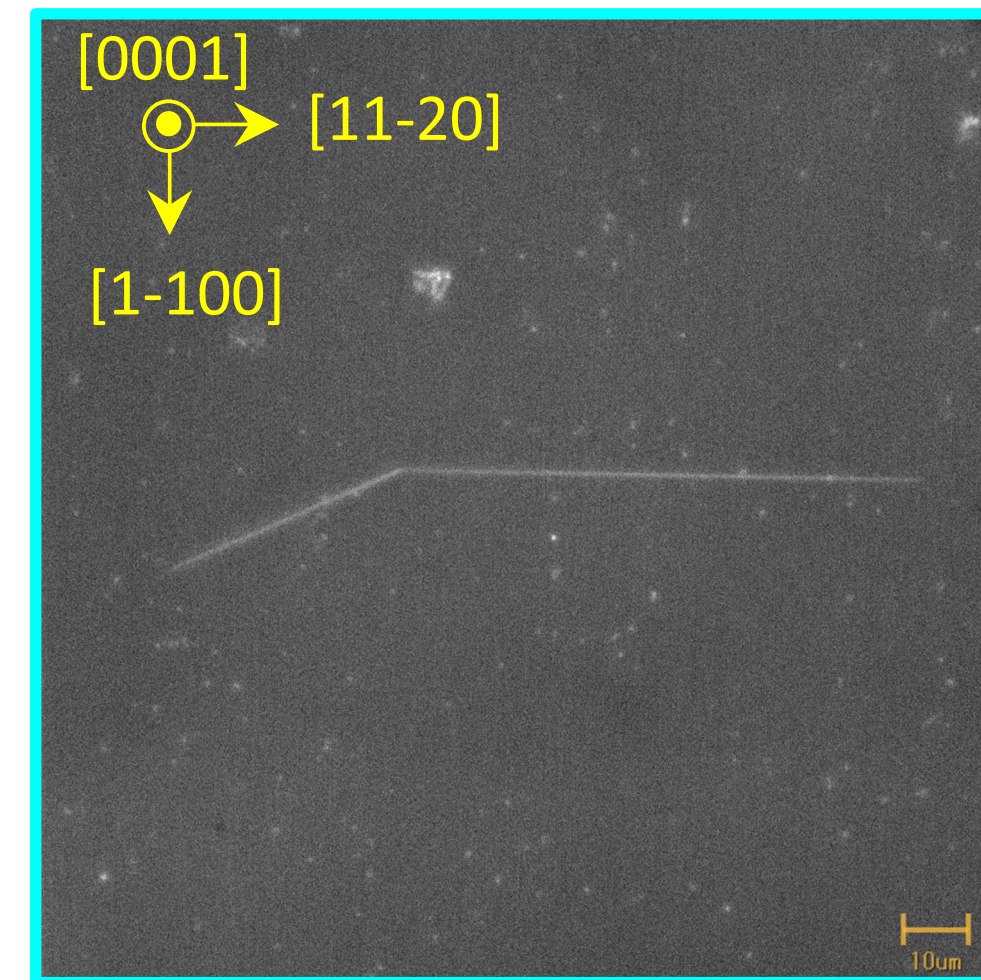
Sample: SiC wafer specimen (10 mm × 5 mm, epitaxial layer: 11 μm, buffer layer: 0.5 μm).
No UV irradiation or electrical stressing was applied prior to the observation.
PL observation was performed at wavelengths above 700 nm.



Stitched PL Image
(5× Objective Lens)



PL Image
(10× Objective Lens)

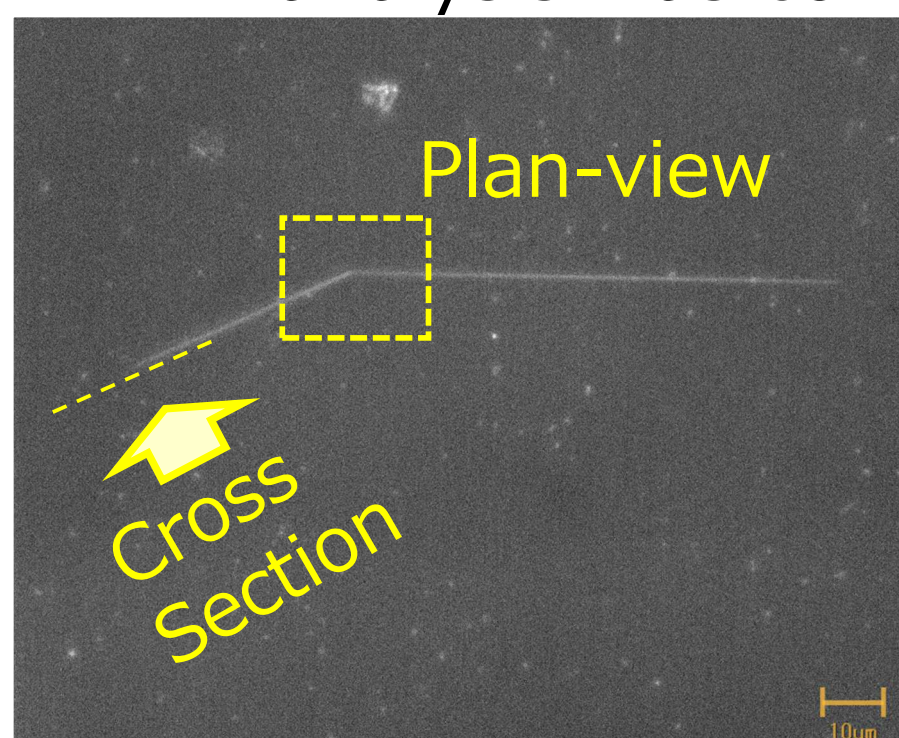


PL image
(≈100× objective lens)

PL observation revealed a BPD that changes its propagation direction from [0-110] to [11-20] along its path.

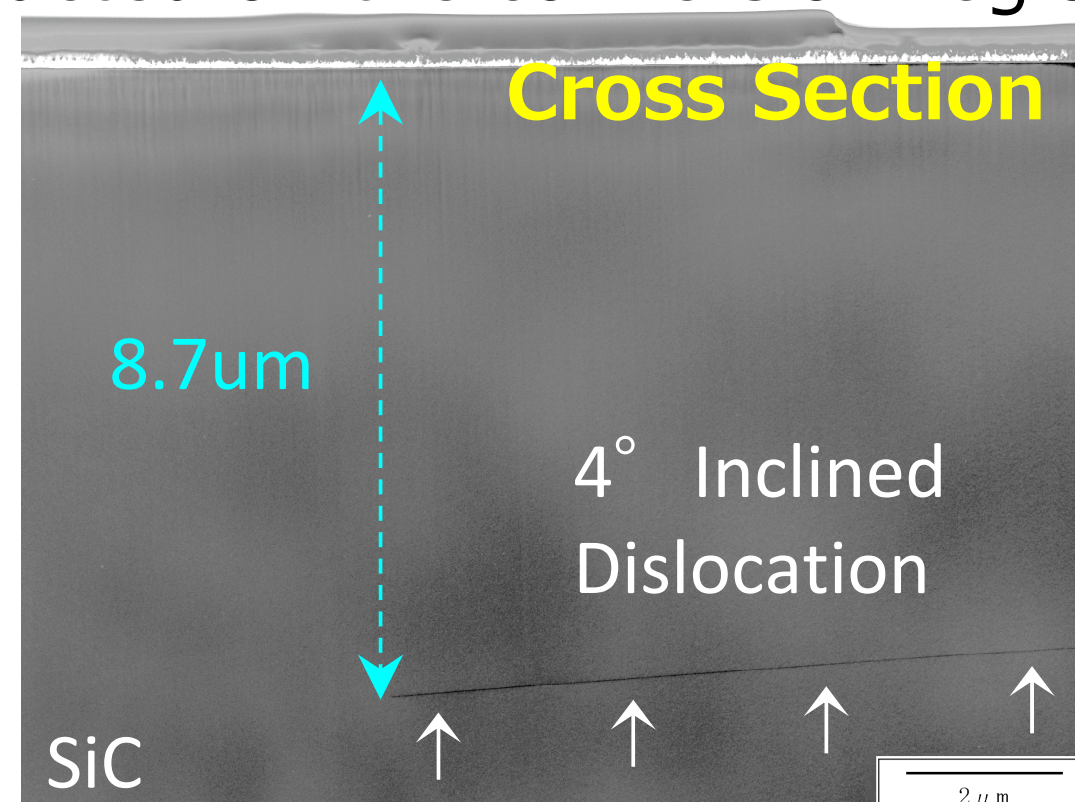
Transmission Electron Microscopy

Cross-sectional TEM analysis was performed on the left edge of the PL-emitting region, while plan-view TEM analysis was conducted on the conversion region.



Plan-view

Cross Section

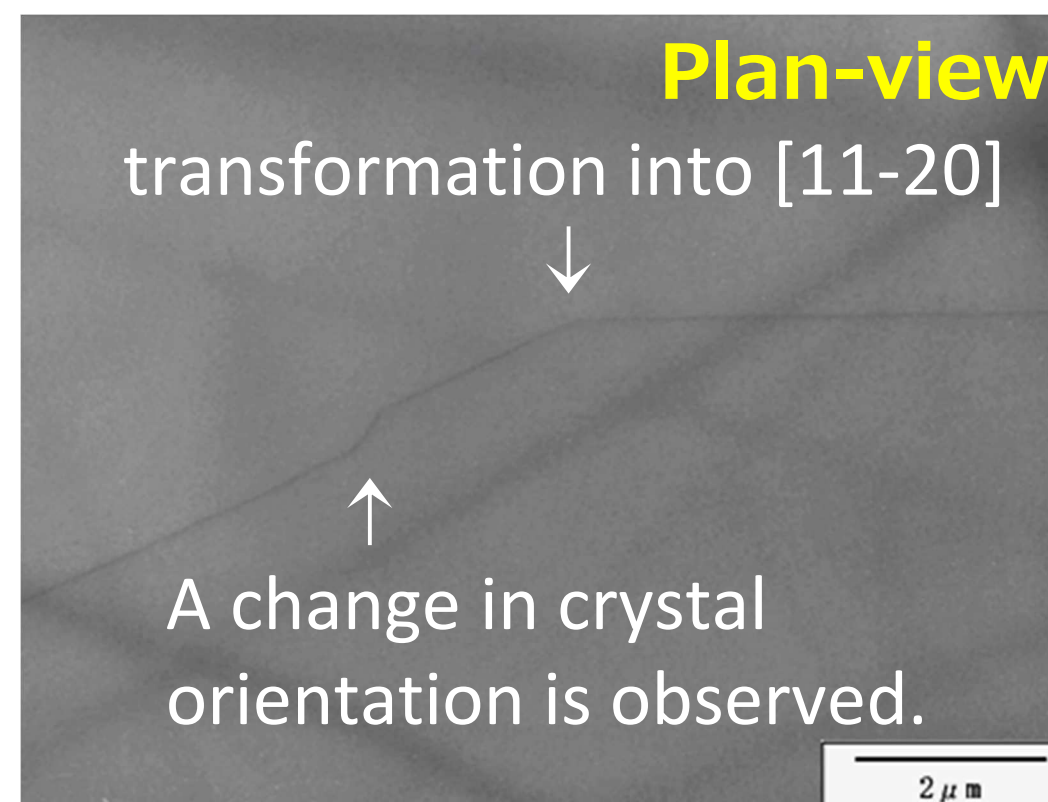


Cross Section

8.7μm

4° Inclined
Dislocation

SiC



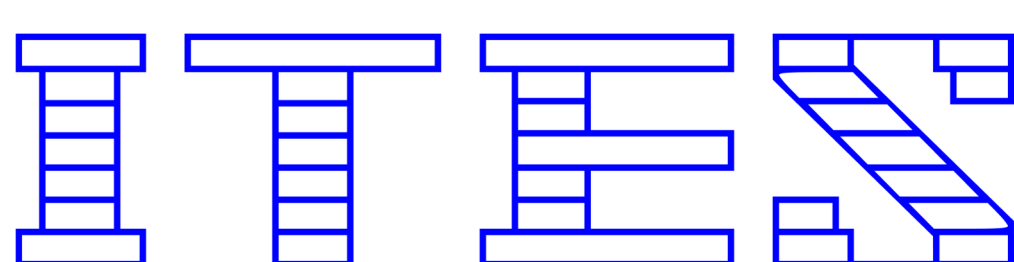
Plan-view

transformation into [11-20]

A change in crystal
orientation is observed.

TEM observation provides depth information and detailed defect characteristics, such as local lattice distortions, that cannot be fully captured by PL imaging alone.

PL enables defect localization and overall defect mapping, followed by detailed defect characterization by TEM.



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