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6. AUTHORS
Odille c. Noriega (Presenter)

7. PERFORMING ORGANIZATION NAMES AND ADDRESSES
Texas State University
601 University Dr.

San Marcos, TX 78666 -4684

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14. ABSTRACT
Low dislocation density is important for optoelectronic devices requiring long minority carrier lifetimes. The classic method of measuring dislocation density is to subject a material to a chemical etchant that produces a pit at the intersection of a dislocation with the surface. The measurement of dislocation density then is a measurement of etch pit density. For conventional materials recipes for generating etch pits are commonplace. For other materials, dislocation etching is not well-established with different chemistries required for different crystal orientations.

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Report Title

Comparison of Cathodoluminescence, Imaging Micro-Photoluminescence, and Confocal Photoluminescence Microscopy for Determination of Defect Densities in Semiconductors

ABSTRACT

Low dislocation density is important for optoelectronic devices requiring long minority carrier lifetimes. The classic method of measuring dislocation density is to subject a material to a chemical etchant that produces a pit at the intersection of a dislocation with the surface. The measurement of dislocation density then is a measurement of etch pit density. For conventional materials recipes for generating etch pits are commonplace. For other materials, dislocation etching is not well-established with different chemistries required for different crystal orientations. Cathodoluminescence (CL) has also been shown to be an effective tool for measuring dislocation density. Dislocations intersecting the surface strongly reduce the intensity of the intrinsic CL producing a dark spot associated with a threading dislocation. This technique also measures other non-radiative features such as precipitates or inclusions. We evaluate two types of photoluminescence (PL) mapping to measure non-radiative defects and correlate the measurements with CL. The primary impetus is to develop an optical technique that can be used in a more production-friendly environment without degrading sample surfaces while producing accurate dislocate densities. This study illustrates the utility of each technique while contrasting the strengths and weaknesses.

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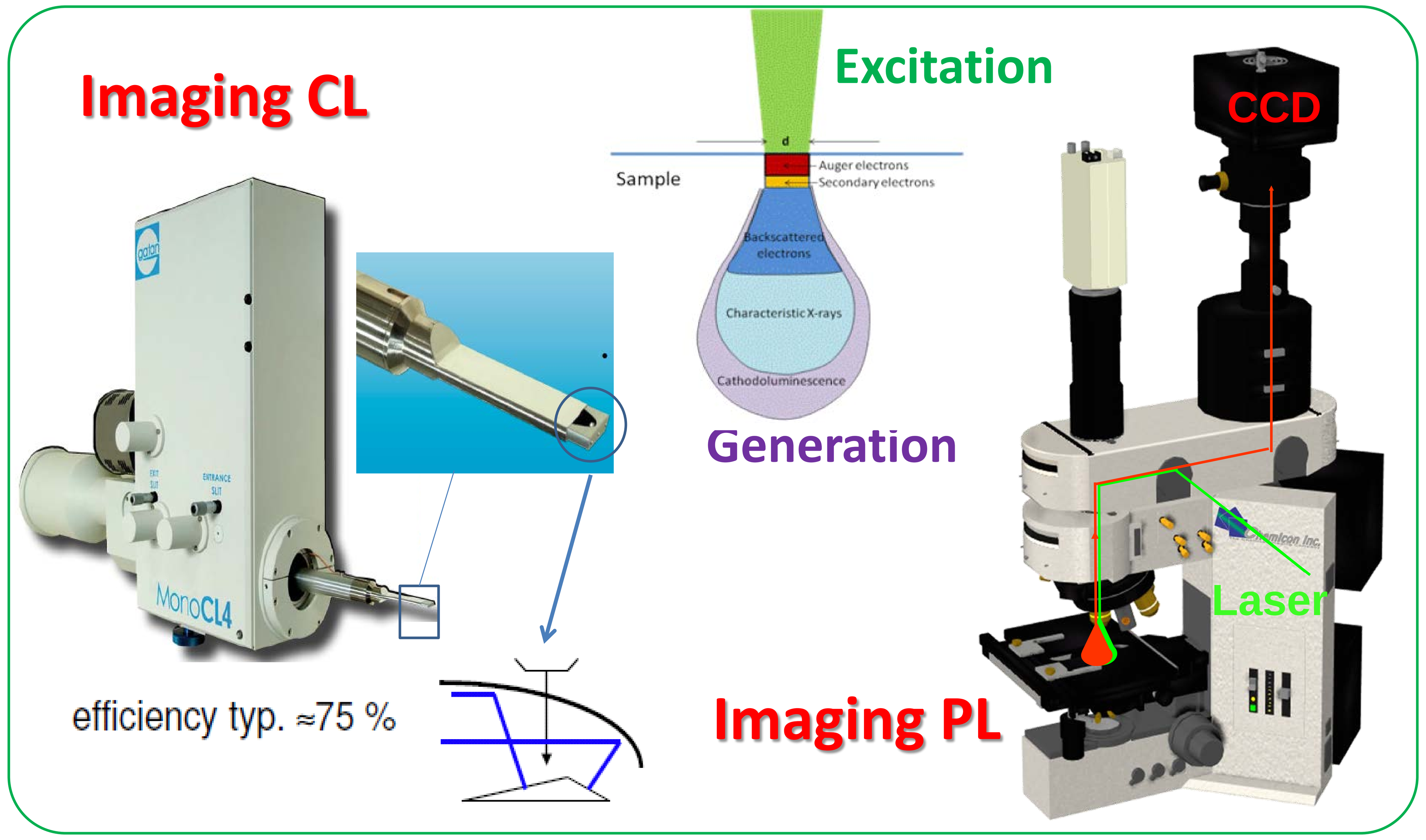
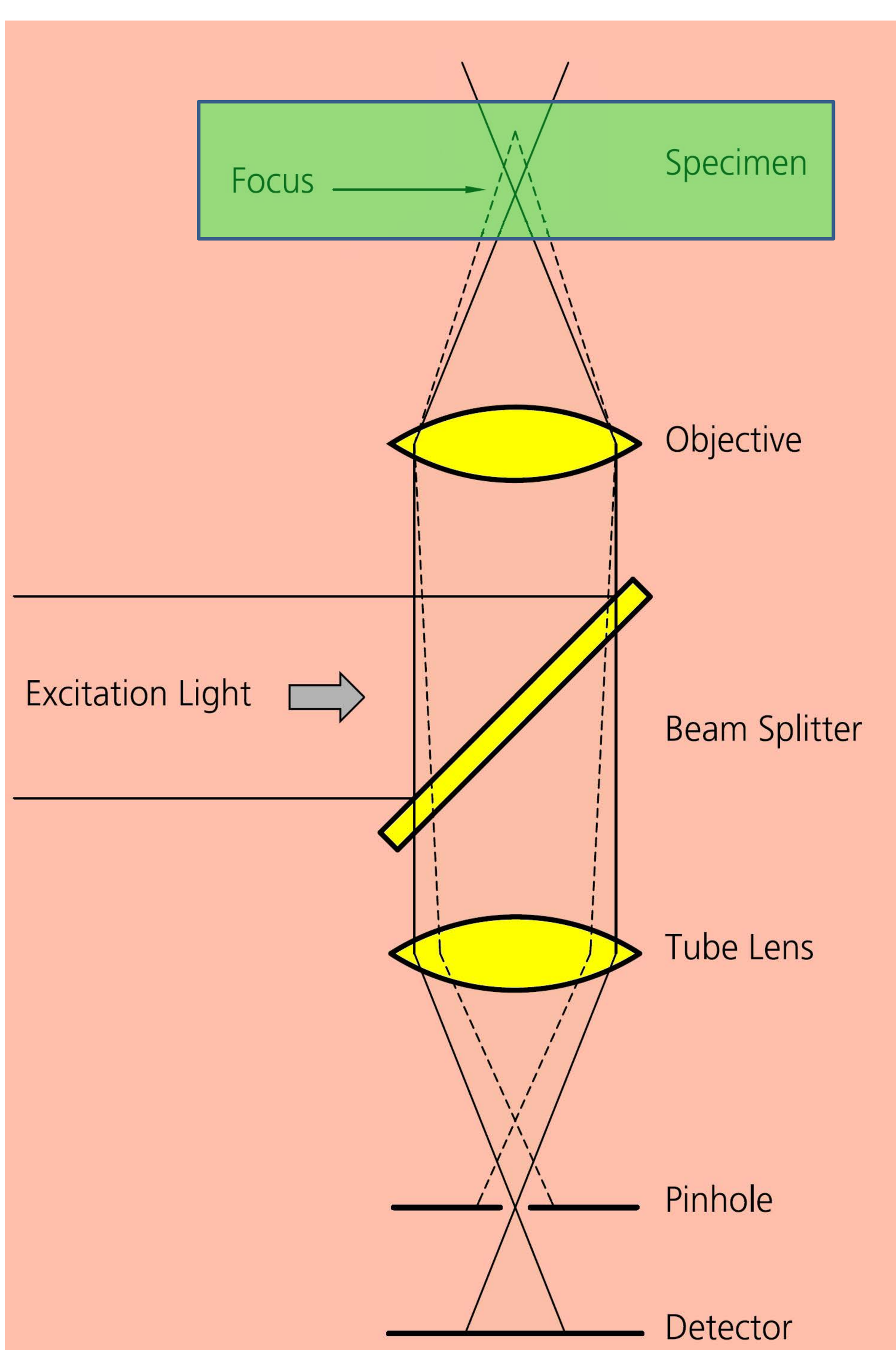
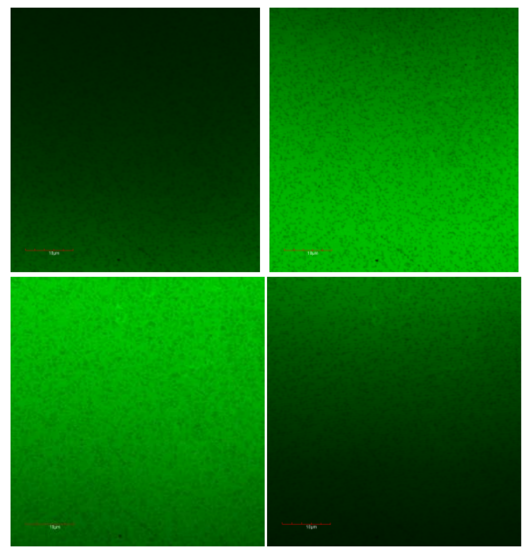


Laser Confocal Microscopy (Confocal PL)

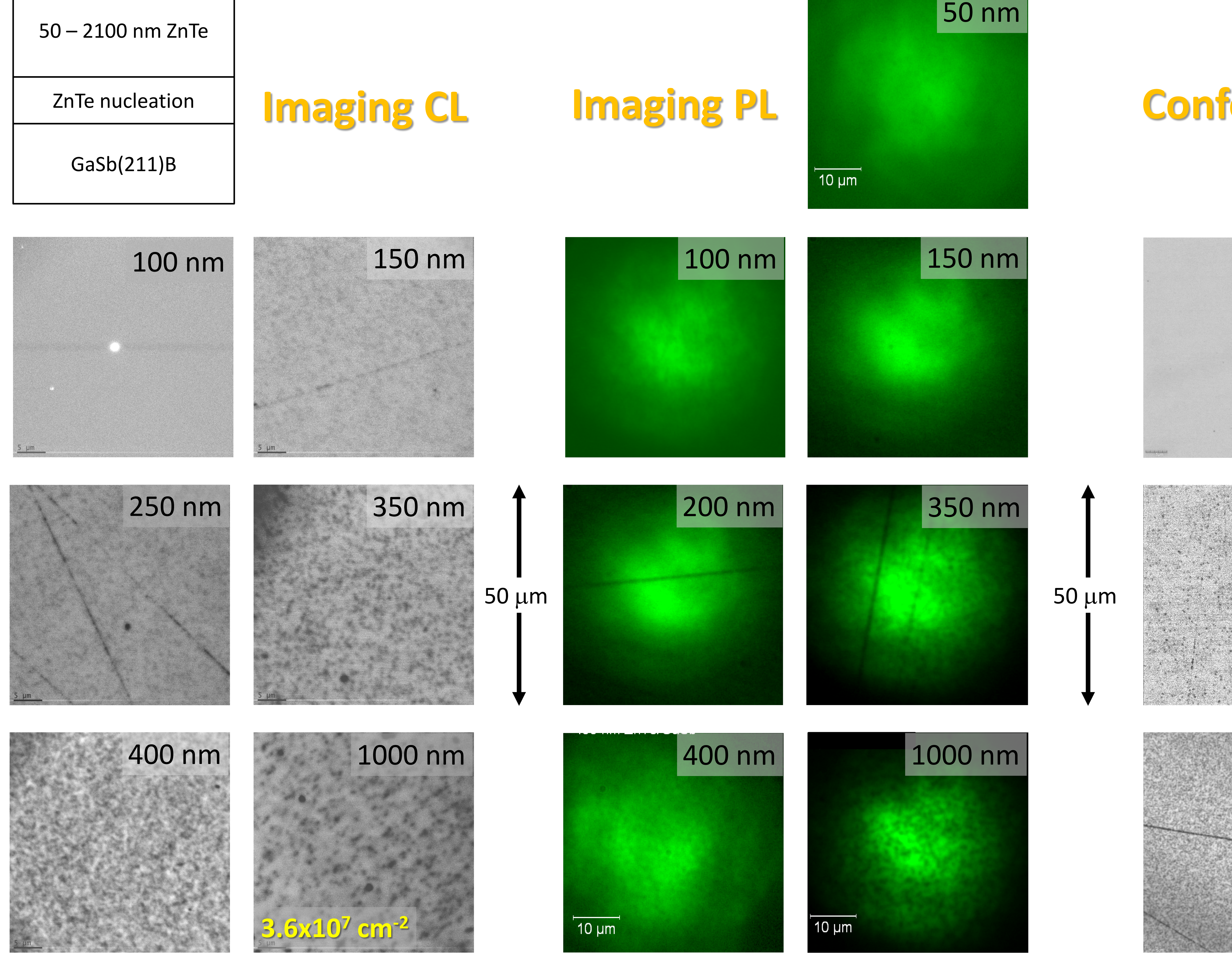


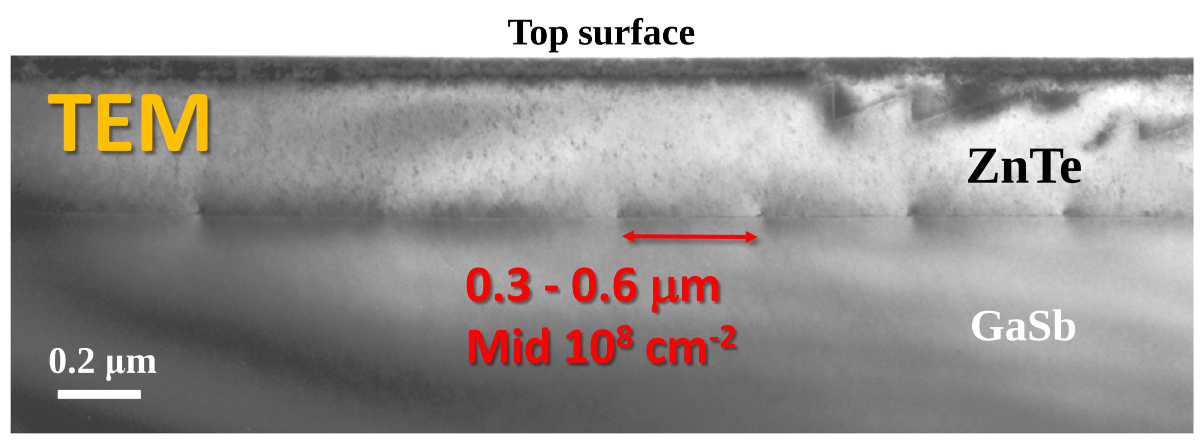
Principle of confocal imaging



0.25 µm Steps on 0.25 µm Thick ZnTe

50 – 2100 nm ZnTe
ZnTe nucleation
GaSb(211)B

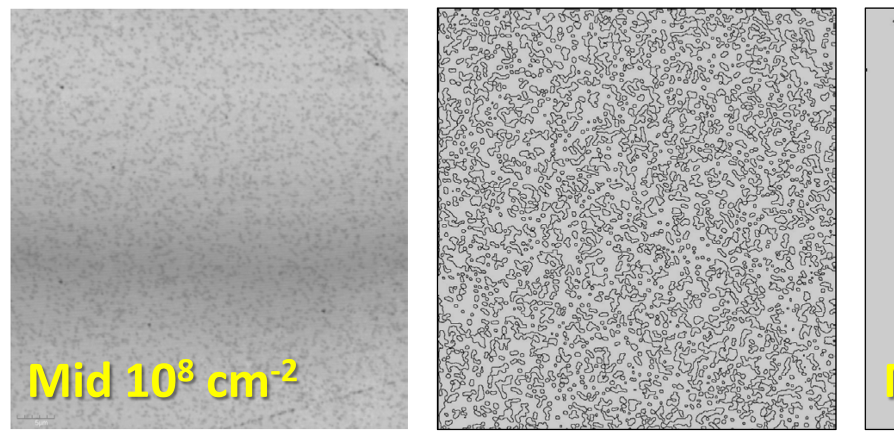




250 nm ZnTe/GaSb

TEM ⇨ Low threading dislocation density

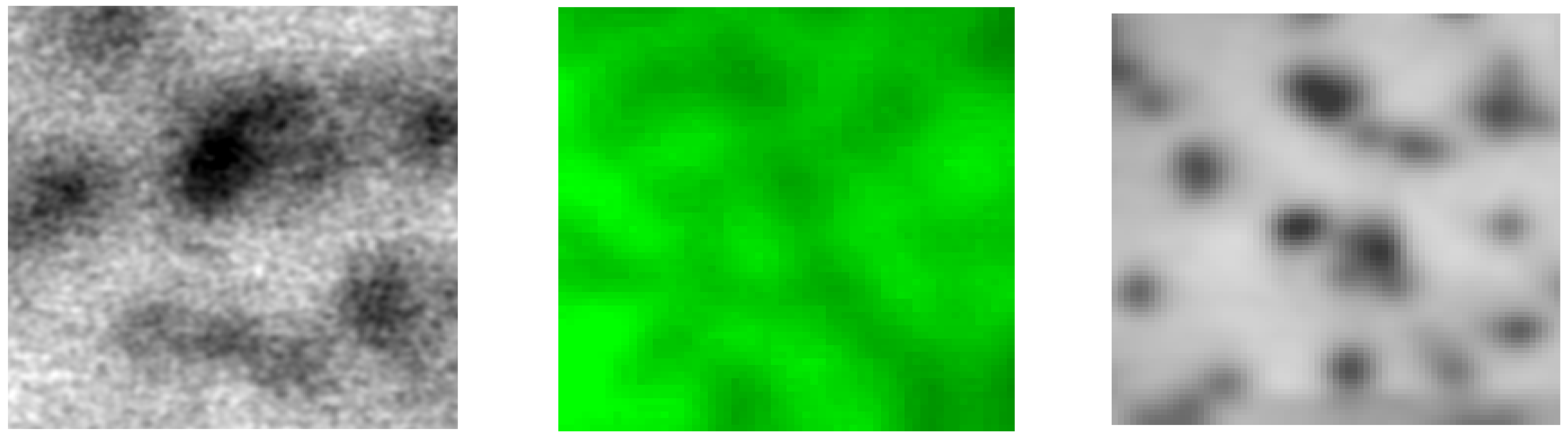
Confocal PL, CL ⇨ High density of dark spots



Full Measurement

Weak Contrast Contours

Confocal PL provides highest contrast



1000 nm ZnTe