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Odille C.riega (Presenter)

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Texas State University
601 University Dr.

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14. ABSTRACT
We are investigating the use of confocal photoluminescence (c-PL) mapping to measure non-radiative defects (in principle equivalent to EPD) in semiconducting materials. These results have been shown to correlate with similar measurements using cathodoluminescence (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. The technique of c-PL is a point mapping PL measurement where the microscope is operated in

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Report Title

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We are investigating the use of confocal photoluminescence (c-PL) mapping to measure non-radiative defects (in principle equivalent to EPD) in semiconducting materials. These results have been shown to correlate with similar measurements using cathodoluminescence (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. The technique of c-PL is a point mapping PL measurement where the microscope is operated in an optical configuration that significantly enhances both lateral and depth resolution and returns crisp PL images with high contrast. This technique revolutionized fluorescent imaging in biology, and has the potential to become an important semiconductor characterization tool.

The Use of Confocal Photoluminescence Microscopy for Determination of Defect Densities in Various II-VI Semiconductors

O.C. Noriega,[1] A. Savage,[2] T.H. Myers,[2] P.J. Smith,[3] R.N. Jacobs,[3] C.M. Lennon,[4] P.S. Wijewarnasuriya,[5] and Y. Chen[5]

[1]Department of Physics,[2] Material Science, Engineering, and Commercialization Program, Texas State University-San Marcos, TX 78666, USA; [3] U. S. Army RDECOM, CERDEC Night Vision and Electronic Sensors Directorate, Fort Belvoir, Virginia; [4]Corbin Company, Alexandria, VA 22314; [5]U.S. Army Research Laboratory, SEDD. 2800 Powder Mill Rd, Adelphi MD 20783

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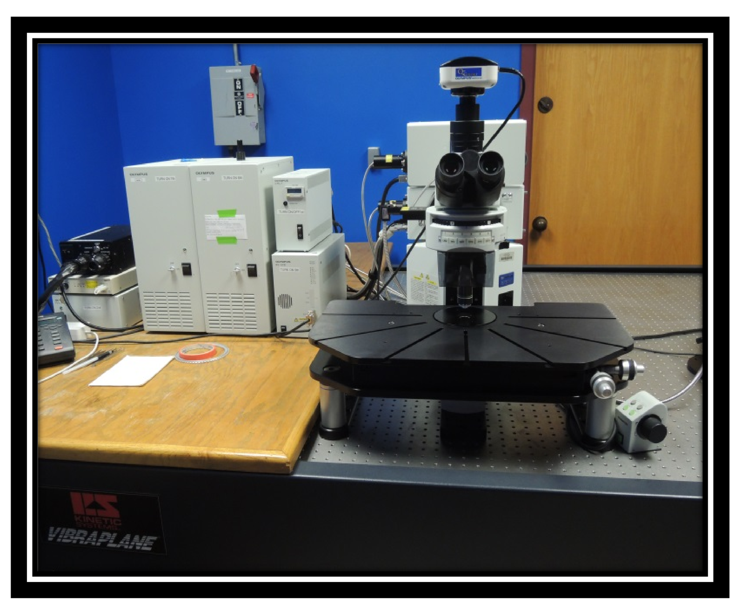
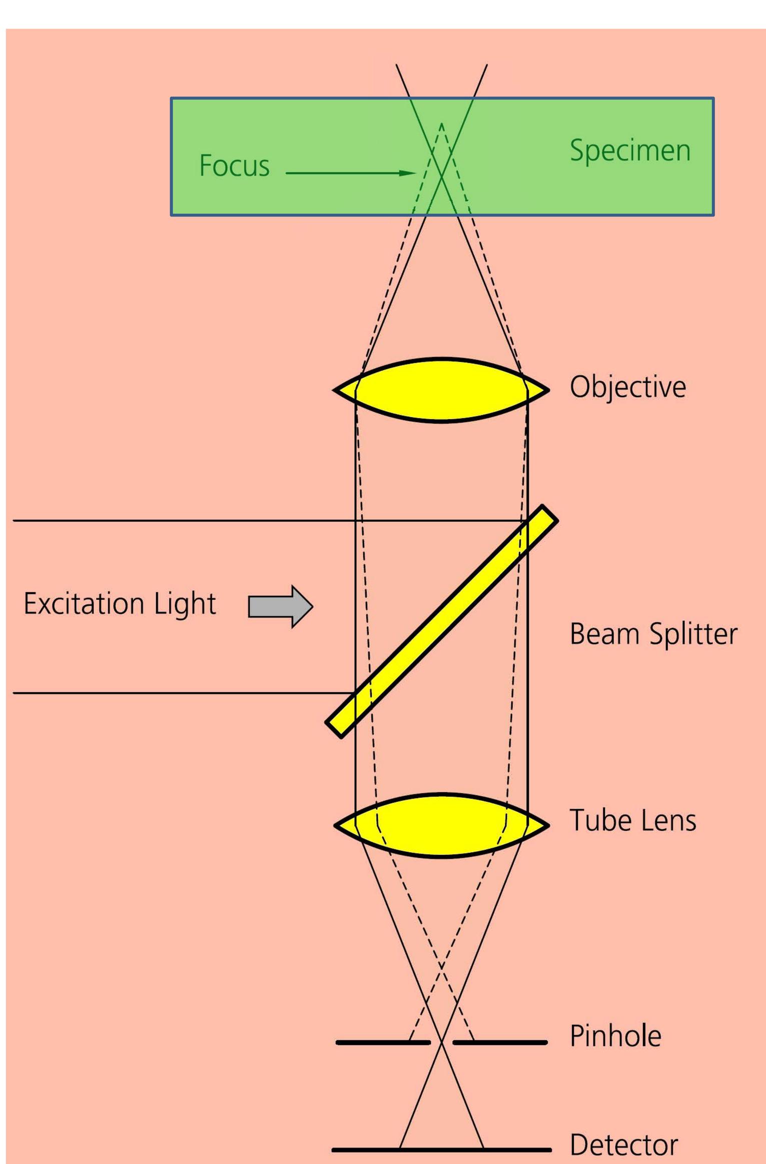
Imaging Confocal PL



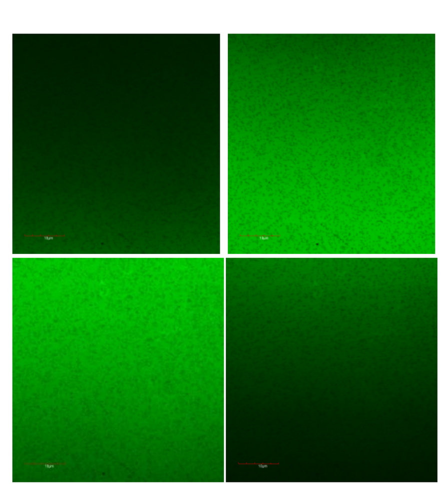
Olympus FV1000 Laser Scanning Confocal Microscope

The Olympus FluoView™ FV1000 laser scanning confocal microscope is designed for high-resolution confocal observation of fixed and living cells, point-detection, spectral detection that does variable bandwidth filtering, high efficiency of excitation, 3-D imaging, and time course experiments. The FV1000 has a multi-line Argon lasers: 515, 488, and 458, and Diode lasers 405, 559, and 635. The FluoView™ FV1000 also comes equipped with a transmitted light detector for brightfield or DIC imaging, and has a BX61WI fixed stage with a motorized upright microscope.

Laser Confocal Microscopy (Confocal PL)



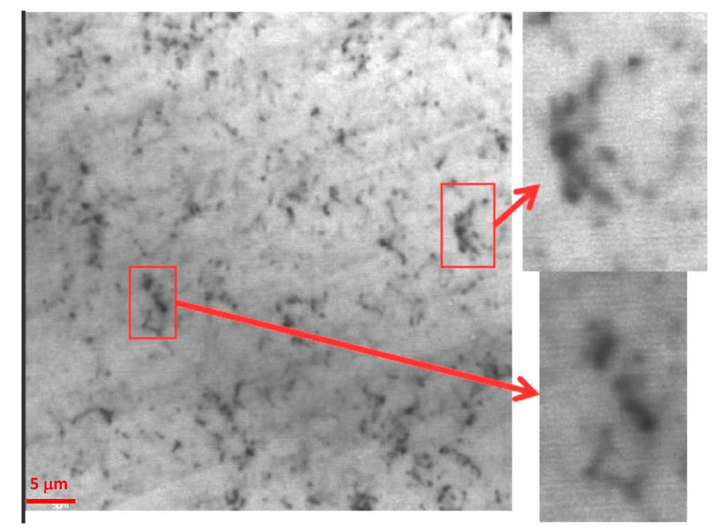
Principle of confocal imaging



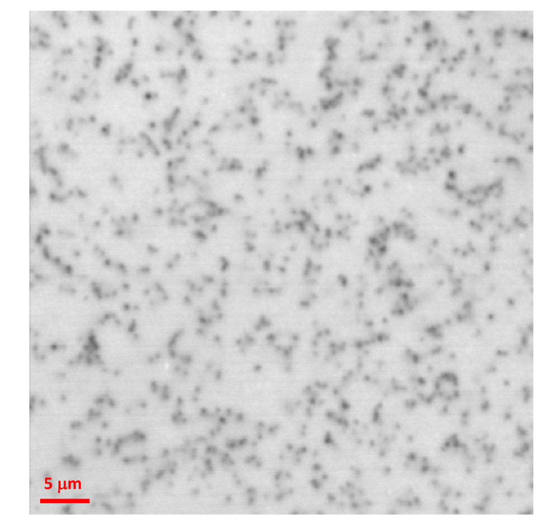
0.25 µm Steps on 0.25 µm Thick ZnTe

Depth resolution is about 0.5 µm

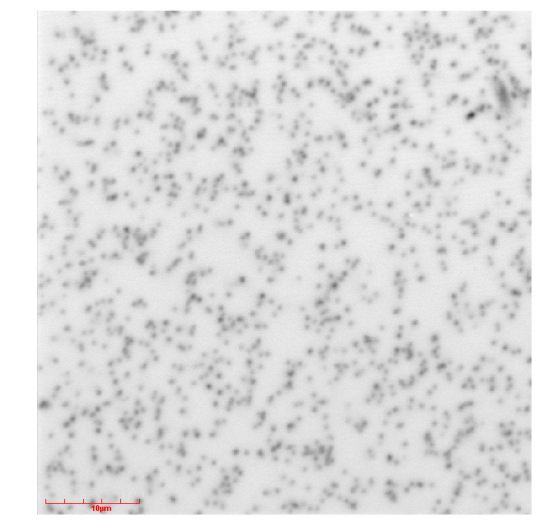
Evaluation of II-VI Growth on Alternative Substrates



c-PL micrograph of ZnTe/Si suggestive of dislocation clustering with a measured "dislocation" density of 2x10^{7}cm^{-2}

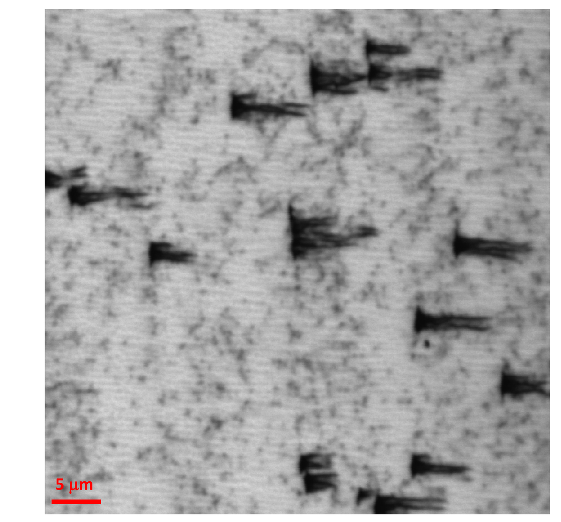


c-PL micrograph of CdTe/Si less suggestive of dislocation clustering with a measured "dislocation" density of 2x10^{7}cm^{-2}

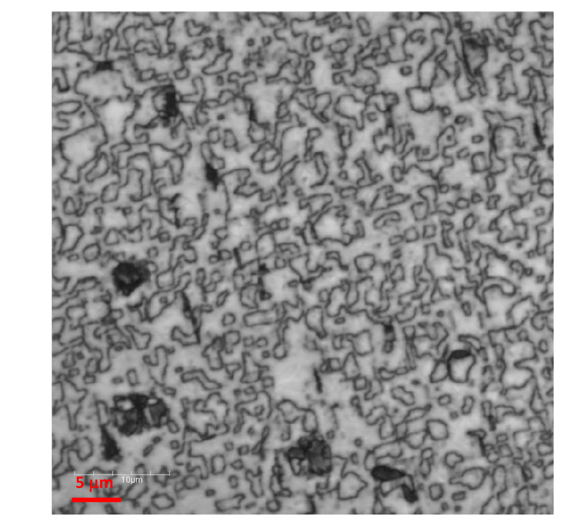


c-PL micrograph of (211)B CdTe/GaAs showing a "non-clustered" defect distribution with a density of 2x10^{7}cm^{-2}.

Twin-related Defects

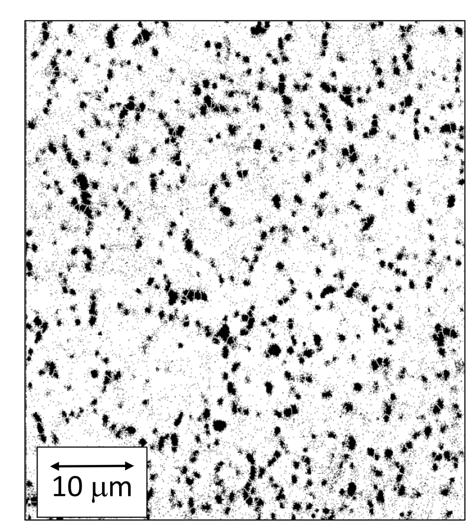


c-PL micrograph of (211)B CdTe/Si showing twinning occurring during MBE growth

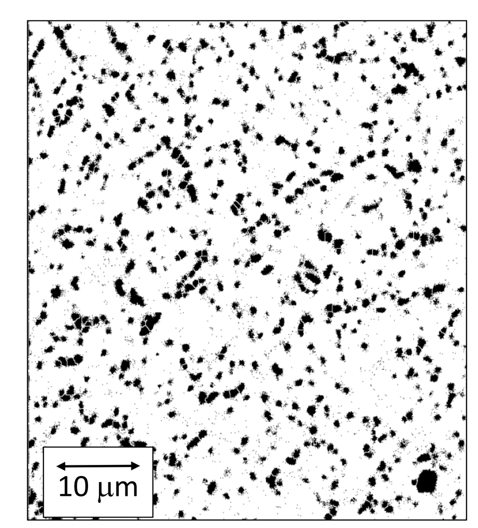


c-PL micrograph of (111)B CdTe/CdTe showing twinning occurring during MBE growth

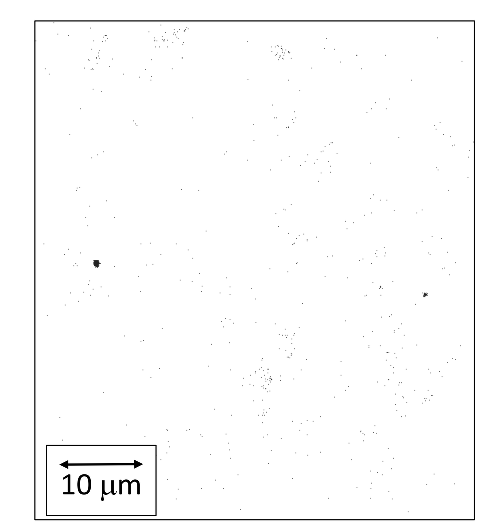
Effect of Lattice Matching



~3x10^7 cm^{-2}
2-µm thick
ZnTe/GaSb (211)B

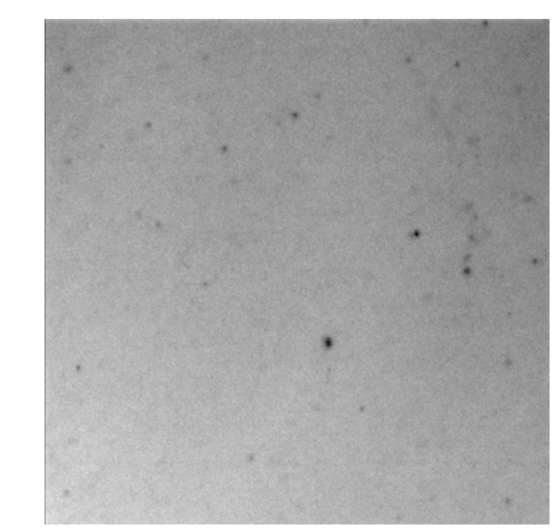


~3x10^7 cm^{-2}
2-µm thick
ZnTe/GaSb (100)

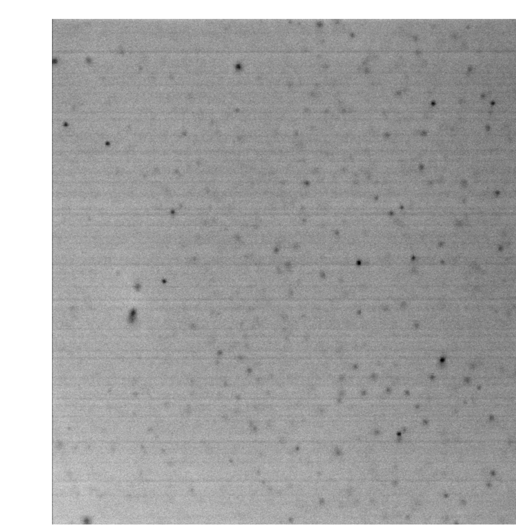


~7x10^4 cm^{-2}
1.2-µm thick $ZnTe_{0.99}Se_{0.01}$/GaSb (211)B

Evaluation of CdTe Substrates



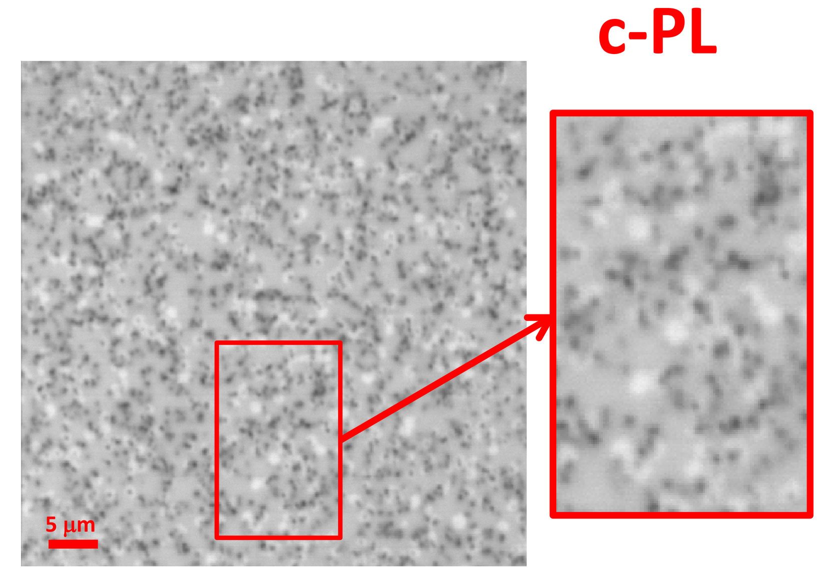
High Resistivity (211)B CdTe dark spot distribution with a density of 1x10^{6}cm^{-2}. (Te Precipitates?)



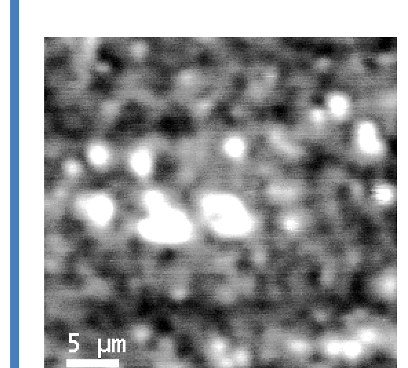
P$^+$-doped (211)B CdTe dark spot distribution with a density of 1x10^{7}cm^{-2}. (Te Precipitates?)

Bright Features Observed in Some CdTe/Si c-PL and CL

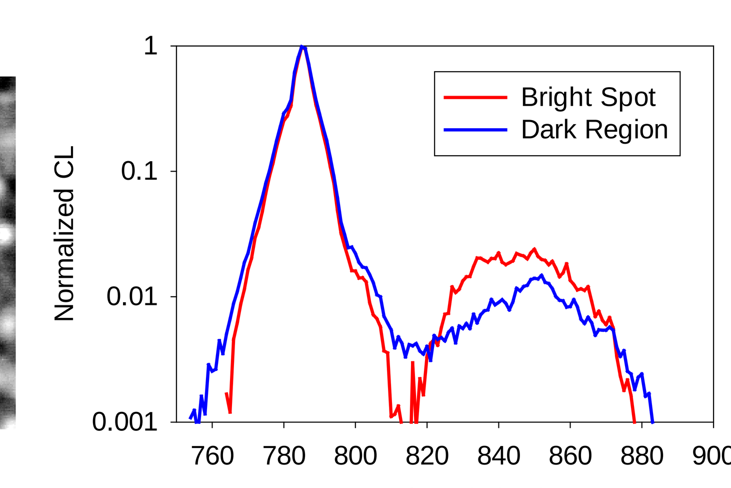
c-PL

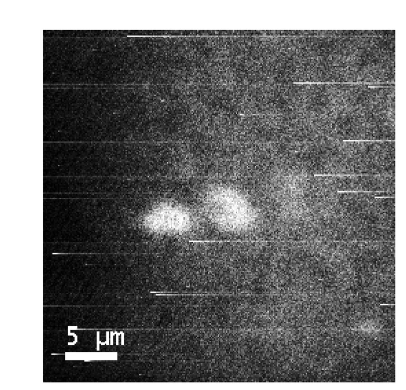


CL

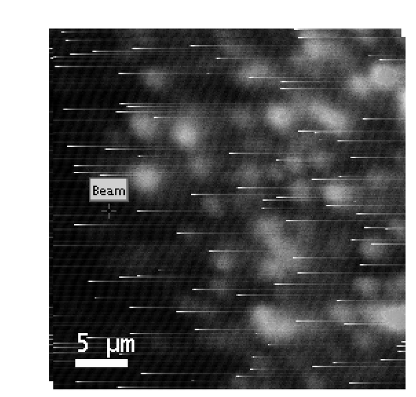


Panchromatic Image

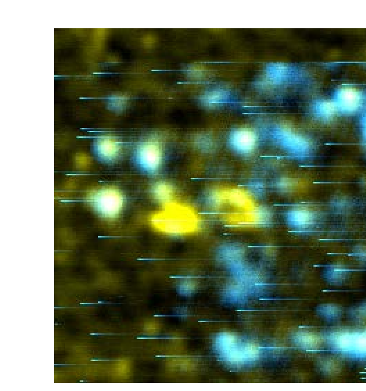




783.3 nm (narrow slit) Spectral Image

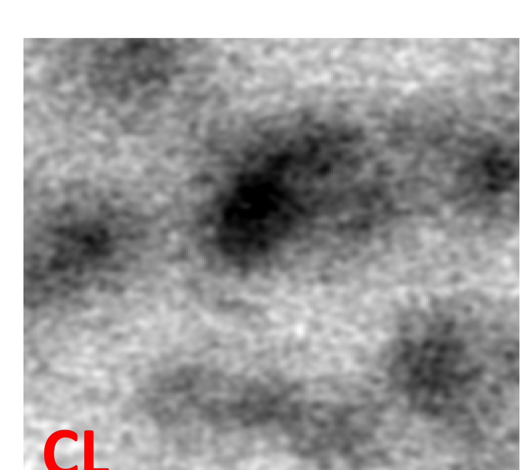


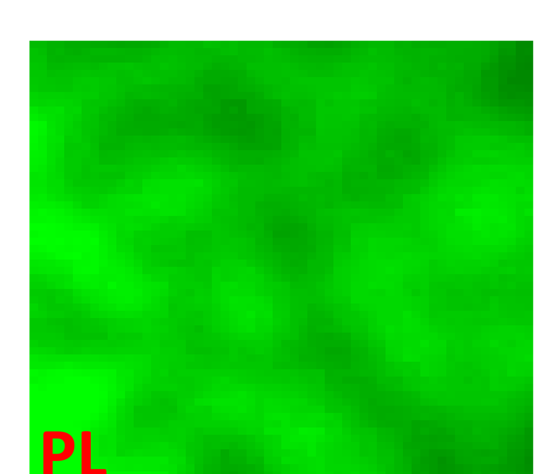
848 nm (wide slit) Spectral Image

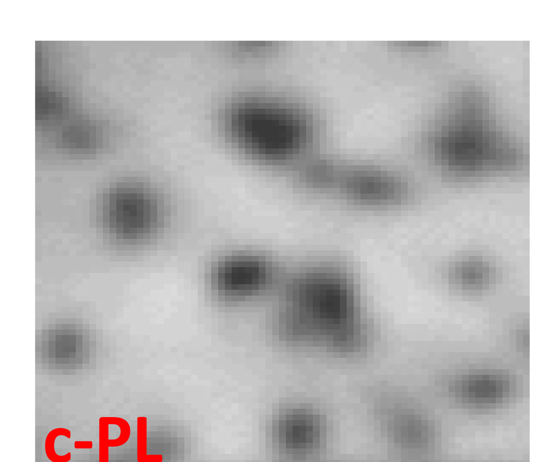


Overlay 848 nm and Panchromatic

Confocal PL provides highest contrast of PL, CL Imaging







1000 nm ZnTe

5 µm

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