CASE STUDY

Measuring Spectra of Single Quantum Dot Nanocrystals Emitting in SWIR

Researcher Objectives

Dr. Han Htoon is a researcher in the Materials Physics and Applications Division of the Center for Integrated Nanotechnologies (MPA-CINT), Los Alamos National Laboratory (LANL). The distinguishing characteristic of CINT is its emphasis on exploring the path from scientific discovery to the integration of nanostructures into the micro and macro worlds.

Dr. Htoon's expertise encompasses many areas of nanophotonics and optical nanomaterials, including low-temperature, single-nanostructure optical spectroscopy and imaging; quantum optical measurements of individual nanostructures; single-nanostructure spectro-electrochemistry experiments; correlated structure, electrical, and optical characterization; magneto-optical spectroscopy; scanning confocal Raman microscopy; and scanning probe microscopy.

Recently, Dr. Htoon's group at CINT utilized a NIRvana®:640LN camera from Princeton Instruments to perform single-nanocrystal spectroscopy for PbS quantum dots emitting at ~1250 nm.

"The unprecedented long integration times and low dark counts [of the NIRvana:640LN] enabled single-nanocrystal spectral experiments, which cannot be achieved with conventional InGaAs detectors for these dots." — *Dr. Han Htoon*

NIRvana:640LN in Action

For the PbS quantum dot study, a NIRvana:640LN camera featuring a two-dimensional InGaAs focal plane array capable of being cooled down to 83 K (-190°C) via liquid nitrogen was coupled to a Princeton Instruments IsoPlane® 320 imaging spectrograph.

According to Dr. Htoon, the cryogenically cooled NIRvana camera's unprecedented long integration times and low dark counts enabled the groundbreaking single-nanocrystal spectral experiments by providing levels of contrast and sensitivity that cannot be achieved with other InGaAs cameras when working with these quantum dots (see **Figure 1** and **Figure 2**).

TE-cooled InGaAs camera *NIRvana:640LN*

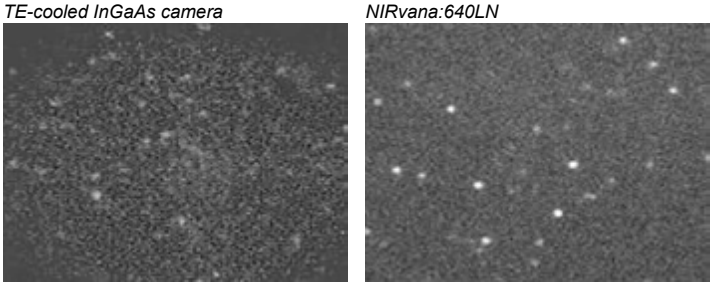

Figure 1.
Blinking movies of single PbS quantum dots emitting at ~1250 nm. Both movies were taken using a two-dimensional InGaAs detection array under the same experimental conditions. Thermoelectrically cooled camera (left) vs. cryogenically cooled NIRvana:640LN (right). Excitation: CW 405 nm. Power density: 3 W/mm². Integration time: 10 sec. Objective: 50x/0.65NA. Room temperature. Movies courtesy of Dr. Han Htoon, MPA-CINT / LANL.

TE-cooled InGaAs camera *NIRvana:640LN*

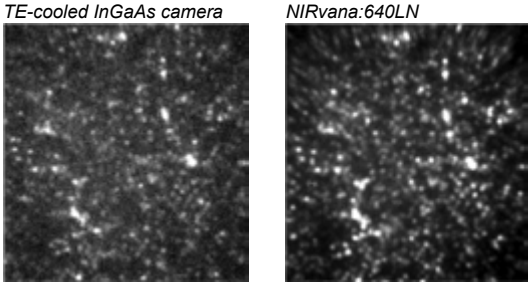

Figure 2.
Images of the same region of a concentrated PbS quantum dots sample. Both images were taken using a two-dimensional InGaAs detection array under the same experimental conditions. Thermoelectrically cooled camera (left) vs. cryogenically cooled NIRvana:640LN (right). Excitation: CW 405 nm. Power density: 3 W/mm². Integration time: 10 sec. Objective: 50x/0.65NA. Room temperature. Images courtesy of Dr. Han Htoon, MPA-CINT / LANL.

Dr. Htoon's group is the first to report single-nanocrystal spectral studies for this type of quantum dot with emission in the short-wave infrared (SWIR) region. Their work will benefit the understanding and development of SWIR semiconductor nanocrystals for applications ranging from human health to national defense.

Researcher website

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