QDot™

QDot™ PbS Quantum Dots Application Guide

THE NEXT GENERATION MATERIAL FOR OPTOELECTRONICS:

1. Superior photoelectrical properties in NIR range
2. Broad absorption through all UV-visible and tunable in NIR range (from 700 to 2000 nm)
3. Device grade QDs with high purity, surface cleanness and narrow particle size distribution

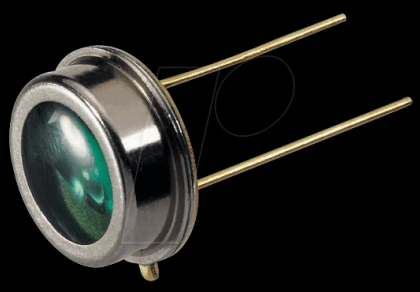
QDot™ is a trademark of Quantum Solutions:

We develop and manufacture PbS and Perovskite QDs. We have large scale production capabilities with the high standards of quality control. We benefit from expertise in QD optoelectronic devices prototyping and testing.

MAIN APPLICATION AREAS:

NIR IMAGE SENSORS

Near infrared light photodetection for face recognition, autonomous cars, machine vision, AR and VR

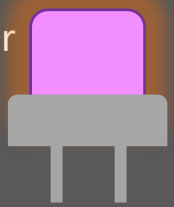


SOLAR CELLS

Increases the efficiency of silicon based solar panels

NIR QD LEDs

Active material for NIR LEDs in 900-2000 nm range



X-RAY IMAGING

Next generation active material for X-ray scanning

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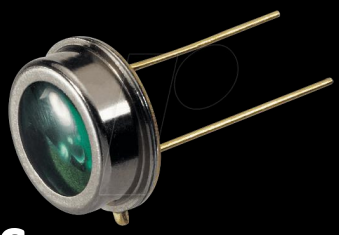
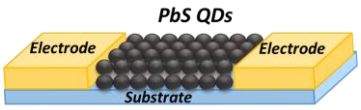
QDot™ PbS Quantum Dots for NIR Image Sensors



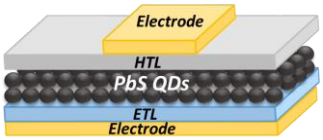
Near infrared sensing is getting very important in such devices as photo-cameras (for biometrics), autonomous cars (obstacles detection), machine vision (quality control and product inspection), AR and VR (for eyes tracking), in night vision and surveillance. Current active NIR absorbers, such as InGaAs and Ge, have high cost of production (high temperature epitaxial method) and cannot be integrated on a Si-based integrated read out circuit (ROIC). QDot™ PbS QDs have higher sensitivity, wider absorption range and compatibility with Si-based sensors.

BENEFITS:

- Broad tunable absorption in NIR range from 700 to 2000 nm
- Superior photoelectrical properties with high devices EQE and detectivity
- Facile integration with Si-based sensors (CMOS or Si photodiode) by solution spin-coating



Photoconductor with PbS QDs



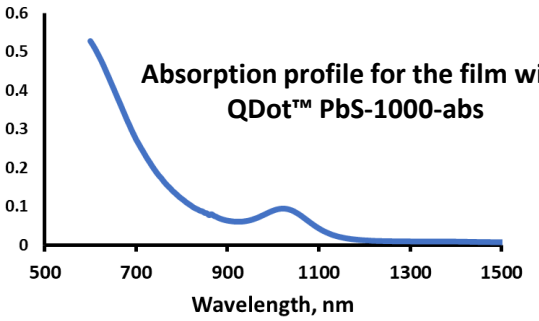
Photodiode with PbS QDs

PERFORMANCE:

Material	QDot™ PbS Quantum Dots
Absorption range	Through all visible up to NIR (tunable from 700 nm to 2000 nm)
Particle sizes	From 2 to 10 nm depending on the required absorption profile
Devices typical EQE	5-40 % upon excitation in NIR
Devices typical response time	< 50 µs
Devices typical specific detectivity	up to 1x10^{11} cm·Hz$^{1/2}$/W

DEVICE EXAMPLE:

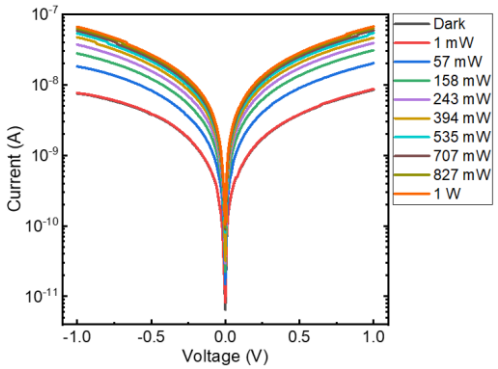
QDot™ PbS QDs were used as an active layer in the photoconductor with gold electrodes. QDot™ PbS QDs were deposited by spin coating (5-10 layers). Each layer processing consisted of spin coating of PbS QDs (octane, 50 mg/mL), followed by ligands exchange with 1,2-EDT and washing with methanol.



Absorption profile for the film with QDot™ PbS-1000-abs

The device absorbs the light through all visible spectra up to NIR light (tunable from 700 – 2000 nm). QDot™ PbS QDs device current linearly depends on the light intensity. The typical response time for devices is < 50 µs, but can reach < 5 µs upon devices special processing. The EQE can reach up to 40 % and typical specific detectivity is up to 1x10^{11} cm·Hz$^{1/2}$/W.

I-V curves for QDot™ PbS-1000-abs under 1000 nm laser



Products portfolio:

- **QDot™ PbS Quantum Dots**

PbS Quantum Dots, oleic acid capped, 700-2000 nm emission/excitonic absorption peaks

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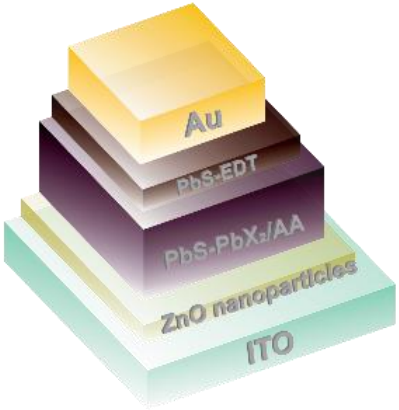
QDot™ PbS Quantum Dots for Solar Cell

QDot™ PbS QDs can be utilized in solar cell to capture more solar spectrum in the near infrared range. The ability to tune QDs absorbance wavelength in the NIR range makes it versatile for tandem solar cells with other materials such as silicon wafer or perovskite films solar cell. Current development of stand-alone PbS solar cell already achieved 10% certified efficiencies.

BENEFITS:

- Broad tunable absorption in near infrared range from 700 to 2000 nm
- Enable solution and room temperature processable solar cell
- Can be tandem with other solar cell technology such as silicon or perovskite solar cell, adding up to 5% to the total power conversion efficiency.



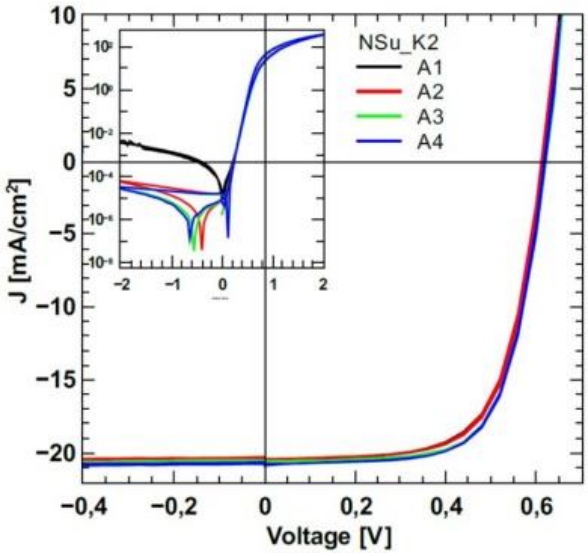
PERFORMANCE:

Material	QDot™ PbS Quantum Dots
Absorption range	Through all visible up to NIR (tunable from 700 nm to 2000 nm)
Particle sizes	From 2 to 10 nm depending on the required absorption profile
Devices typical PCE	8-9 % upon excitation in NIR

DEVICE EXAMPLE:

QDot™ PbS QDs with absorption 920 nm were used as an active layer in the solar cell with gold electrodes and ZnO electron transporting layer. QDot™ PbS QDs treated with PbI2/PbBr2 and ammonium acetate were deposited by spin coating as an active layer. For hole transporting layer, layer processing consisted of ligands exchanged QDot™ PbS QDs with 1,2-EDT was used.

The device absorbs the light through all visible spectra up to NIR light (tunable from 700 – 2000 nm). The obtained solar cell using our PbS QDs show promising power conversion efficiencies up to 8.77%.



Measurement	Jsc	Voc	FF	PCE	Area
A-1	20.66	0.62	0.66	8.45	0.10
A-2	20.54	0.61	0.67	8.45	0.10
A-3	20.68	0.62	0.68	8.69	0.10
A-4	20.88	0.62	0.68	8.77	0.10

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