Quantum SOLUTIONS

PbS Quantum Dots Application Guide

THE NEXT GENERATION MATERIAL FOR OPTOELECTRONICS:

1. Broad absorption through all visible and NIR light (2000 nm)
2. Tunable emission profiles from 900 to 2000 nm
3. High PLQY (> 40-60 %) and narrow FWHM (< 100-140 nm)

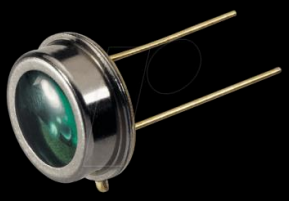
About Quantum Solutions:

We are a manufacturer of 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.

APPLICATION EXAMPLES:

NIR photodetectors

NIR photodetection for face recognition, autonomous cars, AR and VR, …

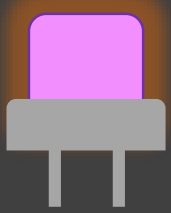


Solar cells

Increases the efficiency of silicon based solar panels

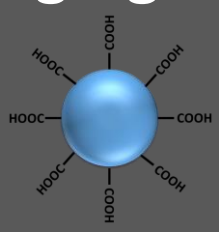
NIR QD LEDs

Efficient active material for NIR LEDs in a wide range 900-2000 nm



Biomedical imaging

Enables to detect cancer and other species by NIR imaging



quantum-solution.com info@quantum-solution.com +966 563023423 @Quantum_S_

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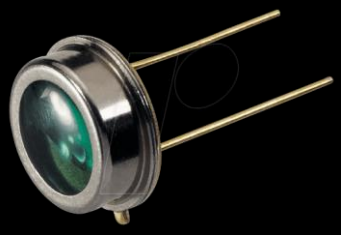
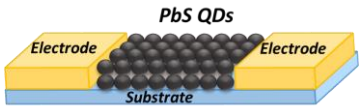


PbS Quantum Dots for NIR Photodetectors

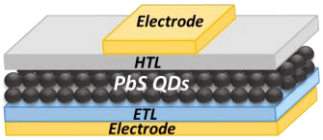
Near infrared sensing gains a widespread application in such devices as photo-cameras (for face recognition), autonomous cars (obstacles detection), AR and VR (for eyes tracking), in night vision and surveillance, biomedical imaging, quality control and product inspection. New sensor technologies are enablers for the digital transformation allowing us to integrate devices for IoT or collect Big Data. Current active NIR absorbers, such as InGaAs and Ge, have high cost of production (high temperature epitaxial method) and doesn't allow to combine with Si-based photodiode in a single device. PbS QDs have higher sensitivity, wider absorption range and compatibility with Si-based sensors.

BENEFITS:

- Broad tunable absorption through all visible range to NIR 800 - 2000 nm
- High devices EQE
- High detectivity and short response time
- Facile integration with Si-based sensors (CMOS or Si photodiode) by solution spin-coating



Photoconductor with PbS QDs



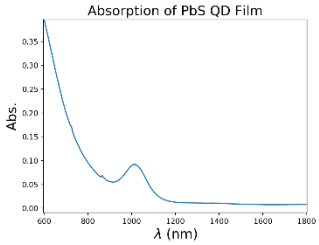
Photodiode with PbS QDs

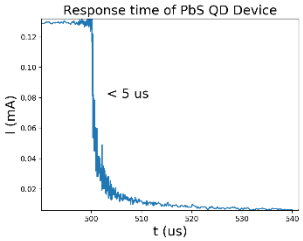
PERFORMANCE:

Material	PbS Quantum Dots
Absorption range	Through all visible up to NIR (tunable from 800 nm to 2000 nm)
Particle sizes	From 2.5 to 9 nm depending on the required absorption profile
Devices typical EQE	10-30 % upon excitation in NIR 50-70 % upon excitation in VIS
Devices typical response time	< 30 µs
Devices typical detectivity	$10^{10} - 10^{13}$ Jones

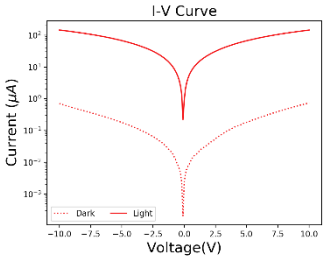
EXPERIMENTAL DATA for QD-LS-980-abs (PbS QD, 980 nm excitonic absorption peak):

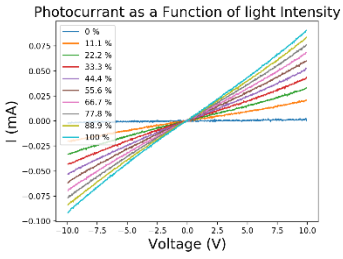
PbS QDs were used as an active layer in the photoconductor with gold electrodes. PbS QDs were deposited by spin coating (5-10 layers). Each layer processing consisted of spin coating of PbS QDs (octane, 50 mg/mL), followed by ligands exchange with 1,2-EDT and washing with methanol.





The device absorbs the light through all visible spectra up to 1100 nm with the first excitonic absorption peak 1015 nm (shifted from 980 in solution). The response time is < 5-20 µs. I-V curve in dark/light modes shows that PbS QDs is a very sensitive material with the current linearly dependent on the light intensity.





Products portfolio:

- PbS (Lead Sulfide) Quantum Dots

PbS QDs, oleic acid capped, 800-2000 nm emission/excitonic absorption peaks

RELATED LITERATURE (with our contribution):

1. Zhijun Ning et al. **Nature Materials 2014**. V. 13, pp. 822–828

quantum-solution.com info@quantum-solution.com +966 563023423 @Quantum_S_