



QDot™ Perovskite Quantum Dots Application Guide

THE NEXT GENERATION MATERIAL FOR OPTOELECTRONICS:

- 1 Superior photoemissive material with broad absorption and tunable wavelengths emission (410 – 690 nm)
- 2 The narrowest FWHM among all types of QDs (<20-35 nm)
- 3 Near unity PLQY (up to 100 %)

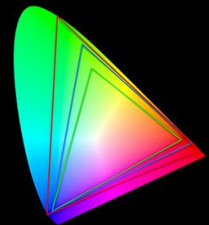
QDot™ is a trademark of Quantum Solutions:

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:

QD DISPLAYS

Enhances color gamut for HDR LCD displays. Can be used as printable inks as color filters on blue OLEDs, μ LEDs or blue LCD pixels



X-RAY IMAGING

High-efficiency scintillator material for X-ray detection



UV SENSORS

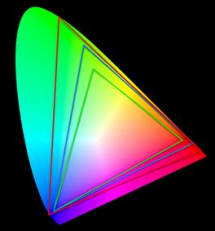
Increases UV sensitivity of Si based photodetectors



QD LEDs

For widest color gamut and highest contrast displays



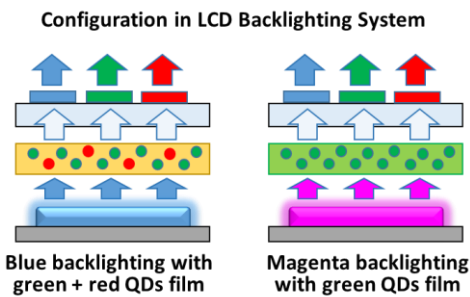


QDot™ SharpGreen Perovskite QDs Film for LCD Displays

Quantum dots extend the color gamut of LCD displays, present more vibrant colors with better contrast in TVs, laptops and tablets. Ideal solution for HDR displays to meet Rec2020 standard. On top of that, QDs help to reduce the energy consumption (up to 25 %). Nowadays, the technology is adopted by many TV manufacturers. QUANTUM SOLUTIONS offers novel QDot™ SharpGreen Perovskite QDs Film for LCD application (“LCD backlighting”). This material has emission 525 nm, high photoluminescence efficiency (up to 100 %) and narrow band emission (< 20-25 nm) that make it a better quality alternative to the current CdSe or InP QDs.

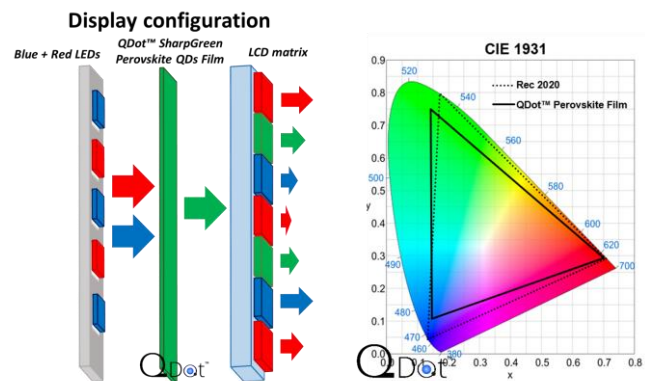
BENEFITS:

- LCD display with > 80% Rec2020, > 90 % DCI-P3 and > 95% Adobe RGB color gamut coverage
- Emission for Rec2020 and beyond - 525 nm
- The narrowest FWHM among all QDs (< 20-25 nm)
- High PLQY up to 100 %
- RoHS compliant for LCD backlighting, cadmium free
- High reliability



LCD Display Performance:

QDot™ SharpGreen Perovskite QDs Film in combination with magenta LED extend the color gamut of LCD display to the record high Rec2020 > 80%, DCI-P3 > 90% and Adobe RGB > 95%.



QDot™ SharpGreen Perovskite QDs Film:

QDot™ SharpGreen Perovskite QDs Film can be used as a LCD backlighting unit in combination with magenta LEDs.

Qdot™ SharpGreen Film LCD optical properties

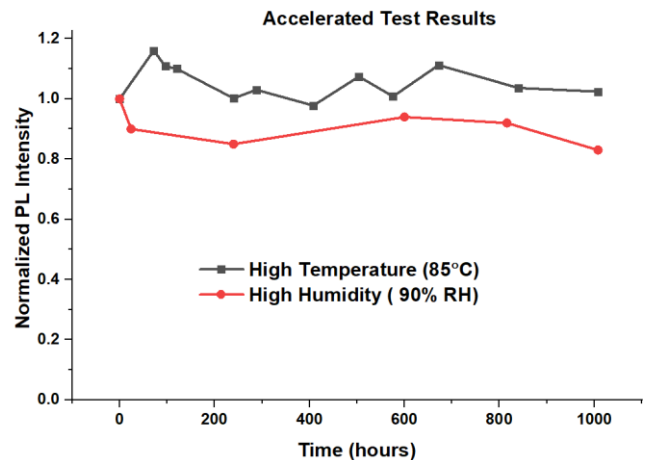
Emission peak	525 ± 3 nm
FWHM	< 25 nm
PLQY	> 70 %
Pb content	< 1000 ppm (RoHS compliant)



Reliability:

QDot™ SharpGreen Film has high reliability under heat, light and humidity. It retains > 80 % of initial photoluminescence within 1000 h of accelerated exposure tests:

- ✓ under heat (85 °C/blue light 10 mW/cm² exposure)
- ✓ under high relative humidity (90 % RH at 60 °C)



Products portfolio:

[QDot™ SharpGreen Perovskite QDs Film](#)



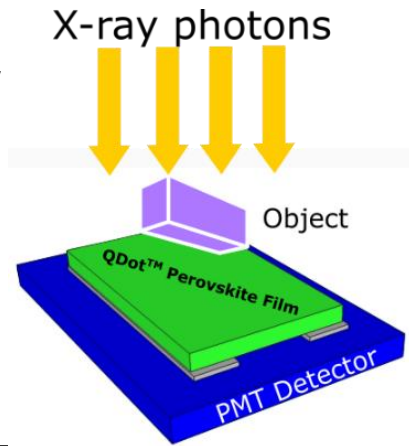


Perovskite Quantum Dots for X-Rays

Scintillators, which are capable of converting ionizing radiation into visible photons, are very important for such areas as: inspection, failure/cracks detection, security X-ray imaging, nuclear cameras, and computed tomography. QDot™ Perovskite Quantum Dots can be used as an efficient X-ray scintillation material. It exhibits strong luminescence (tunable in the range of 450-685 nm) under X-rays that is readable by the conventional silicon imaging camera. It is also compatible with PMT detectors, silicon photodiodes or photomultipliers.

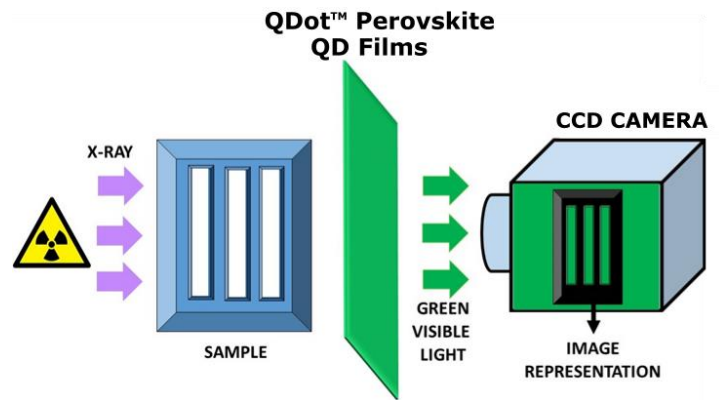
BENEFITS:

- High sensitivity (from 13 nGy/s)
- High light output (50 % of CsI:TI)
- Short decay time (40 ns)
- High stopping power
- Solution processable
- Enable flexible X-ray detector



DEVICE EXAMPLE:

QDot™ Perovskite QDs are a novel superior X-ray scintillator material with an exceptional sensitivity. The fast response to X-ray photons is critical especially in medical radiography and also industrial inspection.



PERFORMANCE:

QDot™ Perovskite Quantum Dots

Emission peak	410 – 685 nm
FWHM	< 20-25 nm
Decay time under 661 keV	< 50 ns
Light output at 10kV (% of CsI:TI)	50 %
Detection limit	13 nGy/s

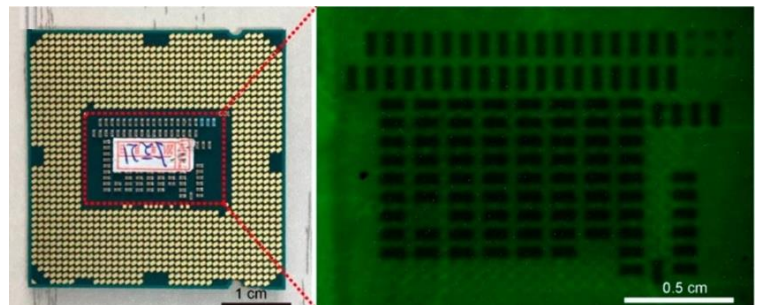
QDot™ Perovskite QDs as an X-ray scintillator can convert X-ray photons to visible light which can be easily detected by commercial available photodetector (CCD camera). Solution process ability and good compatibility with photodetector make it appealing for commercial application.

Products portfolio:

[QDot™ Perovskite ABX3 Quantum Dots](#)

[QDot™ SharpGreen Perovskite QDs](#)

[QDot™ SharpGreen Perovskite QDs Film](#)



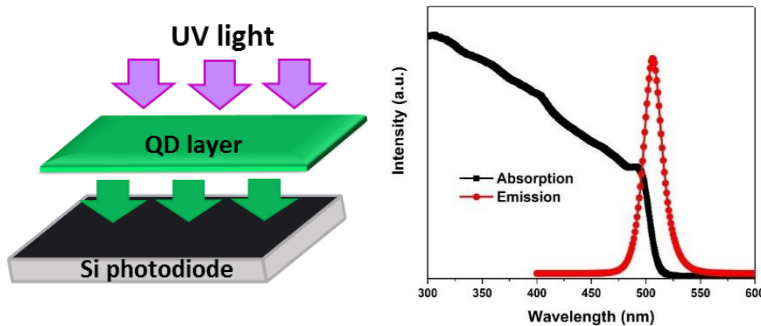


Perovskite Quantum Dots for UV Sensors

Silicon photodiode is the most widely used commercial photodetector for a broad range of applications, from imaging to light sensors. Unfortunately, it has low responsivity and suffer in capturing UV light range (< 400 nm), due to the low penetration depth of high energy UV photons in the silicon-based materials. QDot™ Perovskite Quantum Dots can be utilized as a color-converting layer to enhance the UV light sensitivity of Si-based photodetectors.

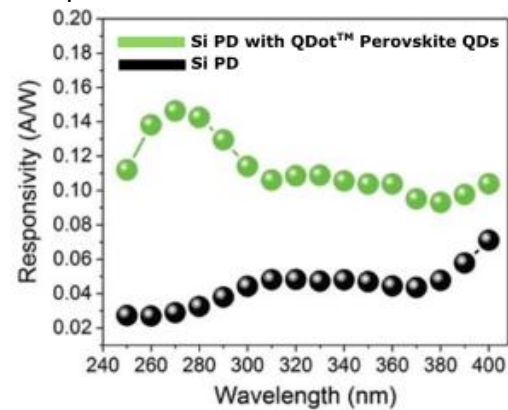
BENEFITS:

- High photo-conversion of UV light into visible light (PLQY up to 100 %)
- High absorption coefficient of UV light
- Tunable emission 410-685 nm



DEVICE EXAMPLE:

QDot™ Perovskite QDs can convert UV light into lower energy green light where Si-based photodetectors have a high sensitivity. QDot™ Perovskite QDs ABX3-510 can be used in the form of QDs in a polymer film or a spin coated layer on top of the Si-based photodetector.

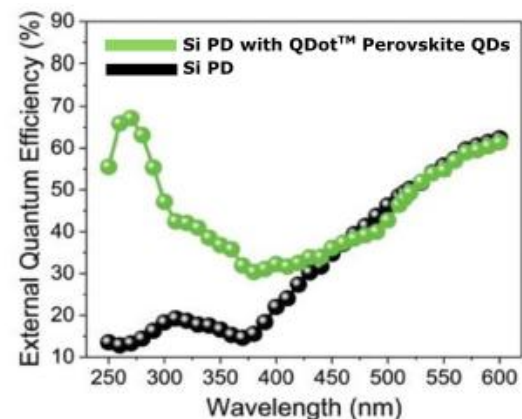


PERFORMANCE:

QDot™ Perovskite Quantum Dots

Emission	410-685 nm
PLQY at UV light excitation	Up to 100 %
FWHM	< 20-35 nm
UV light absorption range	100-400 nm
PL decay time (372 nm)	4.5 ns
Responsivity improvement in Si-PD with QDot™ Perovskite QDs	10^2 - 10^3

By utilizing only very thin layer of QDot™ Perovskite QDs on top of Si-based photodetector, the responsivity of the devices increases in response to UV light, without scarifying the response to the the visible light.

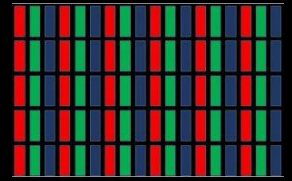


Products portfolio:

[QDot™ Perovskite ABX3 Quantum Dots](#)

[QDot™ SharpGreen Perovskite QDs](#)

[QDot™ SharpGreen Perovskite QDs Film](#)

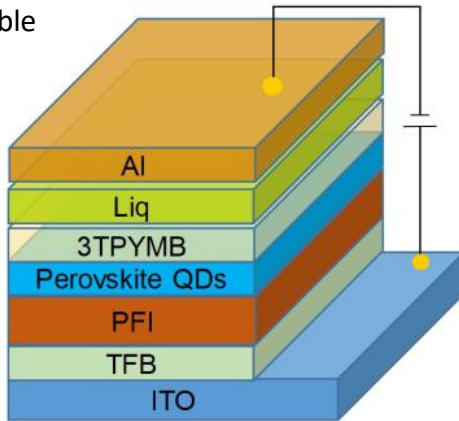


Perovskite ABX3 Quantum Dots for QD LEDs

QD LEDs is an emerging technology that promises to enhance current OLED displays with higher brightness, durability and color purity. It will be an ultimate solution for flexible and curved displays in TVs, mobile and wearable devices, virtual and augmented reality glasses, automotive displays and signage. QDot™ Perovskite ABX3 Quantum Dots show a promise in that field alongside with InP and CdSe quantum dots. QDot™ Perovskite ABX3 powders QDs are especially efficient for blue and green QD LEDs.

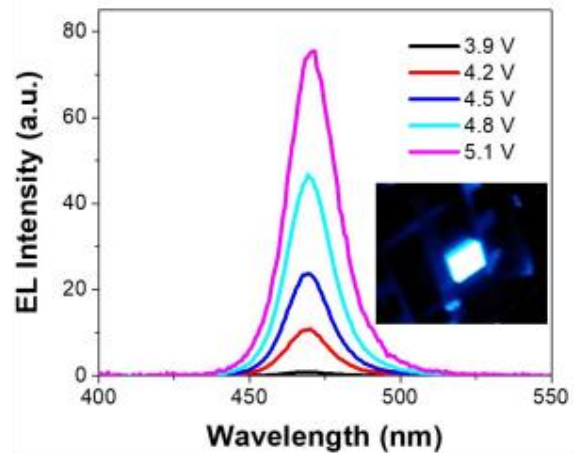
BENEFITS:

- High brightness (from 500 Cd/m² for blue and from 1000 Cd/m² for green lights)
- High EQE (from 2% for blue and 5% for green)
- Short decay time (< 5-20 ns)
- Solution processable



DEVICES EXAMPLE:

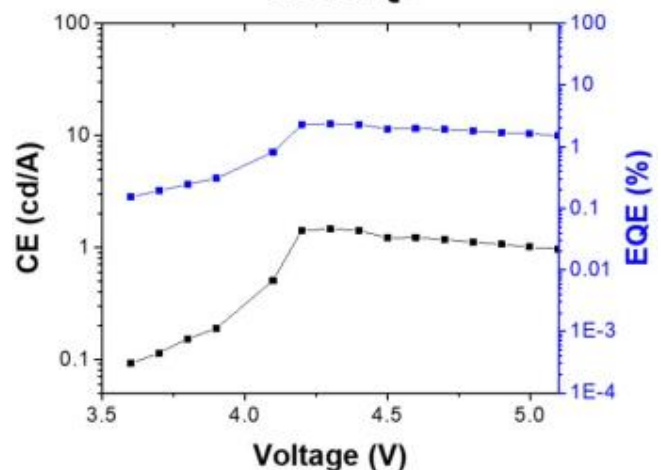
QD LED based on green QDot™ ABX3-510 powder exhibits strong electroluminescence at 510 nm with FWHM 18 nm. EQE max is > 5 % with luminance max > 1000 Cd/m². QD LED based on blue QDot™ ABX3-450 powder demonstrates the emission at 450 nm with FWHM 20 nm. It has relatively high EQE max over 2 % with brightness 500 Cd/m².



QD LED PERFORMANCE:

	QDot™ ABX3-450 powder	QDot™ ABX3-510 powder
QDs core type	CsPb(Cl/Br) ₃	CsPbBr ₃
Emission	450 nm	510 nm
FWHM	< 20 nm	< 20-25 nm
Decay time	< 5-20 ns	< 5-20 ns
EQE max	> 2 %	> 5 %
Luminance max	> 500 cd/m ²	> 1000 cd/m ²

CE & EQE



Products portfolio:

[QDot™ Perovskite ABX3 Quantum Dots](#)