Quantum Dots for Advanced Research and Devices

PRODUCT PORTFOLIO:

Perovskite Quantum Dots
Emit light in the entire visible spectral region from 450 to 630 nm

Zero-D Perovskite
Emit light at 520 nm

CdSe/CdS Quantum Dots
Emit light in the entire visible spectral region from 500 to 660 nm

PbS Quantum Dots
Emit light in the near infrared (IR) range from 900 to 1600 nm

ABOUT QUANTUM SOLUTIONS

QUANTUM SOLUTIONS company is an expert in the synthesis of Quantum Dots (QDs). Our novel patent pending flow reactor synthesis enables us to produce highly uniform QDs with precise size control of tunable emission peaks, narrow emission bands and high quantum yields. Quality control is provided by modern equipment: UV-vis-IR spectrometer, a fluorescence spectrometer with broadband and integrating sphere capability, Transmission electron spectroscopy and Diffractometer.

SCOPE OF APLLICATIONS

Application area	Perovskite	Zero-D	CdSe/CdS	PbS
QD LEDs and lasers	✓		✓	✓
QD backlight	✓	✓	✓	
QD solar cells				✓
QD photodetectors	✓		✓	✓

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QUANTUM SOLUTIONS

Quantum Dot LEDs and lasers

PRODUCT PORTFOLIO:

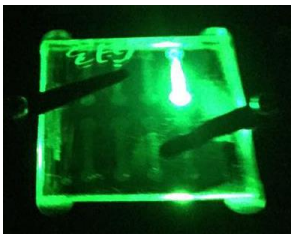
PbS Quantum Dots
For infrared LEDs and lasers

Perovskite Quantum Dots
For visible LEDs and lasers

CdSe/CdS Quantum Dots
For visible LEDs and lasers

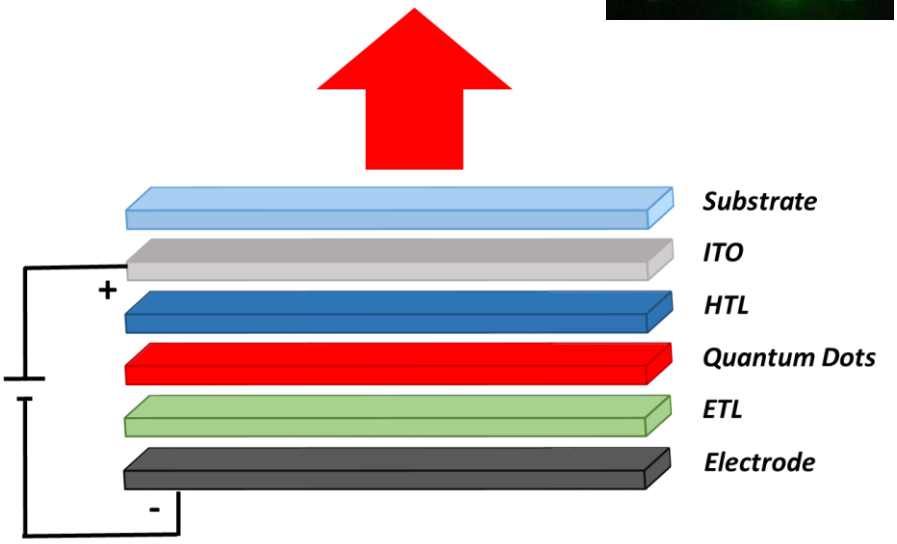
QUANTUM DOT LEDS AND LASERS BENEFITS

The uniqueness of Quantum Dot LEDs and lasers is that different wavelengths can be achieved by variation of Quantum Dot sizes that isn't possible using bulk semiconductor LED and laser technology. Also Quantum Dots become very attractive for optoelectronic devices owing to possibility of fabrication of QD LEDs and lasers by roll-to-roll printing and the compatibility with lightweight, flexible plastic substrates that open the potential for low-cost fabrication of large-area flexible devices. Visible QD LED is considered as a next generation display technology after OLED-Displays, exhibits pure color position, high luminance and lower power consumption.



QD LED FABRICATION

QD LED can be prepared as follows. The hole transporting layer (HTL) is spin-coated on ITO on a substrate. The substrate can be made of glass or polymer material. Then QDs is deposited by spin-coating. For visible LEDs you can use Perovskite or CdSe/CdS Quantum Dots. PbS Quantum Dots are for infrared LEDs. Then an electron transporting layer (ETL) and electrodes are deposited using a thermal evaporation system. Electrodes can be prepared from Ag, Au, Al etc.



RELATED ARTICLES

PbS quantum dots: **X. Gong et al.** Highly efficient quantum dot near-infrared light-emitting diodes. Nature Photonics. 2016, 10, 253–257; **G. J. Supran et al**. High-performance shortwave-infrared light-emitting devices using core–shell (PbS–CdS) colloidal quantum dots. Adv. Mater. 2015, 27, 1437–1442.

Perovskite quantum dots: **S. Veldhuis**. Perovskite Materials for Light-Emitting Diodes and Lasers. Advanced materials. 2016, DOI: 10.1002/adma.201600669; **J. Song et al**. Quantum dot light-emitting diodes based on Inorganic Perovskite Cesium Lead Halides (CsPbX3). Advanced materials. 2015, 27, 7162–7167.

CdSe/CdS quantum dots: **X. Dai et al.** Solution-processed, high-performance light-emitting diodes based on quantum dots. Nature. 2014, 515, 96-99; **O. Chen et al**. Compact high-quality CdSe–CdS core–shell nanocrystals with narrow emission line widths and suppressed blinking. Nature materials. 2013, 12, 445-451.

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QUANTUM SOLUTIONS

Quantum dots for backlighting

PRODUCT PORTFOLIO:

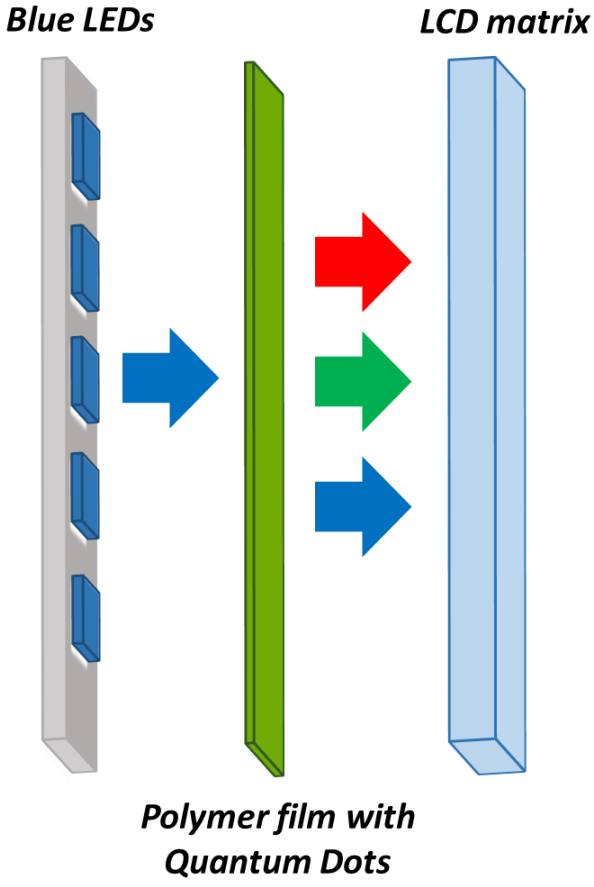
Perovskite Quantum Dots
Emit light in the entire visible spectral region from 450 to 630 nm

Zero-D Perovskite
Emit light at 520 nm

CdSe/CdS Quantum Dots
Emit light in the entire visible spectral region from 500 to 660 nm

QUANTUM DOT BACKLIGHTING BENEFITS

The QD backlighting system is an emerging technology for LCD and lighting devices. It is the QD polymer film or QD coating that converts wavelength of incoming lights. For example in the LCD backlight the part of blue light from conventional LED is converted into pure green and red colors. Then RGB lights go to the LCD matrix and produce a display image. Such QD backlight system brings a wide color gamut, more bright and contrast images. Also it decreases energy consumption significantly. Nowadays, many TV makers adopted this technology, such as Sony, Samsung and LG.



QD BACKLIGHT SYSTEM FABRICATION

QD backlight system can be fabricated as follows. Colloidal Quantum Dots are mixed with polymer solution. The polymer can be PMMA, polyurethane, etc. Then Quantum Dot polymer film is prepared on a suitable substrate. The final Quantum Dot film is used with blue or UV LED to make a backlighting system.

RELATED ARTICLES

Perovskite quantum dots: **L. Protesescu et al.** Nanocrystals of Cesium Lead Halide Perovskites (CsPbX3, X = Cl, Br, and I): Novel Optoelectronic Materials Showing Bright Emission with Wide Color Gamut. Nano letters. 2015, 15, 3692–3696; **X. Li et al.** CsPbX3 Quantum Dots for Lighting and Displays: Room-Temperature Synthesis, Photoluminescence Superiorities, Underlying Origins and White Light-Emitting Diodes. Advanced Functional Materials. 2016, 26, 2435-2445.
CdSe/CdS quantum dots: **T-H Kim.** Bright and stable quantum dots and their applications in full-color displays. MRS bulletin. 2013, 38, 712-720. **B. Huang.** "Giant" red and green core/shell quantum dots with high color purity and photostability. Superlattices and Microstructures. 2016, 91, 201-207; **G.J. Supran et al**. QLEDs for displays and solid-state lighting. MRS Bulletin. 2013, 28, 703-711.

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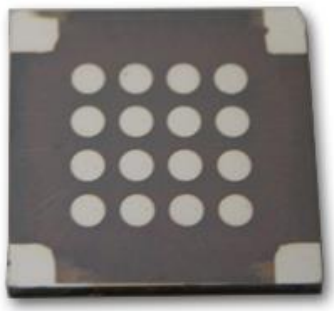
Quantum Dots for solar cells

PRODUCT PORTFOLIO:

PbS Quantum Dots
Works in the near infrared (IR) range from 900 to 1600 nm

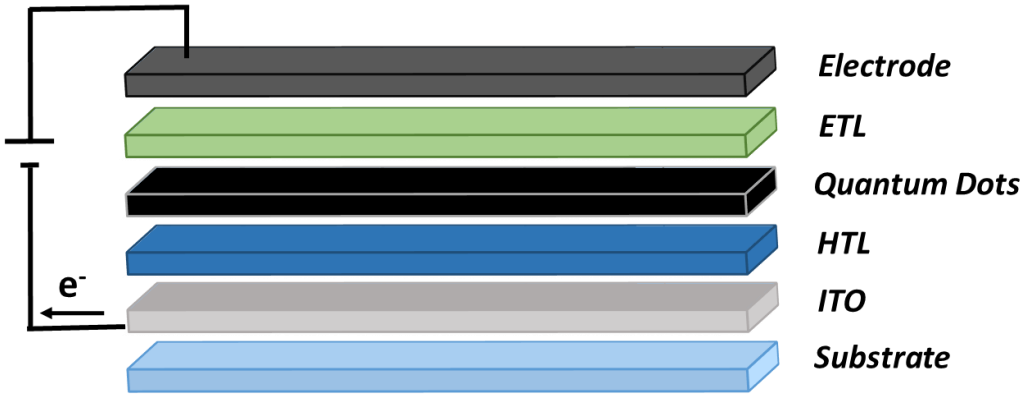
QUANTUM DOT SOLAR CELL BENEFITS

PbS quantum dots are of particular interest in solar photovoltaic applications, in which the semiconductor's large Bohr exciton radius enables quantum size-effect tuning over the broad solar spectrum. Also this material offers avenues to tandem and multijunction solar cells from a single material via size-effect bandgap tunability. Moreover, their processing from the solution phase should in principle allow rapid, large-scale manufacturing and ready integration with flexible substrates, facilitating roll-to-roll processing.



QD SOLAR CELL FABRICATION

Solar cell devices can be prepared as follows. The PbS Quantum Dot film is deposited in a layer-by-layer fashion by spin coating on HTL/ITO/glass substrate layers. P-type PbS quantum dots of various band gaps can be deposited. Then ETL and top electrode consisting of Ag or Au are deposited by thermal and electron beam evaporations.



RELATED ARTICLES

X. Lan et al. Passivation Using Molecular Halides Increases Quantum Dot Solar Cell Performance. Advanced Materials. 2016, 28, 299–304; **Z. Ning et al**. Air-stable n-type colloidal quantum dot solids. Nature materials. 2014, 13, 822-828; **C. M. Chuang. et al.** Improved performance and stability in quantum dot solar cells through band alignment engineering. Nature materials. 2014, 13, 796-801; **J. Pan et al.** Automated Synthesis of Photovoltaic-Quality Colloidal Quantum Dots Using Separate Nucleation and Growth Stages. ACS Nano. 2013, 7 (11), 10158-10166; **X. Wang et al**. Tandem colloidal quantum dot solar cells employing a graded recombination layer. Nature Photonics. 2011, 5, 480-484.

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Quantum Dots for photodetectors

PRODUCT PORTFOLIO:

PbS Quantum Dots
For infrared light sensing

Perovskite Quantum Dots
For visible light sensing

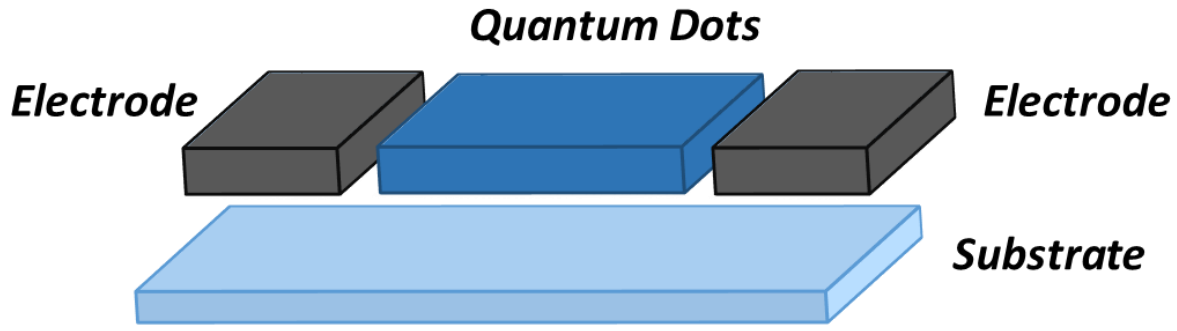
CdSe/CdS Quantum Dots
For visible light sensing

QUANTUM DOT PHOTODETECTOR BENEFITS

Photodetectors for infrared light can be utilized in night vision, atmospheric spectroscopy for gas detection, biomedical imaging, quality control and product inspection. Photodetectors for visible light is utilized in image sensors to transform incoming light into electronic signal, and also be used in surveillance, machine vision, industrial inspection, spectroscopy, and fluorescent biomedical imaging. The advantages of using Quantum Dots are that they can be easily integrated with silicon electronics or with flexible organic substrates, and also be deposited on electrodes prefabricated on a substrate by simple methods: ink-jet printing, solution casting and low-temperature evaporation. Additionally, optical absorption and emission spectra of QDs are widely tunable through the quantum size effect

QD PHOTODETECTOR FABRICATION

QD photodetector can be fabricated as follows. Electrodes are deposited on the substrate by evaporation. Then colloidal Quantum Dots or mixture of QDs in polymers are spin-coated on a substrate to form solid QD film or QD polymer composite between electrodes.



RELATED ARTICLES

G. Konstantatos. Colloidal quantum dot photodetectors. Colloidal Quantum Dot Optoelectronics and Photovoltaics, eds. G. Konstantatos and E. H. Sargent. Published by Cambridge University Press. © Cambridge University Press, 2013. **G. Konstantatos et al**. Nanostructured materials for photon detection. Nature nanotechnology. 2010, 5, 391-400.

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