Quantum SOLUTIONS®

QDot™ ETL and HTL materials

Technical Data Sheet

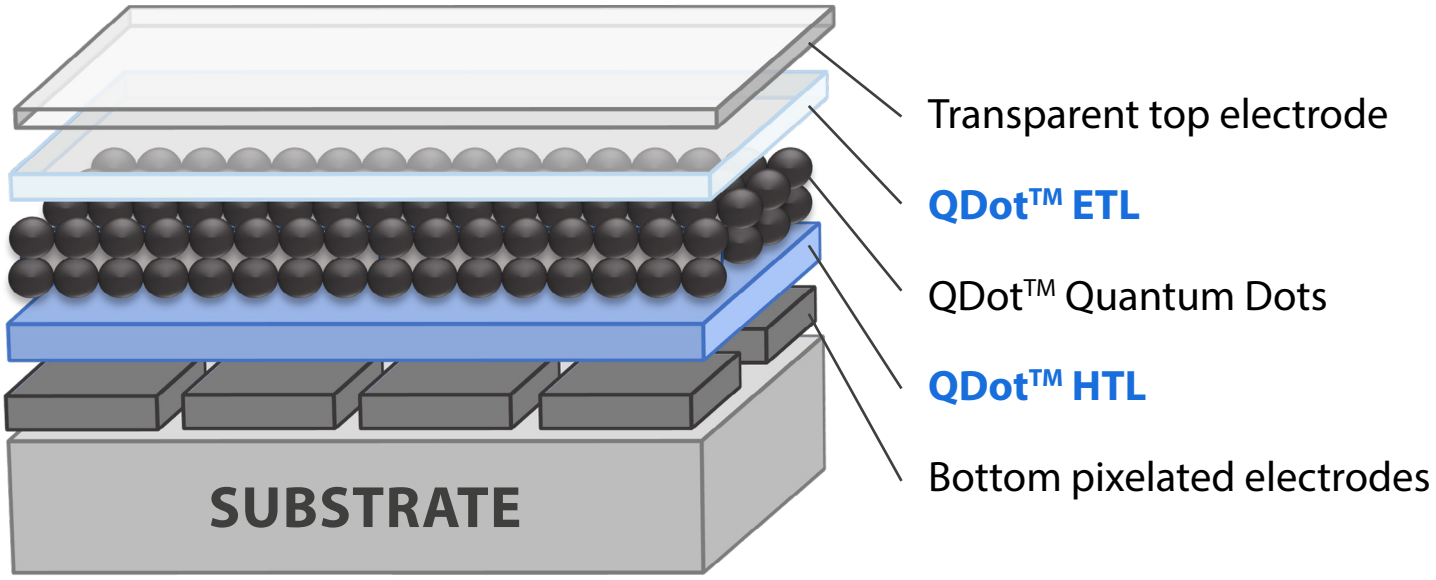
Products introduction and highlights

Quantum Solutions offers a range of materials for fabricating a QDot™ photodiode stack, which can be used in sensing and imaging applications. The principal device structure comprises several thin layers, referred to as a QDot™ stack, placed on top of a substrate. Working from the bottom up, the structure includes a bottom electrode, an HTL (hole transport layer), a quantum dots absorber, an ETL (electron transport layer), and a transparent top electrode.

QDot™ stack materials, including HTL, quantum dots, and ETL, can be deposited onto any target substrate, such as glass, silicon, or a ROIC platform, using spin-coating methods from solution.

These novel solution-based methods for depositing thin films of compound semiconductor materials have made it possible to create artificial nanocrystalline structures that offer unprecedented possibilities. Unlike epitaxial layers, the quality of quantum-dot semiconductors is less dependent on the crystallographic characteristics of substrates and their interfacial relationships. Solution-based methods provide flexibility and broad material choice for specialised carrier transport layers enabling tuneable photodiode functions.

Quantum Solutions provides a library of QDot™ ETL and HTL materials that can be used together with QDot™ quantum dots, enabling the fabrication of highly efficient SWIR photodiodes and image sensors.



QDot™ ETL and HTL materials offer the following features:

- ✔ Carefully designed electronic landscape of ETL and HTL semiconducting materials providing a perfect band alignment with QDot™ PbS quantum dot absorbers. Suitable energy levels can be selected from the library of available materials or fine-tuned upon request.
- ✔ Easy integration on substrates (glass, silicon or CMOS wafers) by spin-coating or other printing processes, guaranteeing affordability, manufacturability and economical price (10 mL is sufficient for one or two 200 mm wafers).
- ✔ Enhanced functionality, stable operation, and long-term environmental durability.

Products selection guide

Quantum Solutions has developed a library of solution-processable QDot™ ETL and HTL materials, which can be used in conjunction with QDot™ PbS quantum dots. QDot™ PbS quantum dots are the preferred material due to their broad absorption spectrum from 400nm to 2500nm and high electrical tunability. The bandgaps and energy levels of QDot™ PbS quantum dots are typically tuned by changing the particle size and ligands through solid or solution-ligand exchange. Depending on the required band alignments, suitable QDot™ ETL and HTL products (as shown in Table 1 and Table 2 respectively) can be selected. The overall performance of the photodiode device depends on several equally important factors, such as the quality of the layers and interfaces, defect density, electrode metal work functions, transparency of the top electrode, encapsulation method, etc.

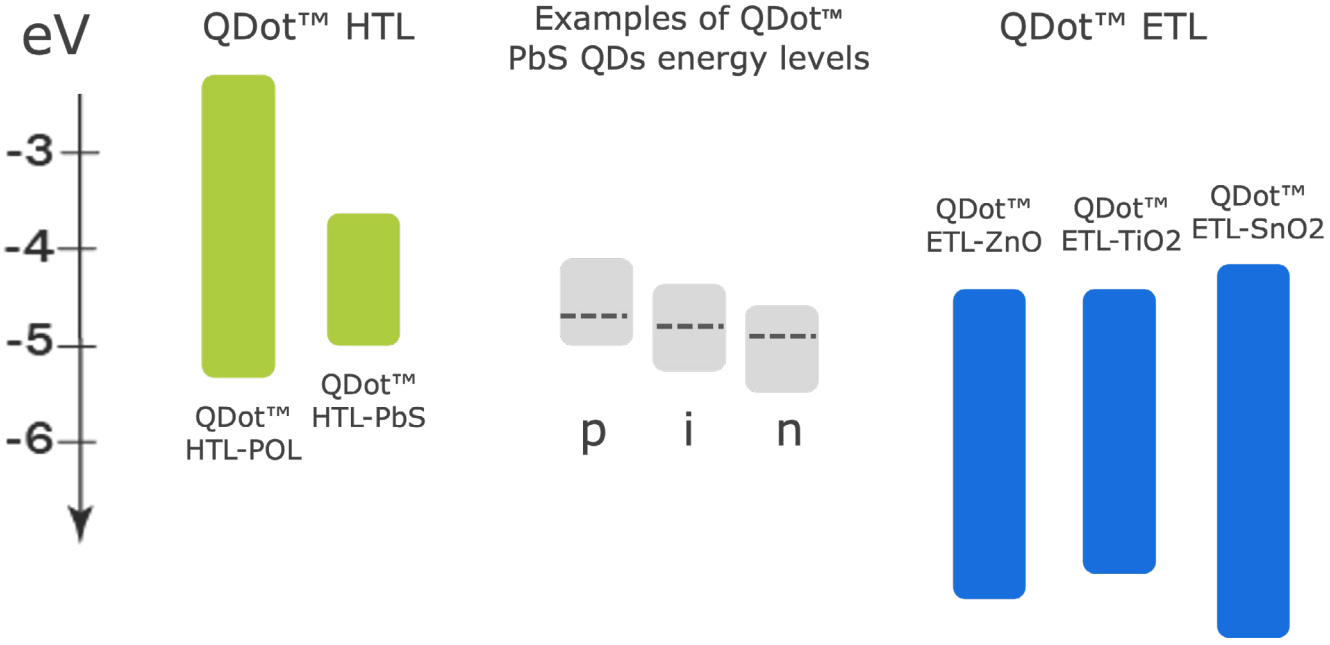


Table 1. Specification of QDot™ ETL materials*

Catalogue Number	QDot™ ETL-ZnO	QDot™ ETL-TiO2	QDot™ ETL-SnO2
Functional material	ZnO	TiO2	SnO2
Bandgap, eV	3.20	2.87	3.88
Conduction band (eV)	4.39	4.40	4.15
Valence band (eV)	7.59	7.27	8.00
Carrier density (cm^{-3})	$>10^{18}$	$>10^{18}$	$>10^{18}$
Electrical mobility ($cm^2/(V{\cdot}s)$)	$>10^{-3}$	$>10^{-4}$	$>10^{-3}$
Solvent	Ethanol	Ethanol	Butanol
Solid content	30 mg/mL	30 mg/mL	20 mg/mL
Appearance	Translucent liquid	Translucent liquid	Translucent liquid
Deposition method	Spin-coating	Spin-coating	Spin-coating
Consumption, µL/cm2	10 - 20	10 - 20	10 - 20
Film transparency for 1450 nm	99.6%	99.2%	99.6%

Table 2. Specification of QDot™ HTL materials*

Catalogue Number	QDot™ HTL-POL	QDot™ HTL-PbS
Functional material	HOMO polymer	PbS
Bandgap, eV	2.90	1.25
Conduction band (eV)	2.33	3.70
Valence band (eV)	5.23	4.95
Carrier density (cm^{-3})	$>10^{17}$	$>10^{17}$
Electrical mobility ($cm^2/(V{\cdot}s)$)	$>10^{-5}$	$>10^{-5}$
Solvent	Chlorobenzene	Octane
Solid content	10 mg/mL	50 mg/mL
Appearance	Transparent liquid	Black liquid
Deposition method	Spin-coating	Spin-coating with solid ligand exchange process with thiol ligand in acetonitrile (included in the kit)
Consumption, µL/cm2	10 - 20	10 - 20
Film transparency for 1450 nm	100%	87.7%

**A detailed manual for the spin-coating process will be provided upon purchasing the product.*

Notes for handling

Shelf Life 12 months. Recommended for use within 6 months. Shipping and storage temperature: 4-25 °C. Store in a dark environment, either in the original packaging or in airtight, sealed packaging, within a glovebox. Only repackage within the glovebox. Avoid exposure to air. Carry out procedures inside a glovebox or another enclosed inert gas environment.