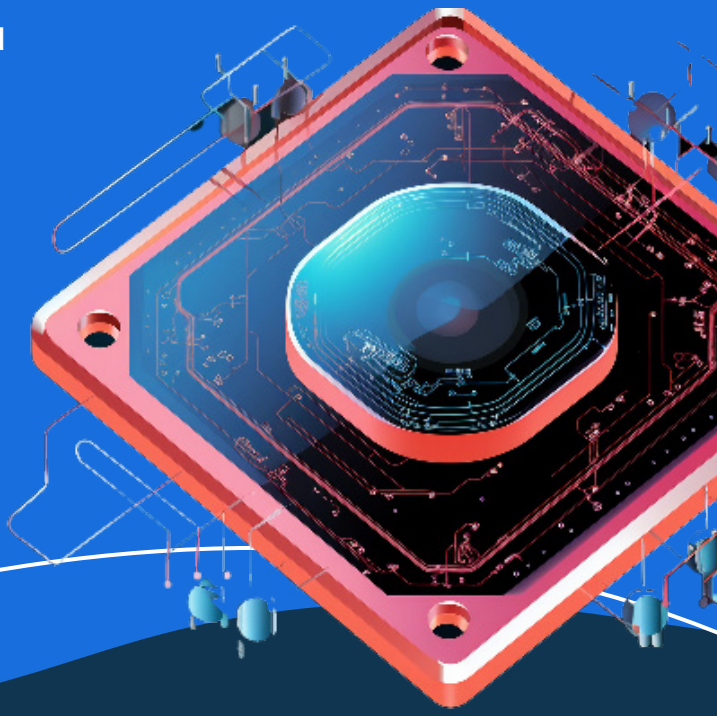
QDot™ materials for X-ray direct detection sensors

Application Note

QDot™ materials for X-ray direct detection sensors

As sensor technologies advance to improve output and performance, there is a growing demand for high performance direct detection X-ray sensors. These sensors have the capability to carry out X-ray photons energy discrimination and counting that expand their use in various industries. Their enhanced performance holds promising potential for applications in:



- **Medicine**
- **Industrial inspection**
- **Security systems**

The latest X-ray detectors with energies resolution ability can generate highly detailed images and distinguish different spectral properties using lower radiation doses than before. Nonetheless, the X-ray direct detectors currently in use, which rely on CdTe and CdZnTe (CZT) crystals, are associated with prohibitively high expenses and a complex manufacturing procedure. This restricts their applicability to highly specialized use cases. In contrast, direct X-ray detection systems utilizing QDot™ Perovskite Single Crystals provide a cost-effective alternative.

CdTe or CdZnTe (CZT)

- ✗ Complex
- ✗ Limited adoption and impact
- ✗ Expensive

Quantum Solutions QDot™ perovskite single crystals

- ✓ High sensitiivity
- ✓ Impressive resolution
- ✓ Affordable price

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BENEFITS

Solution-processed

Solution-processed compound semiconductor materials to be used in direct X-ray photodetectors and image sensors.

High Crystallinity

High crystallinity and purity perovskite single crystals are grown at low temperatures, enabling precise control over crystal stoichiometry and dimensions.

Simple processing

Easy integration on substrates (glass, silicon, or CMOS wafers) by solution processed methods, guaranteeing affordability and manufacturability.

DEVICE ARCHITECTURE EXAMPLES

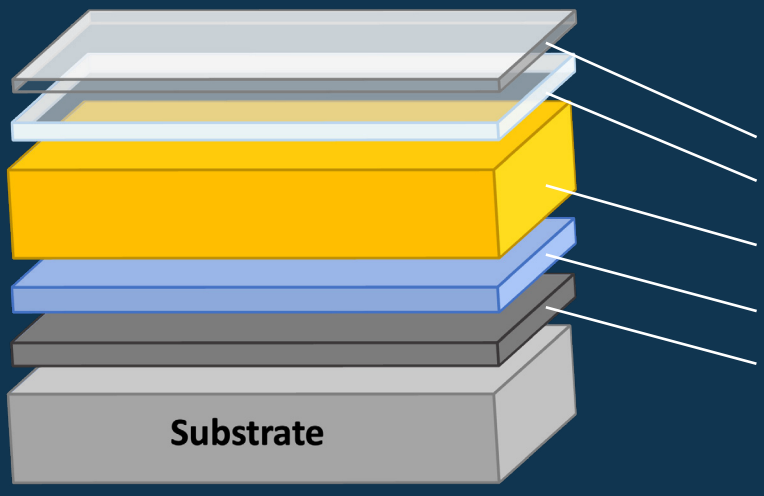

Figure 1. Example of QDot™ X-ray photodiode architecture

Top electrode

ETL

QDot™ Perovskite Single Crystal

HTL

Bottom electrode

QDot™ Perovskite Single Crystals can be integrated into a QDot™ X-ray photodiode stack using evaporation and bonding techniques. In principle, a QDot™ X-ray photodiode stack consists of a substrate, a hole transport layer (HTL), a QDot™ Perovskite Single Crystal absorber, an electron transport layer (ETL), and a top electrode.

To fabricate the typical sensor device, ETL and HTL layers are thermally evaporated on top of the single crystal (from both sides). With the following evaporation of the bottom and top electrodes. Further details can be found in the following articles: [1, 2, 3, 4, 5, 6, 7].

CASE STUDIES

QDot™ MAPbBr3 perovskite single crystal with 1*1*0.3 cm size was used as an absorptive layer to fabricate X-ray photodetector. For that, gold electrodes were thermally evaporated on both sides of the crystals and contacts were wirebonded to the bottom and top electrodes.

The sensor sensitivity reached 1,770 µC/Gy/cm^2 at a bias condition of 5 V/mm. The dark current of the sensor was below 100 nA/cm^2, and the photocurrent generated varied linearly with the dose rate.

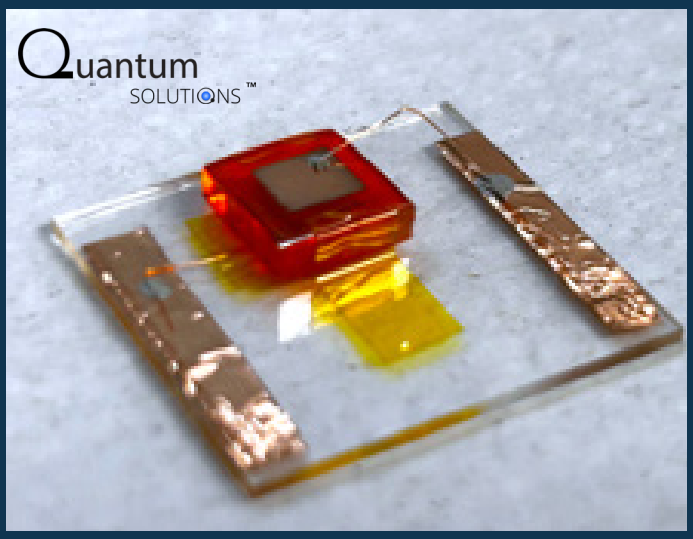

Figure 2. Image of a X-ray photodetector

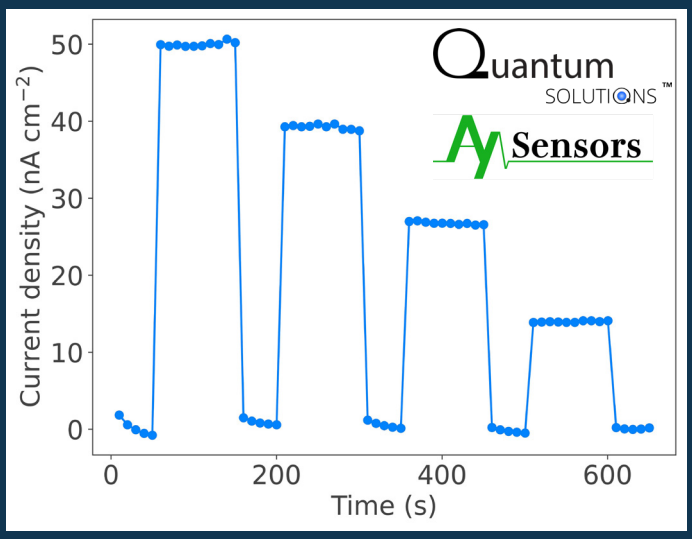

Figure 3. X-Ray response current at different dose rates from 33.6 uGy/sec to 6.7 uGy/sec.

PRODUCTS PORTFOLIO

QDot™ perovskite single crystals

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