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Halide Perovskite X-ray Detector with a Low Dark Current via Interfacial Engineering

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Recently X-ray photon counting detectors (PCDs) with energy discrimination capabilities based on pulse height analysis have been developed for medical X-ray imaging with substantially improving signal-to-noise and overall performance when compared to the conventional energy integrating detectors (EIDs) that comprising the majority of CT scanners. PCDs for medical X-ray CT require extremely expensive high-purity Cadmium Telluride (CdTe) or Cadmium Zinc Telluride (CZT) semiconductors that suffer from detrimental material defects that act as recombination centres and limit performance. Therefore substantial challenges in the fabrication and deployment of the active layer material have limited their widespread deployment.

Halide perovskite (PVK) materials have emerged as promising materials for X-ray detection, already demonstrating excellent mobility-lifetime products (μτ) comparable to CZT and CdTe, detector-grade bulk resistivity, and high stopping power at high-energy X-rays. To date, high sensitivity up to 10ˆ6 μC Gyair cm−2 and a very impressive lowest detectable dose rate (LoD) of <10 nGy s−1 have been achieved. However, the dark current is still large >1 nA cm−2 which is one of the main obstacles to utilising PVK materials for PCDs. One of the origins of the large dark current is related to the interface defects at the PVK material and charge transport layers in the device stack.
In this talk, we present a high-performing, direct X-ray detector with a device structure based on an alloyed perovskite single crystals synthesized via a state-of-the-art inverse temperature crystallisation (ITC) method. We obtained an impressive low dark current of ˜10 pA cm−2 with high sensitivity ˜10ˆ3 μC Gyair cm−2. This study will open a new direction for PVK X-ray detectors with extremely low dark current towards integration with application-specific integrated circuit (ASIC) chips/backplanes for multi-pixel detection PCDs.

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