Solution-processed 2D Layered Perovksites for High Sensitivity X-ray Detector

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In the past few years, the hybrid lead perovskites materials are the megastar in photovoltaics research field and has grab enormous attention due to its excellent absorption coefficient, charge-transport properties and long carrier life time. The power conversion efficiency (PCE) was 3.8 in 2009 and now exceed 22% in 2018. Moreover, the optoelectronics applications in hybrid lead perovskites materials not only limited in photovoltaics but also in light-emitting diodes (LEDs), photo-detector and high energy radiation detection. Especially in low dimensional perovskites, the LEDs and photo-detector devices have charge confinement and low dark current compare with 3D perovskites. These are attribute to the better crystallinity and long organic cations in the low dimensional perovskites system. Previously, our group had demonstrated using Ruddles-Popper Layered Perovksites for high performance solar cell and LEDs by controlling the crystal orientation in thin film via surface energy to facilitate the charge extraction and charge inject in the system with extended device stability under operation conditions. State-of-the-art solid state X-ray detector utilize germanium and silicon that exhibits an excellent detectivity. However, such performance is only achievable under bulk volume of materials due to its low z number, whereas operation suffers from charge diffusion and drifting that is detrimental to the detector sensitivity. Therefore, to achieve high resolution and sensitivity detector, new material with high Z number and superior transport properties are urgently needed. Low dimensional hybrid lead perovskite materials hold great promise for optoelectronic applications, being a solution grown with . They contain high Z-number element (e.g. Pb, halide) with exceptional transport properties such as carrier mobility-lifetime product, low defect density. Combining those properties, hybrid perovskite materials would be an ultimate candidate for X-ray detector.

Here in this report, we first demonstrated the X-ray detector with Ruddles-Popper layered Perovksites which exhibit light-weight, fast-responded and high sensitivity compare with commercial Silicon detector under ambient conditions. More interestingly, the 200 nm thickness absorber device with preferred orientation can detect the hard X-ray energy source over 10 keV which show great promise for high energy X-ray and low energy Gamma-Ray deterction. Our findings inform a new generation of highly efficient and low-cost X-ray detectors based on Ruddles-Popper Layered Perovksites thin film.