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P2.54: Enhancing X-ray Detection Sensitivity through Hybrid Active Layers of PCDTBT and CdSe Core/CdTe Crown 2D Nanoplatelets

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Due to their unique properties, nanocrystals (NCs) have attracted significant attention in various research fields. The NCs are classified into 0D quantum dots (QDs), 1D nanowires (NWs), and 2D nanoplatelets (NPLs) depending on their structures. Especially, 2D NPLs have the advantage of restricting quantum confinement effects only in the z-axis, unlike other NCs. Furthermore, NPLs composed of core and shell can adjust their properties by changing their structure. In this study, type-II cadmium telluride (CdTe) crowns were combined with cadmium selenide (CdSe) cores to improve the optical and electrical properties. Using 2D CdSe/CdTe core/crown NPLs, an improved indirect X-ray detector with an inorganic/organic hybrid active layer was developed. Figure 1a, shows the hybrid active layer was composed of Poly[N-9'-heptadecanyl-2,7-carbazole-alt-5,5-(4',7'-di-2-thienyl-2',1',3'-benzothiadiazole)] (PCDTBT), and CdSe core/CdTe crown NPLs. Figure 1b shows the corresponding energy levels of the proposed detector and the process of charge collection. To perform experiments on the blending ratio, PCDTBT:CdSe core/CdTe crown solutions were prepared in four different ratios of 1:2, 1:1, 2:1, and 3:1. Figure 2a, shows J-V characteristics of the proposed detectors, and Figure 2b, shows the trend of X-ray radiation parameters (CCD – DCD, sensitivity). The detector was optimized when the blending ratio of PCDTBT and NPLs was 2:1, and the highest JSC was 0.190 mA/cm2. Furthermore, radiation parameters showed a similar trend as JSC, and sensitivity was 0.173 mA/Gy·cm2, which was 77.8% higher than that of the PCDTBT:CdSe core detector [1]. Our results suggest that the use of Type-II CdTe crowns represents a promising approach for enhancing the properties of semiconductor materials and have important applications in a wide range of fields, including electronics, optoelectronics.

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