Efficient interfacial charge transfer in CVD grown non-van der Waals $Bi_2O_2Se/CsPbBr_3$ type-I heterostructure for improved photodetection

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Charge transfer in a 2D semiconductor heterostructure plays an important role in high-performance photodetectors and energy harvesting devices. Herein, we will discuss a series of experimental investigation of interfacial charge transfer in the $Bi_2O_2Se/CsPbBr_3$ (2D/0D) heterostructure through various microscopic and spectroscopic tools. We integrated the few-layer Bi_2O_2Se nanosheet (2D) possessing superior electron mobility and $CsPbBr_3$ nanocrystals (0D) with high light-harvesting capability for efficient broadband photodetection. The band alignment reveals a type-I heterojunction, and the device under reverse bias reveals a fast response time of 12 µs/24 µs (rise time/fall time) and an improved responsivity in the 390 to 840 nm range due to the effective interfacial charge transfer and efficient interlayer coupling at the $Bi_2O_2Se/CsPbBr_3$ interface. Notably, a photodetector with a peak responsivity of ~10^3 A W^{-1} was achieved in the $Bi_2O_2Se/CsPbBr_3$ heterostructure due to the synergistic effects in the heterostructure under ambient conditions. These results are significant for the development of non-van der Waals heterostructure based high-performance low-powered photodetectors.

References

[1] Hossain, M.T., et al.,Nanoscale, 2021. 13(35): p. 14945-14959

Figures

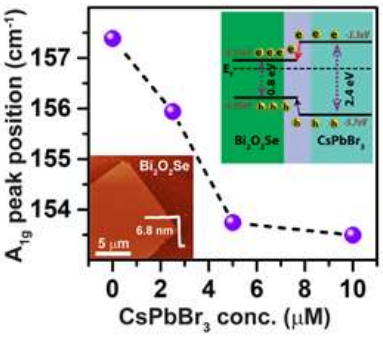

Figure 1: Evolution of characteristics Raman mode (A_{1g}) of Bi_2O_2Se with the variation of $CsPbBr_3$ nanocrystals amount. Lower inset denotes Atomic force microscopy image of few layer Bi_2O_2Se grown on mica. Upper Inset shows the energy band alignment between the $Bi_2O_2Se/CsPbBr_3$ heterostructure.

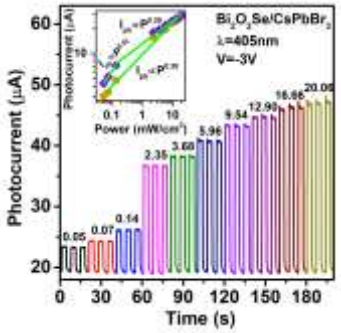

Figure 2: Photocurrent response as a function of the illumination intensity (ON/OFF) for the heterojunction photodetector. The inset shows the power-law fitting.