Highly Sensitive Scalable MoS_2/PbS Photodetector Arrays on Flexible Substrates

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Abstract

Two-dimensional materials and their hybrid architectures with high-absorbance materials, such as transition metal dichalcogenides (TMDCs) and colloidal quantum dots (CQDs) hybrids have shown immense potential in terms of ultrahigh responsivity and specific detectivity, promising response time and flexibility for sensing applications, thereby surpassing the state -of-the-art sensors. [1,2] However, their real-world implementation is limited by the absence of high-performance detectors produced via scalable material synthesis and fabrication methods. Here, we show an array of single layer MoS_2 integrated with PbS CQDs on polyimide (PI) substrate using metal-organic chemical vapor deposition (MOCVD) grown MoS_2 and solution processed lead sulphite (PbS) CQDs. Devices show broadband responsivity, up to 10^6 A/W and ultrahigh specific detectivity up to 10^{14} Jones in room temperature and ambient conditions with mechanical stability under bending and after up to 3000 bending cycles, making them highly attractive for flexible technologies, such as wearables, healthcare applications, and optical communications. Our findings emphasize their exceptional sensitivity across visible to near-infrared wavelengths and the feasibility of large-scale manufacturing of flexible 2D hybrid sensors.

References

[1] R. Chang et al., ACS Appl. Mater. Interfaces, 13 (2021) 59411–59421
[2] S. Mukherjee et al, Nanoscale Adv., 1 (2019) 3279–3287

Figures

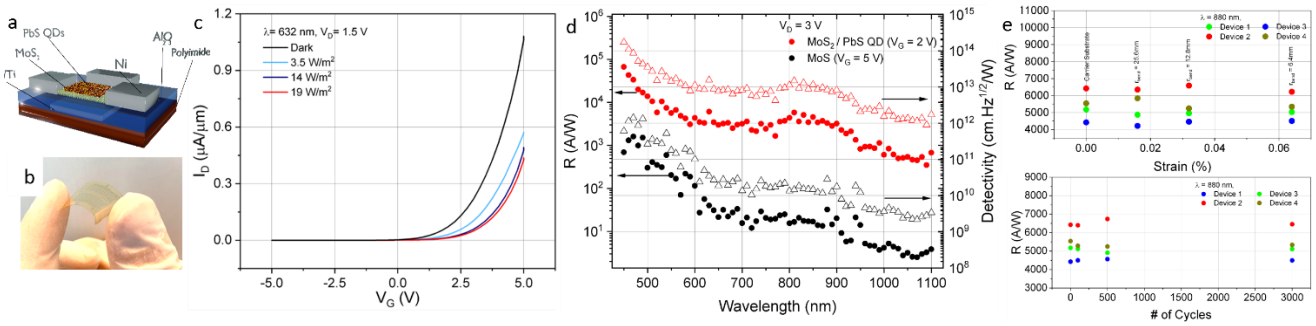

Figure 1: (a) Schematic representation of the MoS_2/PbS hybrid photodetector. (b) Photograph of a photodetector array. (c) Transfer curves in dark and under various illumination intensity. (d) Responsivity and specific detectivity measurements for MoS_2-only and MoS_2/PbS hybrid device. (e) Responsivity measurements under bending and after bending up to 3000 bending cycles.

Acknowledgements: Authors would like to acknowledge the contributions from the European Union's Horizon 2020 program under the grant agreements, MISEL (101016734), and 2Exciting (956813), the EU projects ATTOSWITCH (101135571) and 2D-PL (101189797).