New frontiers in 2D photodetectors

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Atomically thin materials such as graphene and transition metal dichalcogenides are uniquely responsive to charge transfer from adjacent systems, making them ideal charge transport and sensing layers in phototransistor devices. For example, the combination of graphene with atomically thin semiconductors in heterostructure photodetectors, has enabled amplified detection of femtowatt light signals using micron-scale electronic devices. At the same time, the effective implementation of organic semiconductors as a photoactive layer in a hybrid graphene device would open up a multitude of applications in biomimetic circuitry and ultra-broadband imaging but polycrystalline and amorphous thin films have shown inferior performance compared to inorganic semiconductors. In this talk I will review recent progress on atomically thin hybrid photodetectors with detectivities approaching that of single photon counters in ambient conditions [1,2] and an extraordinary linear dynamic range [3]. Finally, I will present a newly discovered inverse charge funneling mechanism for the efficient extraction of photo-excited carriers in planar atomically thin photodetectors based on strain engineered built-in electric fields [4], see Figure 1.

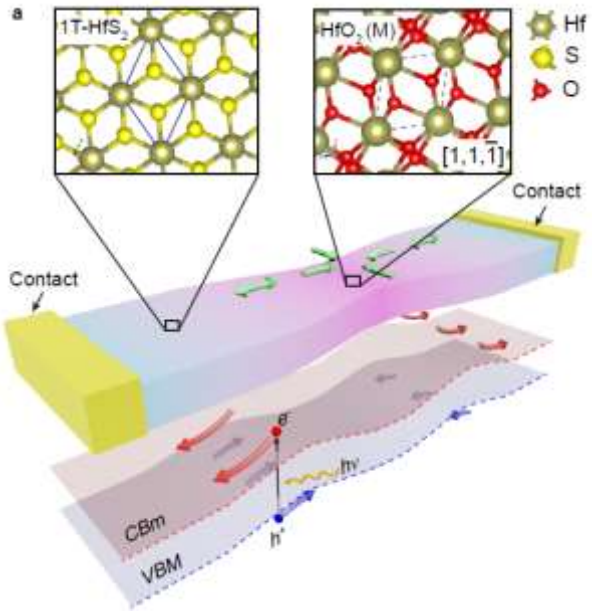

Figure 1. Schematic representation of the inverse charge funneling occurring in strained HfS2 by laser induced oxidation. The photogenerated charges are driven away from the spot where they have been excited due to a strain-induced built in electric field [4].

References

[1] Advanced Materials 29, 1702993 (2017)
[2] Advanced Materials 20, 1700222 (2017)
[3] Science Advances 3, e1602617 (2017)
[4] Nature Communications 9, 1652 (2018)

Figures