

## High photoresponsivity in vertically stacked MoS<sub>2</sub> photodevices

Semiconductor two-dimensional (2D) materials are an emerging class of materials with a wide range of electrical and optical properties. Molybdenum disulfide (MoS<sub>2</sub>) is one of the most studied 2D materials because of its unique quantum confinement.

Vertical photodevices are prepared using a physical vapor deposition method to fabricate the gold (Au) substrate. MoS<sub>2</sub> nanosheets are produced by mechanical exfoliation using a polydimethylsiloxane (PDMS) viscoelastic stamps and are transferred onto the Au substrate by an all-dry deterministic method<sup>[1]</sup>. The photodevice is completed by evaporating 8 μm Au disks over the MoS<sub>2</sub> nanosheets as seen in Figure 1. The photodevices are illuminated using a white supercontinuum laser source and a single grating Czerny-Turner monochromator is used to select the excitation wavelengths.

*I-V* characteristics are measured using an asynchronous set-up and allow us to determine either dark *IV* or illuminated *IV*. Our metal-semiconductor-metal (MSM) photodevice can be modeled as two metal-semiconductor diodes connected back to back<sup>[2]</sup>. Experimental *IV* characteristics are fitted to the model demonstrating a very good agreement. Schottky barriers and ideality factors are extracted from the fitted data and are consistent with the literature<sup>[3]</sup>.

Figures of merit of spectral photoresponsivity and spectral external quantum efficiency at different voltages are extracted from the *IV* characteristics as seen in Figure 2. Two peaks at 1.86 and 2.05 eV are observed and are related to the bound excitons A and B.

High photoresponsivity and external quantum efficiency are obtained in vertical photodevices opening a new path to explore this vertical photodevices.

### References

- [1] Castellanos-Gomez, A. et al. *2D Materials* **1**, 011002 (2014).
- [2] Bao, H. et al. *Small* **4**, 1125-1129 (2008).
- [3] Quereda et al. *2D Materials* **4**, 021006 (2017).

### Figures

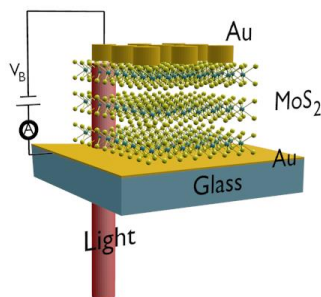


Figure 1: Schematic illustrating the experimental set-up.

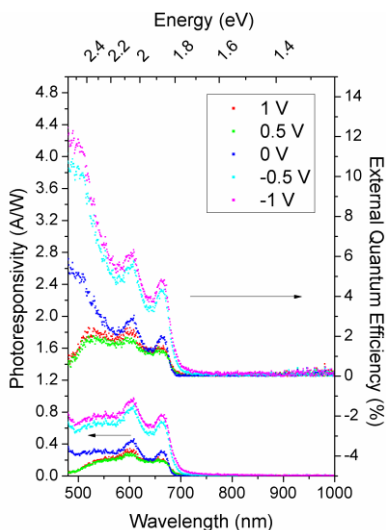


Figure 2: Photoresponsivity and External Quantum Efficiency of the vertical MoS<sub>2</sub> photodevices.