Supporting Information for "Two-dimensional Platinum Diselenide Waveguide-Integrated Infrared Photodetectors"

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Thickness measurements of $PtSe_2$ films

Thicknesses of all $PtSe_2$ films were measured by atomic force microscopy (AFM) and they are shown in Fig. S1.

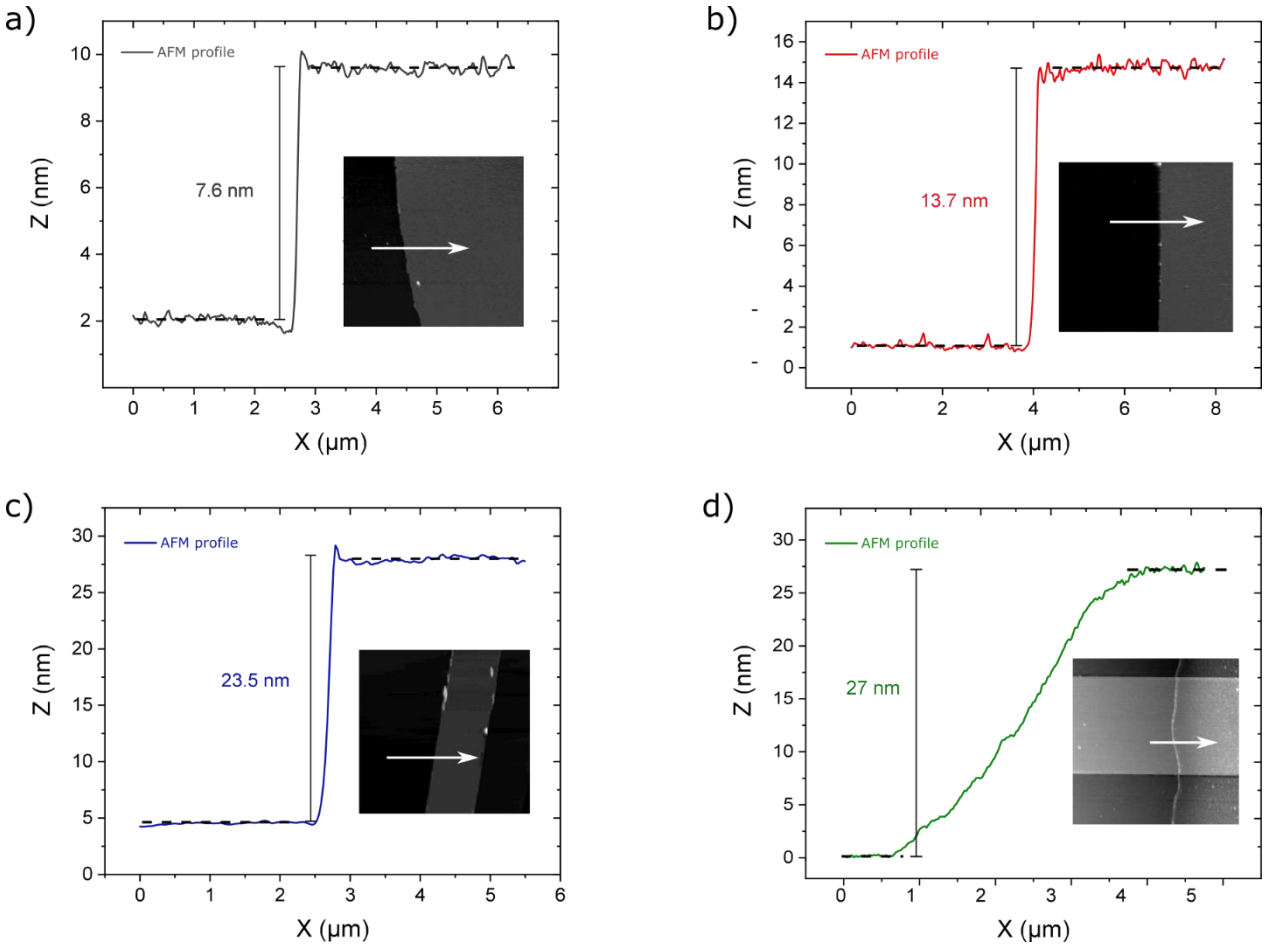

Figure S1. AFM Height measurements and corresponding AFM images of the $PtSe_2$ films.

Opto-electrical measurement set up

To measure the photoresponse of the photodetectors we have used a manual set-up shown schematically in Fig. S2. Laser light of a diode laser at 1550 nm wavelength were modulated at 1 kHz frequency using an electro-optic modulator (Thorlabs LN81S-FC) and guided above the grating couplers of the samples using a single-mode fiber. Photovoltages of the photodetectors were measured using a lock-in amplifier (Zurich Instrument MFLI). The bias voltages were applied to the detectors using a source meter (Keithley 2400). Photocurrents were calculated by dividing the photovoltages of the detectors by the total resistance of them.

All measured photodetectors have the same dimensions, 50 µm wide along the waveguide and 13 µm long perpendicular to the waveguide.

For time resolved measurements, the output of the photodetectors was connected directly to an oscilloscope (Zurich Instrument MFLI).

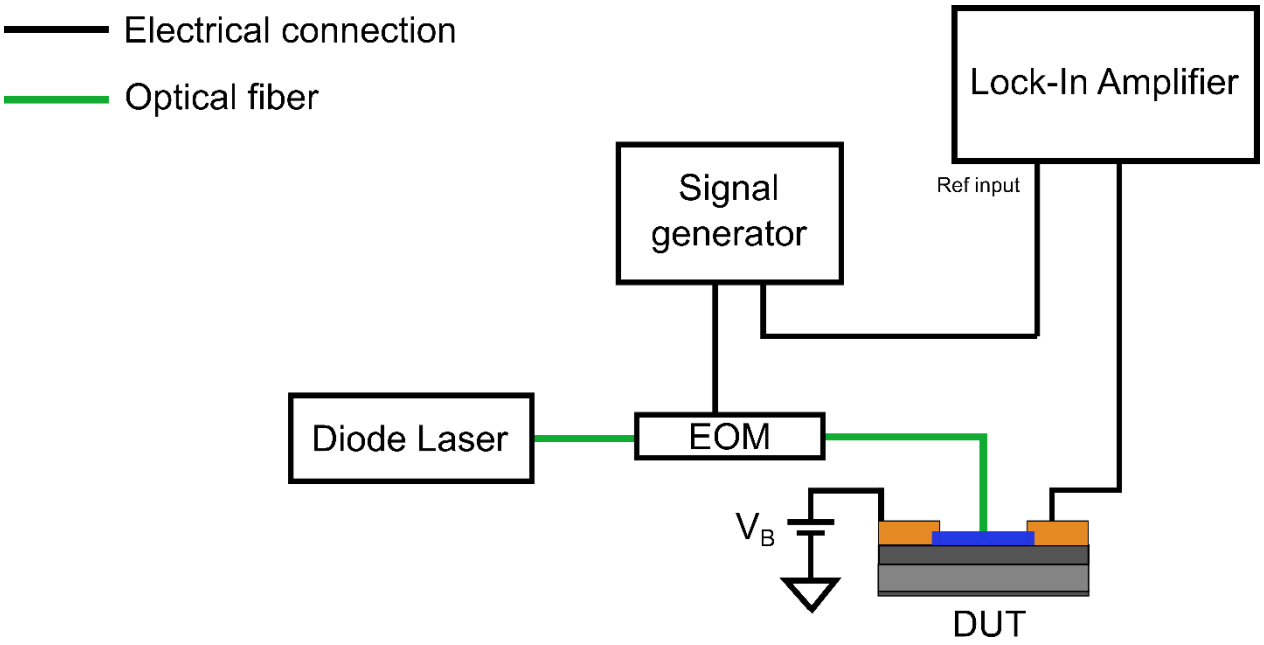

Figure S2. Schematic diagram of opto-electrical measurements set up.

IV-Curve of $PtSe_2$ devices

I_{ds}-V_{ds} measurements have been carried out on all multilayer $PtSe_2$ devices. The IV diagrams exhibit almost linear characteristics for drain voltages ranging from -100 mV to 100 mV (Fig. 2b). This indicates near-ohmic contacts between the films and the Ni/Al electrodes. When the drain voltages are increased, deviations from the linear behavior can be observed more clearly which indicate the existence of Schottky barriers at the interfaces. The reason for the presence of Schottky barriers at the interfaces may be due to a mix of semi-metallic and semiconducting crystallites and is subject to further studies.[1,2]

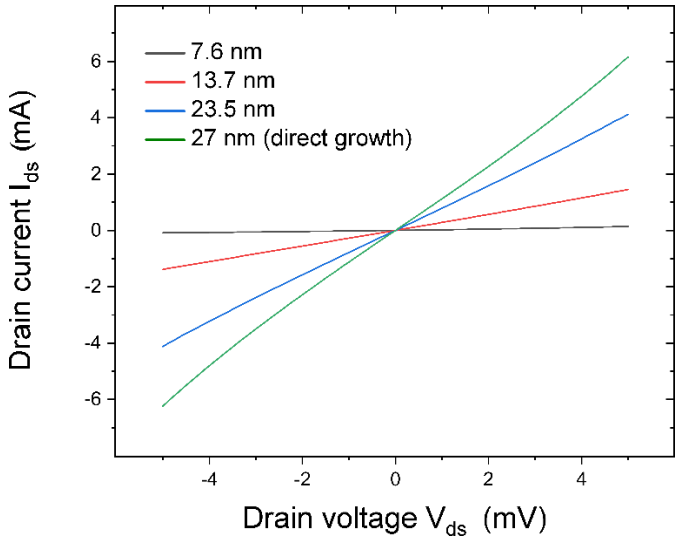

Figure S3. Drain current (I_{ds}) as a function of drain-source voltage (V_{ds}) for voltages ranging from -5 V to 5 V for all $PtSe_2$ devices.

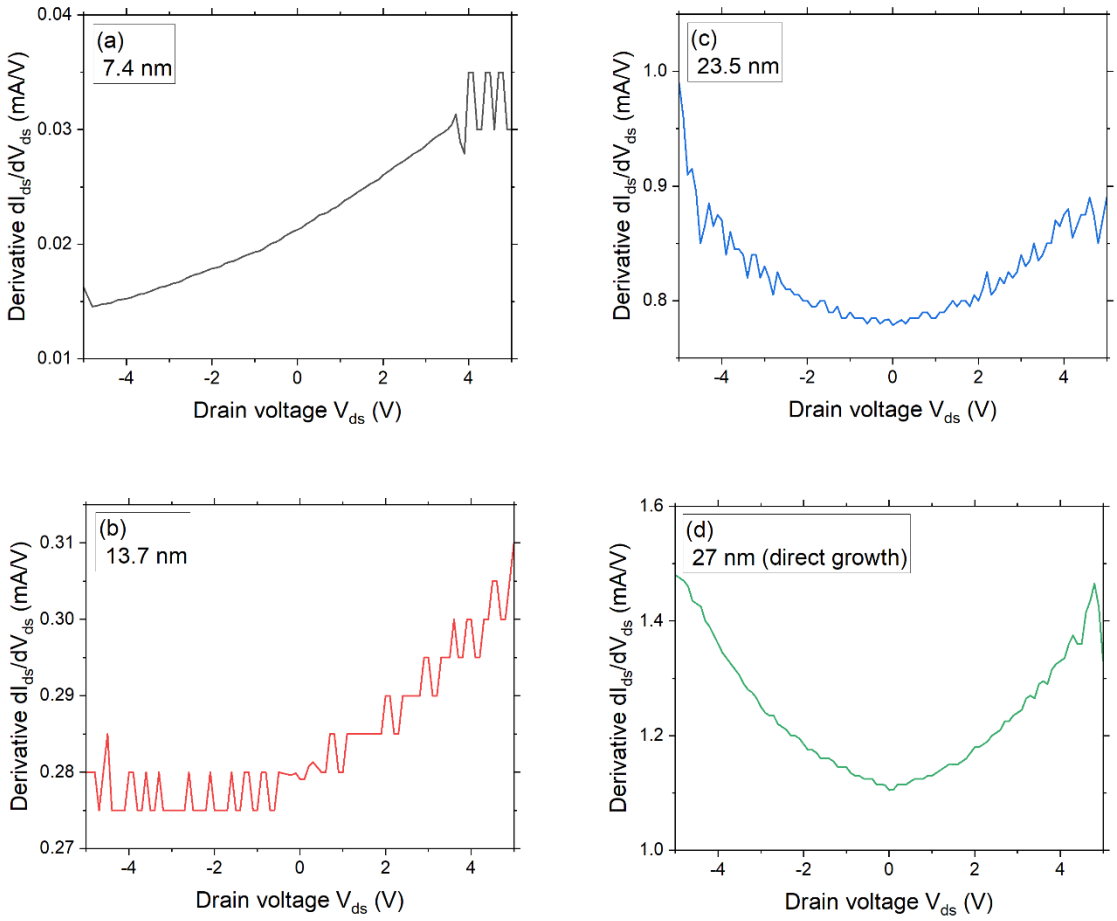

Figure S4. Derivatives of the drain current (I_{ds}) as a function of drain-source voltage (V_{ds}) for voltages ranging from -5 V to 5 V for all $PtSe_2$ devices revealing the non-linearity in the IV curves.

References

(1) Xie, J.; Zhang, D.; Yan, X.-Q.; Ren, M.; Zhao, X.; Liu, F.; Sun, R.; Li, X.; Li, Z.; Chen, S.; Liu, Z.-B.; Tian, J.-G. Optical Properties of Chemical Vapor Deposition-Grown PtSe2 Characterized by Spectroscopic Ellipsometry. *2D Mater.* **2019**, *6* (3), 035011. https://doi.org/10.1088/2053-1583/ab1490.

(2) Ansari, L.; Monaghan, S.; McEvoy, N.; Coileáin, C. Ó.; Cullen, C. P.; Lin, J.; Siris, R.; Stimpel-Lindner, T.; Burke, K. F.; Mirabelli, G.; Duffy, R.; Caruso, E.; Nagle, R. E.; Duesberg, G. S.; Hurley, P. K.; Gity, F. Quantum Confinement-Induced Semimetal-to-Semiconductor Evolution in Large-Area Ultra-Thin PtSe 2 Films Grown at 400 °C. *npj 2D Mater Appl* **2019**, *3* (1), 1–8. https://doi.org/10.1038/s41699-019-0116-4.