Supporting Information

Ultra-High Speed Vertically Illuminated Self-Driven Lateral Asymmetric InSe Photodetector

Srinivasa Reddy Tamalampudi[1,*], Ghada Dushaq[1], Mahmoud S. Rasras[1,*]

[1]*Department of Electrical Engineering, New York University Abu Dhabi, UAE*

SRT and GD are equally first authors

* st4212@nyu.edu, mr5098@nyu.edu

S1 XRD measurement of β-InSe

To determine the phase of the grown InSe single crystal, the crystal was ground into powder, and its XRD spectrum was measured. The measured spectrum peaks were compared with the JCPDS XRD database, showing that nearly all the peaks matched the β-InSe phase spectrum.

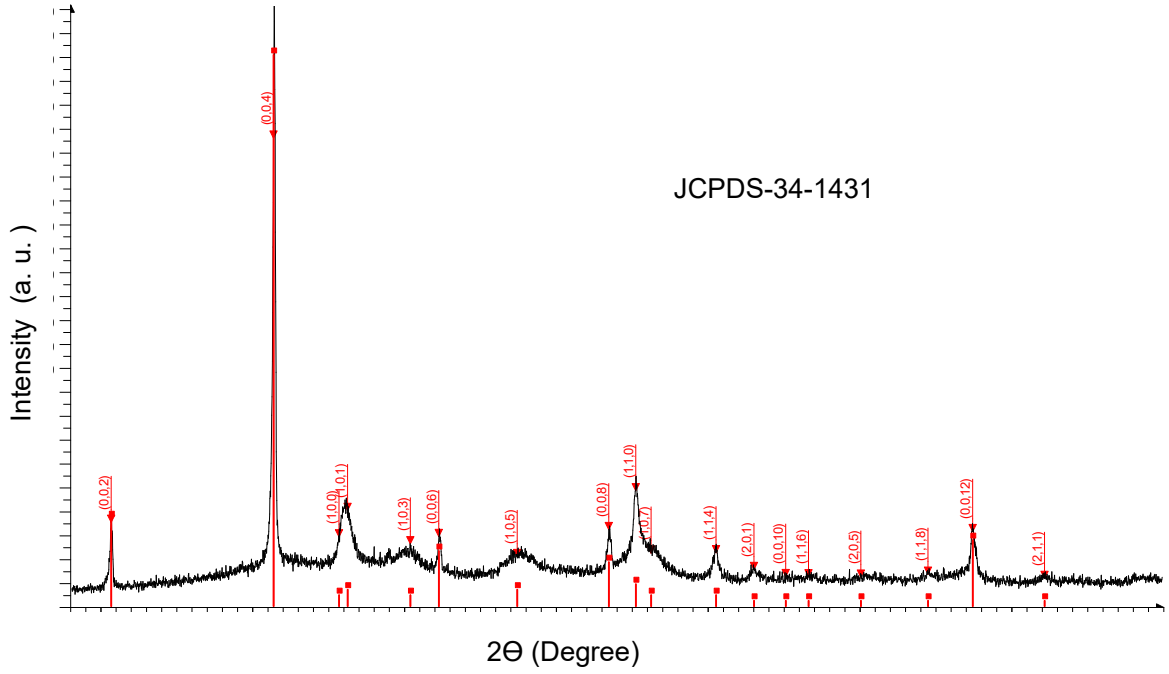

Figure S1: XRD spectrum of the β-InSe

S2 Electrical characteristics of symmetric InSe photodetector

For comparison, we also fabricated a symmetric contact photodetector using aluminum electrodes on both sides. The measured output characteristics exhibited nonlinear behavior, with no rectifying diode-like characteristics observed. The dark current was measured to be 1.8 pA at 0 V.

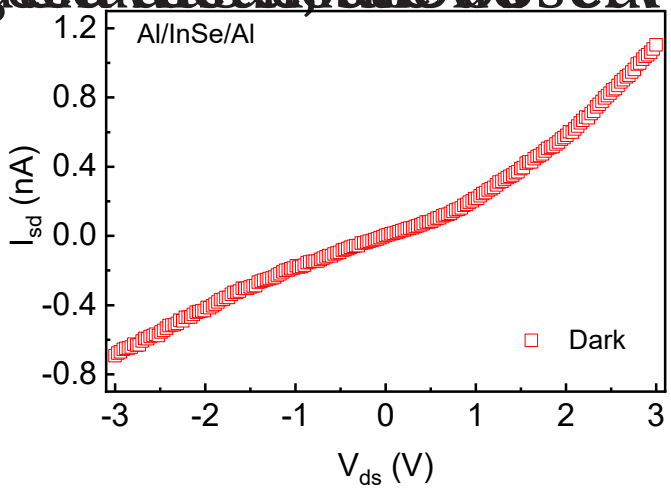

Figure S2: I-V characteristic of Al-InSe-Al device.

S3. Time domain response of the asymmetric Au-InSe-Gr photodetector at a bias voltage of 0V

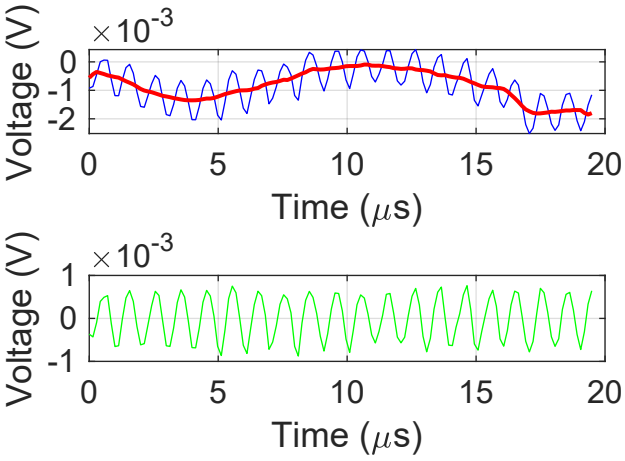

Figure S3: (a) The temporal response recorded in the time domain for 1 MHz modulated optical signals. (b) the response after subtracting the back ground.

S4 3-dB cut off frequency of Al-InSe-Al Photodetector

To further evaluate the speed of the Al-InSe-Al device, its 3-dB cutoff frequency was measured. The results clearly showed that the device did not exhibit any frequency response within the voltage range of -2 V to 0 V. This indicates that the device lacks self-biased photodetector characteristics, likely due to the presence of symmetrical contacts. Further, it was clear the measured speed of the Al-InSe-Al photodetector is lower than the Au-InSe-Gr photodetector.

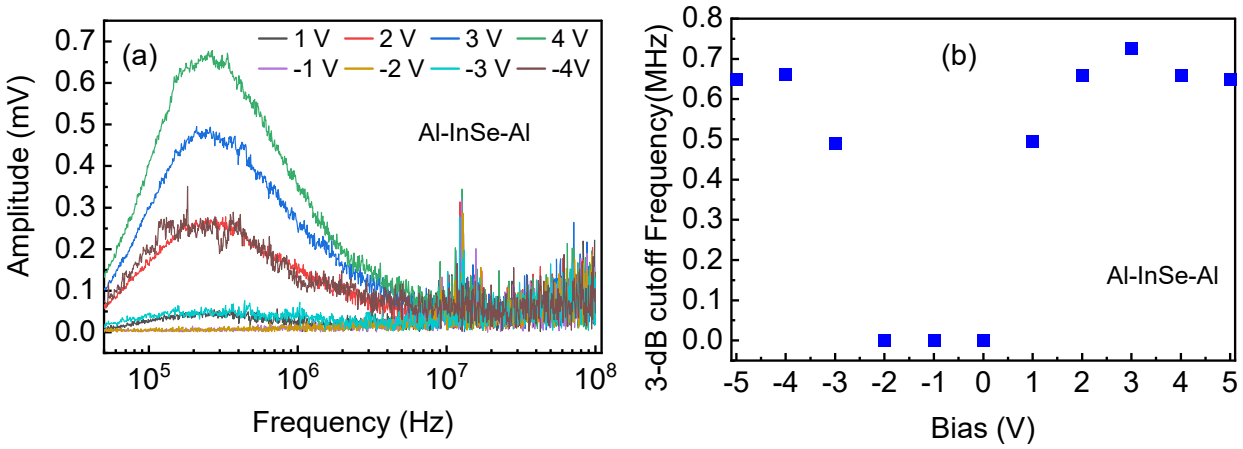

Figure S4: f_{3dB} of Al-InSe-Al Photodetector

S5 Shot noise and thermal noise of a Au-InSe-Gr photodetector

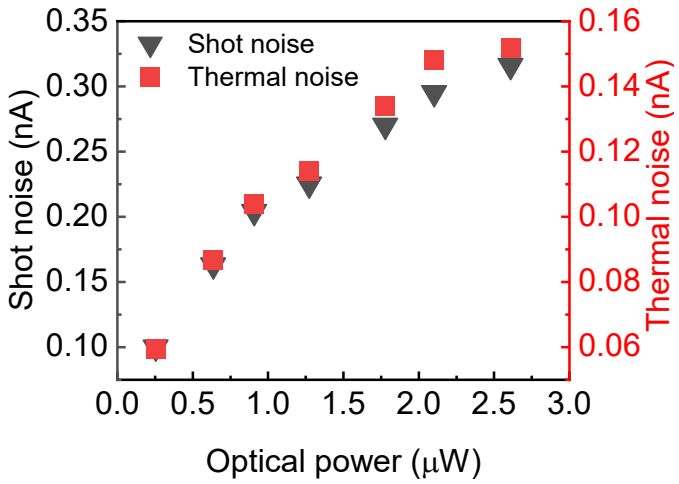

Figure S5**:** (a) Calculated shot noise (black triangles) and thermal noise (red squares) as a function of illuminated optical power.

S6 On/Off Stability of Au-InSe-Gr devices

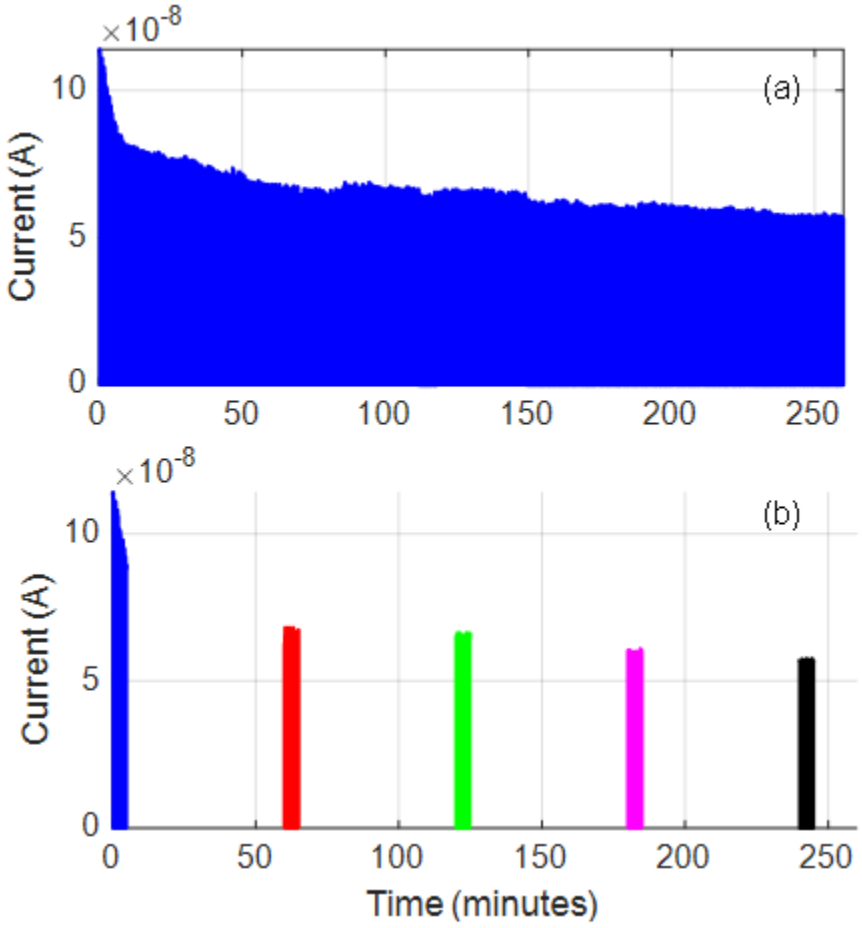

Figure S6: (a) Photoswitching response of the device at V_{ds} = 0 V under periodic light illumination. (b) For better visualization, the transient response is shown for 5 minutes at every 1-hour interval.