Supporting Information

Mixed-dimensional 1D Se-2D InSe van der Waals heterojunction for high responsivity self-powered photodetectors

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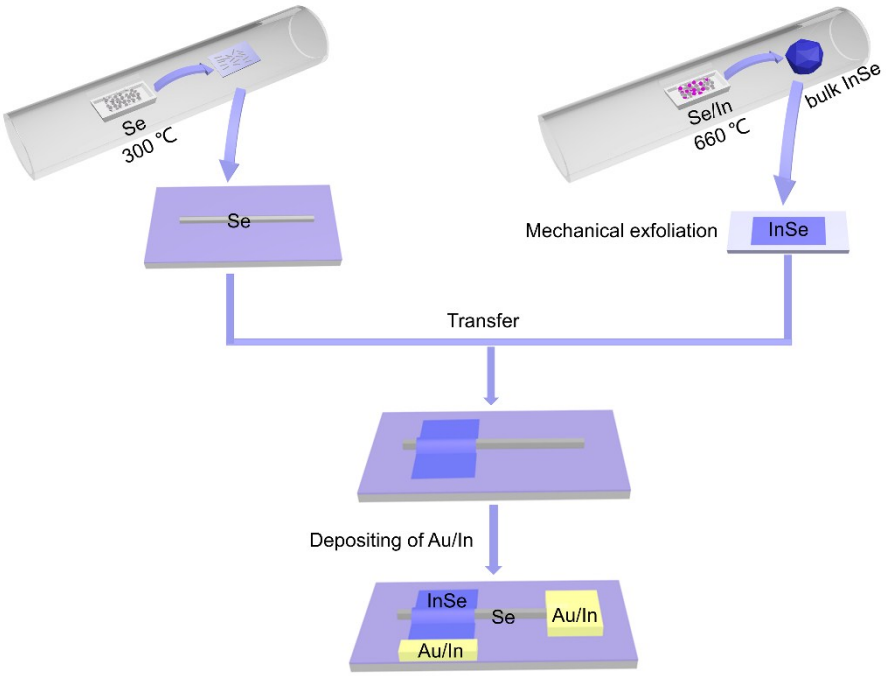

Figure S1 The fabricating process of the mixed-dimensional 1D Se-2D InSe self-powered photodetector.

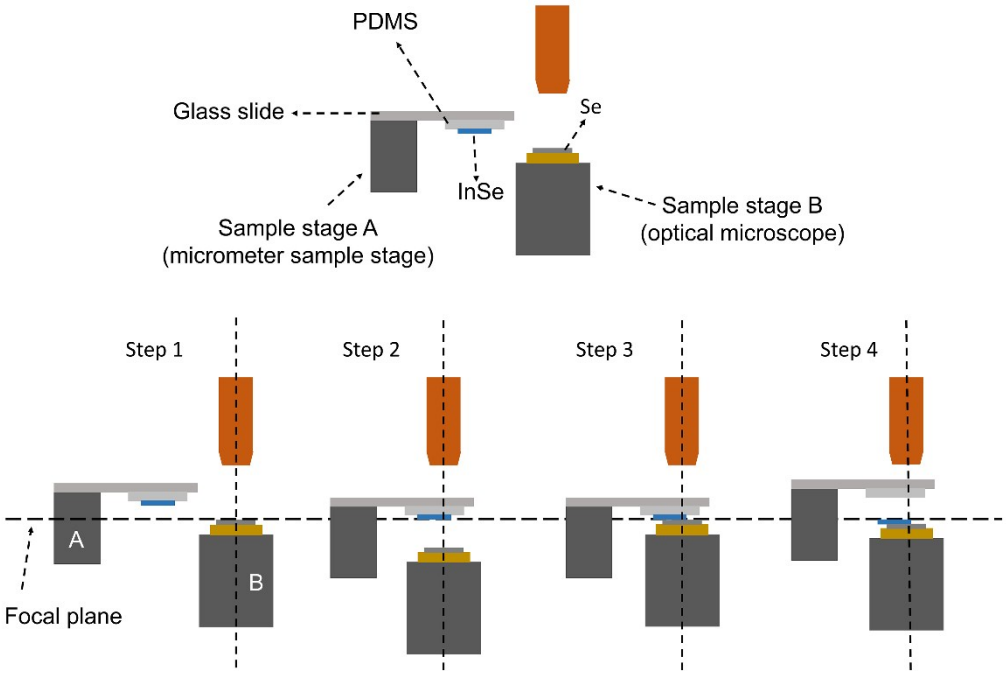

Figure S2 The schematic diagram of target-transfer process

The device is fabricated with a home-made target-transfer micromanipulation. It consists of an optical microscope with a long-working-distance lens and a three axis (x, y, z) micrometer

sample stage. Step 1: The Se nanotube is prepared in the SiO_2/Si substrate, and the position of Se is determined by the optical microscope. Next, the sample stage B is moved downward (z-) away from focal plane and the x y direction is fixed. Step 2: the InSe nanosheet is prepared in the PDMS film using mechanical exfoliation, and they are fixed on the sample stage A. Determine the position of InSe nanosheet by adjusting the x, y, z direction, ensuring the Se and InSe are in the same direction of the z axis. Step 3: Slowly moving up the z axis (sample stage B), when Se nanotube is near the focal plane, the Se and InSe can be observed from the microscope at the same time. With minor adjustment x, y, z axis of sample stage A to ensure InSe nanosheet in proper position, and then the InSe nanosheet is pressed against the Se nanotube surface for several minutes. Step 4: Slowly moving up the z axis (sample stage A), and the InSe nanosheet will be released from PDMS suface. In this way the mixed-dimensional p-Se/n-InSe heterojunction is fabricated.

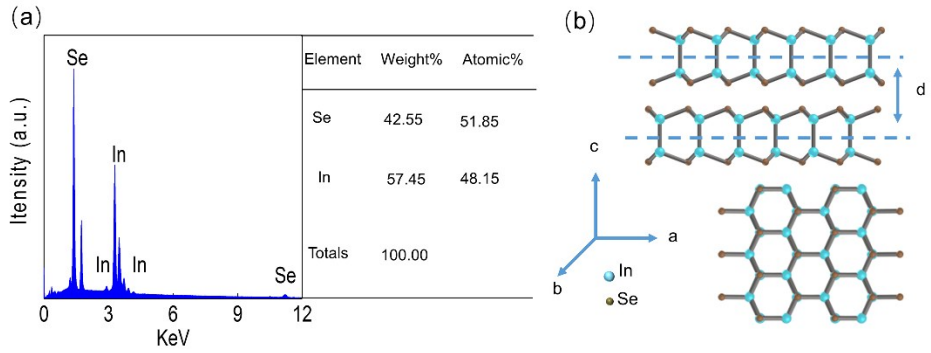

Figure S3 (a) EDS spectrum of the as-prepared InSe crystal. (b) The atomic structure of InSe.

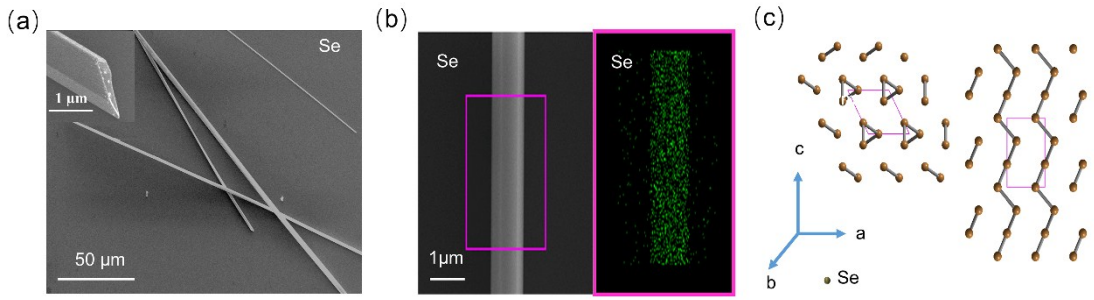

Figure S4. (a-b) SEM image of the Se and EDX mapping of Se elements. (c) The atomic structure of Se.

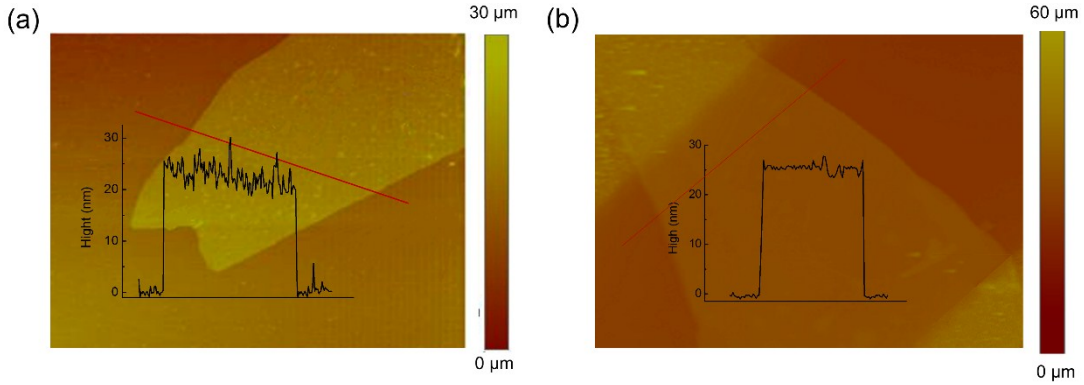

Figure S5 (a) The AFM image of exfoliated InSe nanoflake in the Se/InSe heterojunction (b) The AFM image of exfoliated InSe nanoflake in the InSe photodetector.

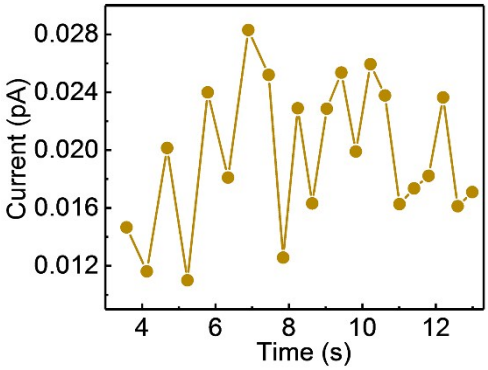

Figure S6 Time-dependent photocurrent of the InSe/Se photodetector under dark condition at zero bias.

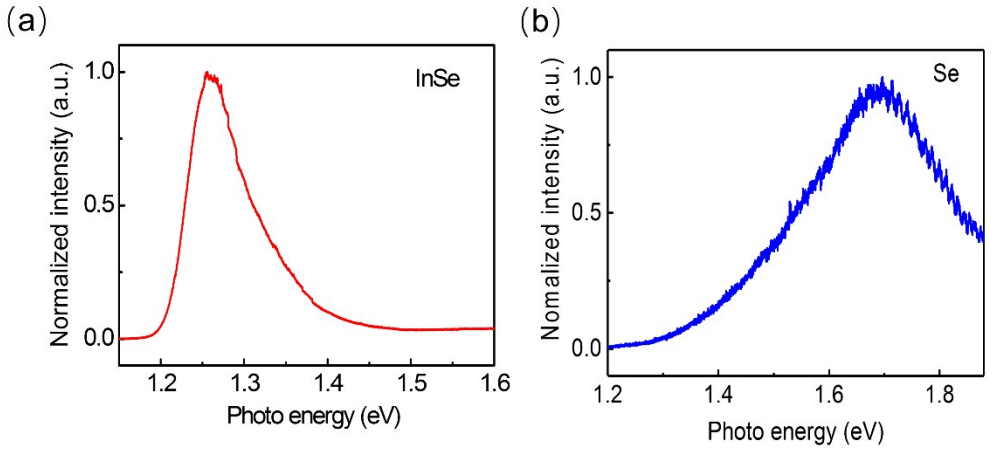

Figure S7 (a-b) The photoluminescence spectra for the pure InSe nanosheet and Se nanotube.

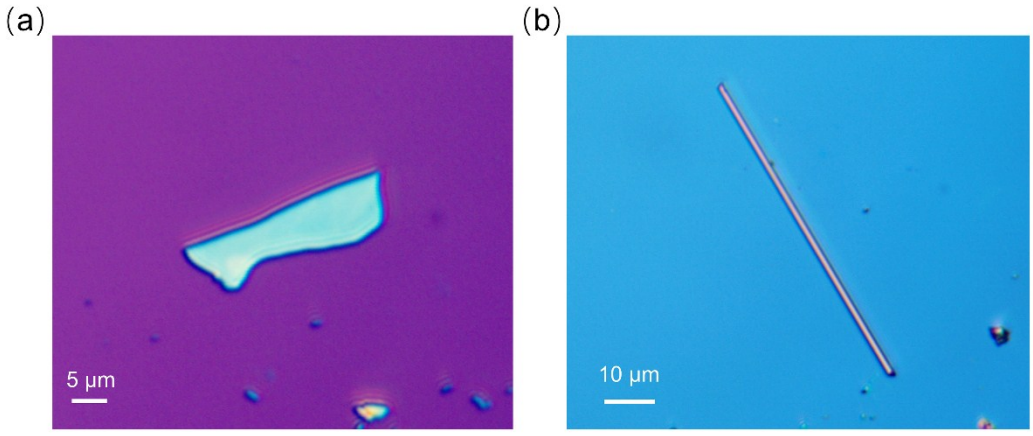

Figure S8. (a) The optical image of the exfoliated InSe nanoflake. (b) The optical image of the Se nanotube.

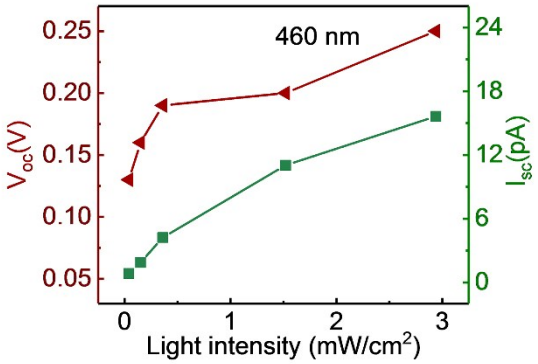

Figure S9 The open-circuit voltage and short-circuit current as a function of the different light intensity under 460 nm light illumination.