Epitaxial growth of two-dimensional SnSe$_2$/MoS$_2$ misfit heterostructures

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Figure S1 Schematic illustration of the CVD system for the growth of (a) Monolayer MoS$_2$ triangular sheets and (b) SnSe$_2$/MoS$_2$ heterostructures.
Figure S2 (a) Optical microscope image of the SnSe$_2$/MoS$_2$ heterojunctions. (b, c) Enlarged view of SEM images (SEI mode) of the area indicated by white rectangle and black rectangle, respectively. We can see the layer-by-layer stacking structures in the SEM images (SEI mode).
Figure S3 (a) Optical microscope image of monolayer MoS$_2$ on SiO$_2$/Si. (b) Optical microscope image of SnSe$_2$/MoS$_2$ bilayers on the substrate. The SnSe$_2$ monolayers were grown on MoS$_2$ via the van der Waals epitaxial growth process. (c) Atomic force microscope image of the region indicated by rectangle in (b), confirming monolayer SnSe$_2$ on monolayer MoS$_2$. (d) A typical raman spectroscopy of the SnSe$_2$/MoS$_2$ heterojunctions.
Figure S4 Optical microscope images of the SnSe$_2$/MoS$_2$ heterojunctions obtained at the relative high- (a) and low- (b) temperature zone. (c) Raman spectra collected from the different positions in (a) and (b). The ratio of peak intensity between A$_{1g}$ of SnSe$_2$ and E$_{12g}$ of MoS$_2$ indicates multilayer of the as-grown SnSe$_2$. The particles on SiO$_2$ in (b) is identified to be SnSe$_2$ by the Raman spectroscopy. (d) AFM image of a multilayer-SnSe$_2$/monolayer-MoS$_2$ heterojunction. The height profile shows thickness of 3.1 nm.

Figure S5 (a) An optical microscope image of a triangular MoS$_2$ monolayer covered partially with a SnSe$_2$ multilayer. Spatially resolved Raman maps for the intensity of A$_{1g}$ of SnSe$_2$ (b), A$_{1g}$ of MoS$_2$ (c), E$_{12g}$ of MoS$_2$ (d), and the peak position of E$_{12g}$ of MoS$_2$ (e), A$_{1g}$ of MoS$_2$ (f).
Figure S6 The photoluminescence spectrum collected from bare MoS$_2$ monolayer and its fitted curves. The emission bands at 1.84 and 1.96 eV correspond to A and B exciton recombination, respectively.