Electronic Supplementary Material (ESI) for RSC Advances.

Supporting Information

Modulation of opto-electronic properties of InSe thin layers via phase transformation

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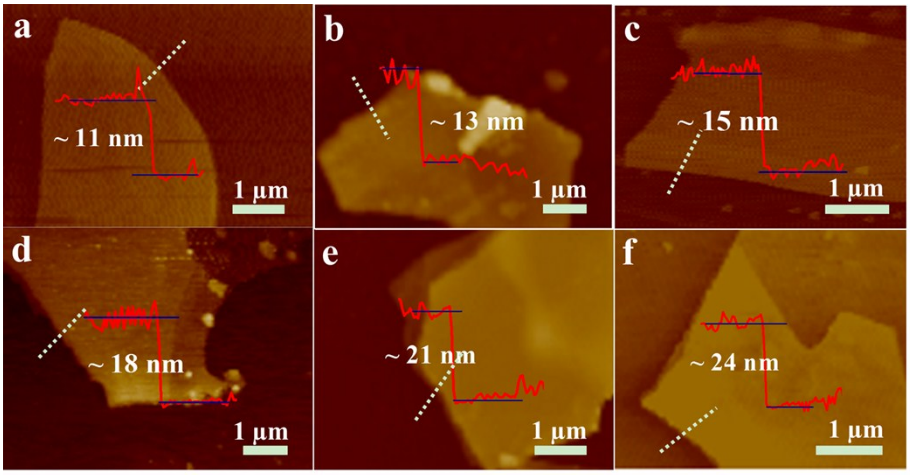

Figure S1. (a to f) AFM images of InSe nanosheets with different thickness of 11, 13, 15, 18, 21, and 24 nm. Insets are corresponding height profiles.

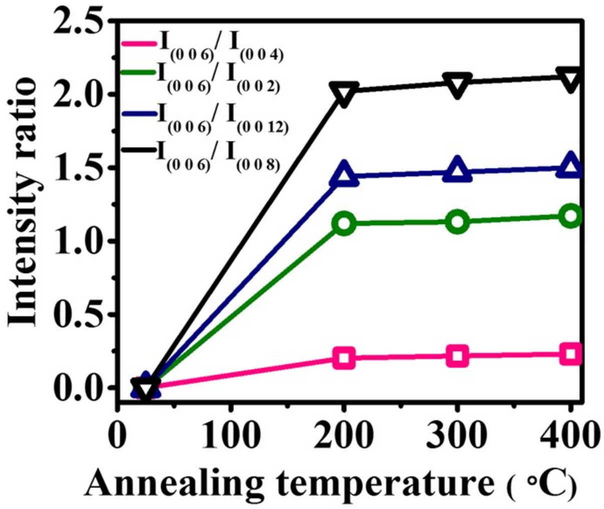

Figure S2. Intensity ratios of $I_{(0\ 0\ 6)}$ of γ- In_2Se_3 to the other peaks of β-InSe.

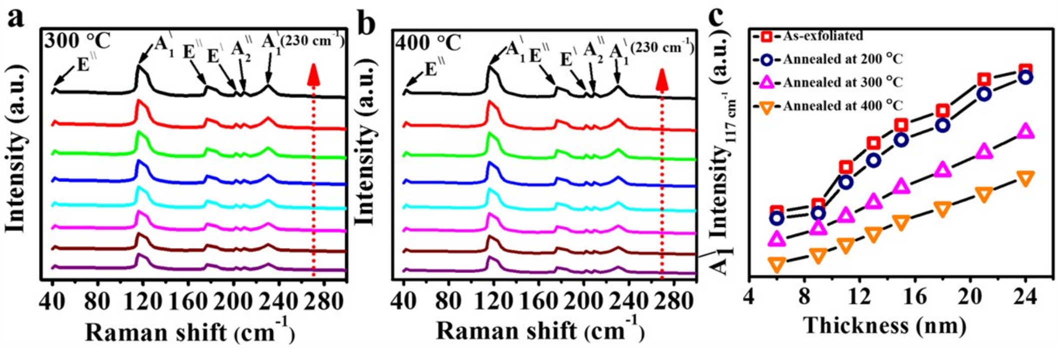

Figure S3. (a and b) Raman modes of annealed sheets at 300℃ and 400℃, respectively. The thickness from bottom to top as indicated by dotted arrows in both a and b are about 6, 9, 11, 13, 15, 18, 21, and 24 nm, respectively. (c) Intensity of $A^{\backslash}_{1}$ mode at 117 cm^{-1} as a function of thickness in as-exfoliated sheet and annealed sheets at 200, 300, and 400 ^{o}C.

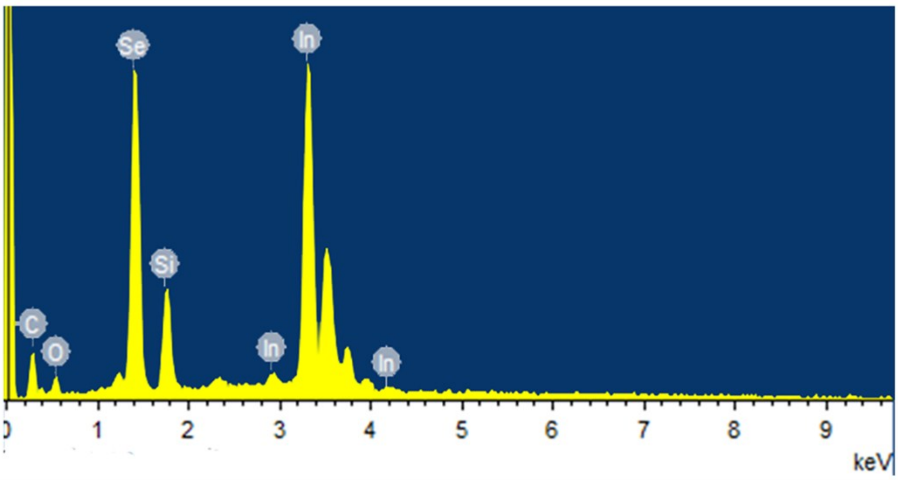

Figure S4. EDS spectrum of as-exfoliated InSe nanosheets.

Table S1. Element composition and In/Se ratio of as-exfoliated and annealed sheets.

Samples	Atomic percentage In (%)	Atomic percentage Se (%)	Atomic ratio of In/Se
As-exfoliated	52.4	47.6	1.10
Annealed at 200 °C	47.2	52.8	0.87
Annealed at 300 °C	45.9	54.1	0.84
Annealed at 400 °C	45.3	54.7	0.83

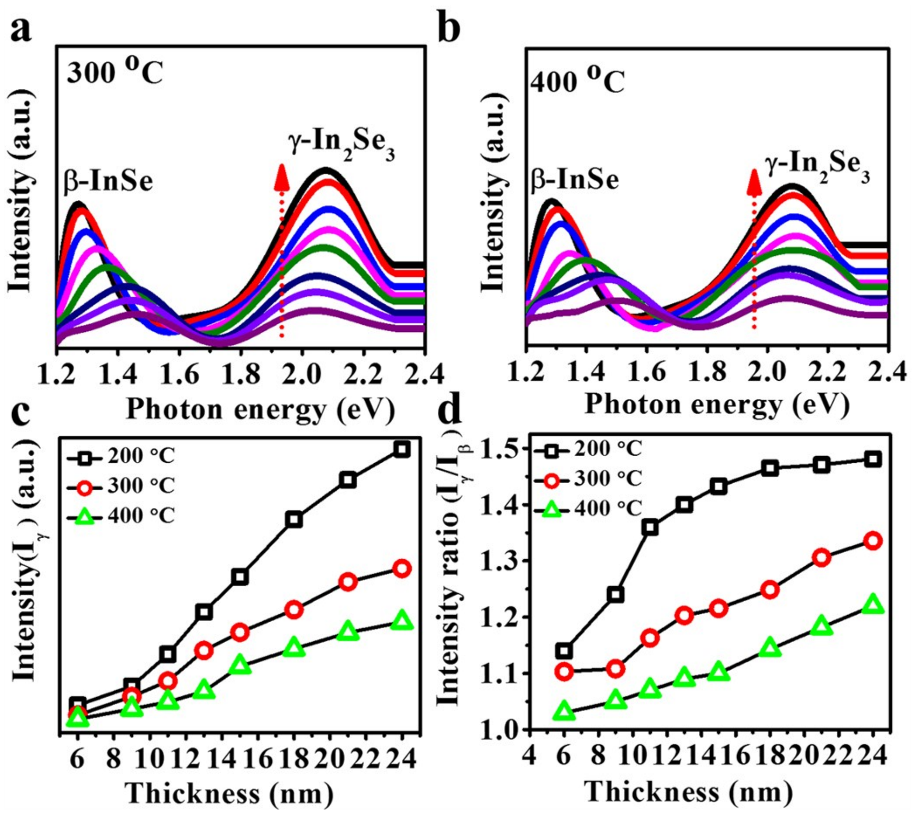

Figure S5. PL spectra of as-exfoliated InSe nanosheets and annealed sheets at 300 °C and 400 °C, respectively. The thickness from bottom to top as indicated by dotted arrows in both a and b are about 6, 9, 11, 13, 15, 18, 21, and 24 nm, respectively. (c) PL peak intensity of γ- In_2Se_3 as a function of thickness. (d) Intensity ratio of $\frac{I_\gamma}{I_\beta}$ versus thickness at different annealing temperatures.

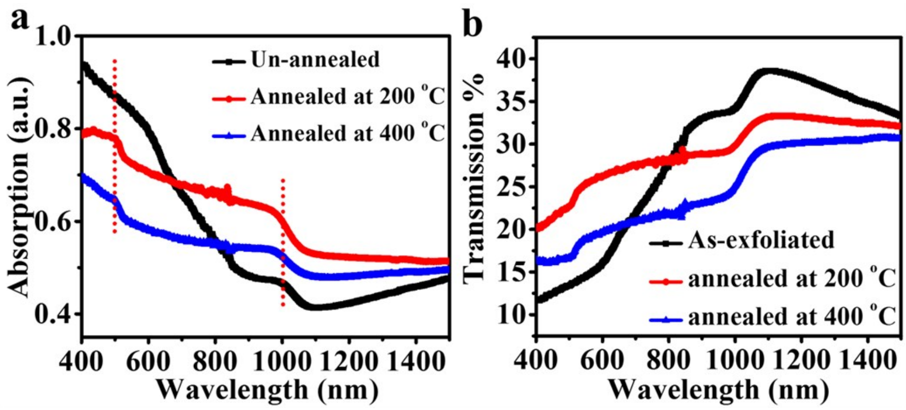

Figure S6. (a) Absorption and (b) transmission spectra of as-exfoliated InSe (black curve) and annealed samples at 200 (red curve) and 400 ^{o}C (blue curve), respectively. InSe is exfoliated on the surface of quartz substrate.

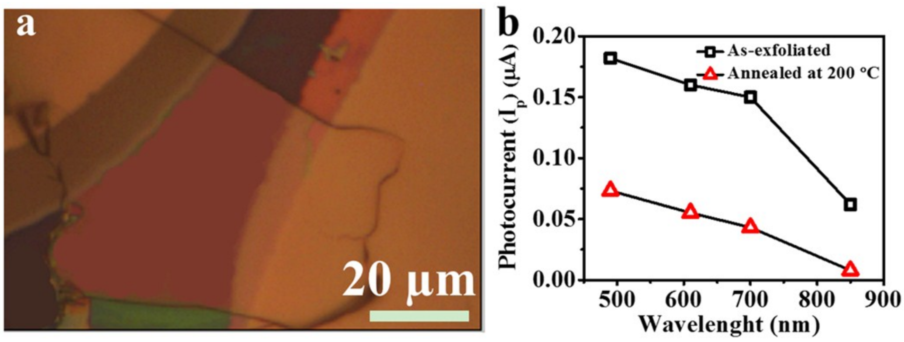

Figure S7. (a) Optical image of InSe photodetector. (b) Photocurrents of as-exfoliated and annealed devices as a function of wavelength.

Table S2. Photodetector parameters of as-exfoliated and annealed sheet.

Photodetector	On/off ratio	Carrier mobility (cm^2 v^{-1} s^{-1})	Photocurrent (μA)	Responsivity (A/W)	Detectivity (Jones)	Quantum efficiency (EQE) (W/A)
As-exfoliated InSe nanosheet	5.51×10^4	10.32	0.182	12.54×10^4	1.72×10^{15}	31.82×10^4
Annealed InSe nanosheet	7.42×10^3	2.37	0.0732	5.05×10^4	1.30×10^{15}	12.82×10^4