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Electronic Supplementary Information

# $CuInSe_2$ ultrathin nanoplatelets: novel self-sacrificial template-directed synthesis and application for flexible photodetectors

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## S1. Experimental section

### *Preparation of ultrathin $CuInSe_2$ nanoplatelets.*

In a typical synthesis, 40mg $Cu(Ac)_2 \cdot H_2O$ (0.2mmol), 60mg $InCl_3 \cdot 4H_2O$ (0.2mmol) and 5 mL oleylamine were added to a 50ml three-neck round bottom flask connected to a Schlenk line apparatus and purged with $N_2$ at 120℃ for 2h. Next, the reaction mixture was allowed to cool to room temperature, and 0.4 mmolar of Se suspended in 5 mL oleylamine was injected. The temperature was then slowly raised to 180℃, which typically took approximately 20min. After maintaining at this temperature for 14 h, the mixture was allowed to cool to room temperature, then ethanol was added to flocculate the nanoplatelets. The precipitate was washed with ethanol and cyclo-hexane for several times and dried under vacuum at 60 ℃ for further analysis.

### *Materials characterization.*

The samples were characterized by X-ray powder diffraction (XRD) by a Philips XQPert Pro Super diffractometer equipped with graphite-monochromatized Cu-Kα radiation (λ=1.54178 Å). Tapping-mode atomic force microscopy (AFM) images were obtained on DI Innova Multimode SPM platform. Transmission electron microscopy (TEM) images were taken on H-7650 (Hitachi, Japan) operated at an acceleration voltage of 100 kV. High-resolution transmission electron microscope (HRTEM) images were operated on JEOL-2010 at an acceleration voltage of 200 kV. UV-Vis-NIR absorption spectra was recorded on a Perkin Elmer Lambda 950 UV/Vis-NIR spectrophotometer. The Current-voltage (I-V) characteristics of the devices were recorded with a Zahner IM6 electrochemical workstation equipped with a power-tunable 455nm blue light source. The vacuum-filtration assembly of the as-synthesized $CuInSe_2$ nanoplatelets was carried out by a mixed cellulose esters membrane with a pore size of 0.22μm, while the film thickness can be readily tuned by changing the concentration of filtrated solution.

### *Fabrication of photoresponse devices.*

P3HT (15 mg) was dissolved in 1mL 1, 2-dichlorobenzene. 100 μL $CuInSe_2$ solution (15 mg/mL in cyclohexane) and 300μL P3HT solution were mixed to form the final ink. Flexible photoresponse devices were fabricated by drop-casting of such ink onto the pre-cleaned polyethylene terephthalate (PET)-Au electrodes at a rate of 500rpm and dried in air naturally.

## S2. Characterization of ultrathin $CuInSe_2$ nanoplateletlets

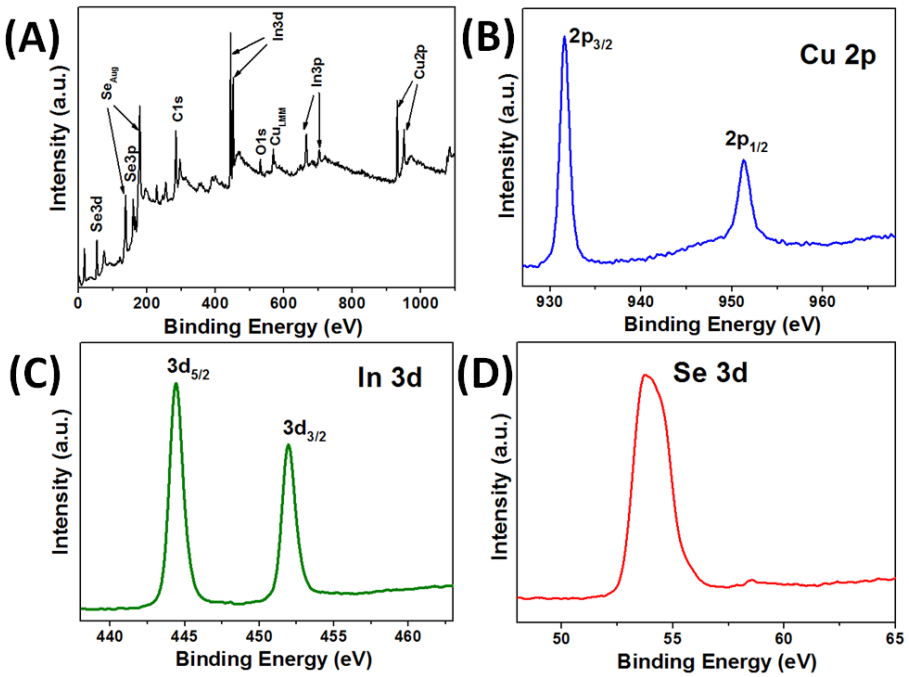


Fig S1. (A) XPS survey spectrum and high-resolution Cu 2p (B), In 3d (C), and Se 3d (D) core level regions. The copper HR-XPS spectrum shows two symmetric peaks at 931.6 and 951.7 eV, The peak splitting of 20.1 eV is in good agreement with the reported values for Cu(I). The Indium 3d peaks located at 444.4 and 451.9 eV are indicative of In(III). The Se 3d binding energy 54.05 eV is also consistent with that observed in chalcopyrite-type $CuInSe_2$.

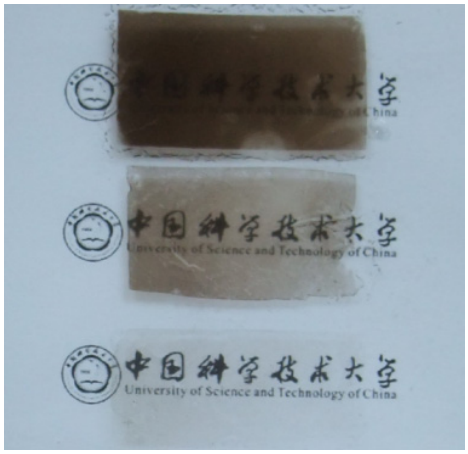

Fig S2. Demonstration of the thin films with different thickness transferred onto a quartz substrate.

## S3. Evolution process for the ultrathin $CuInSe_2$ nanoplatelets

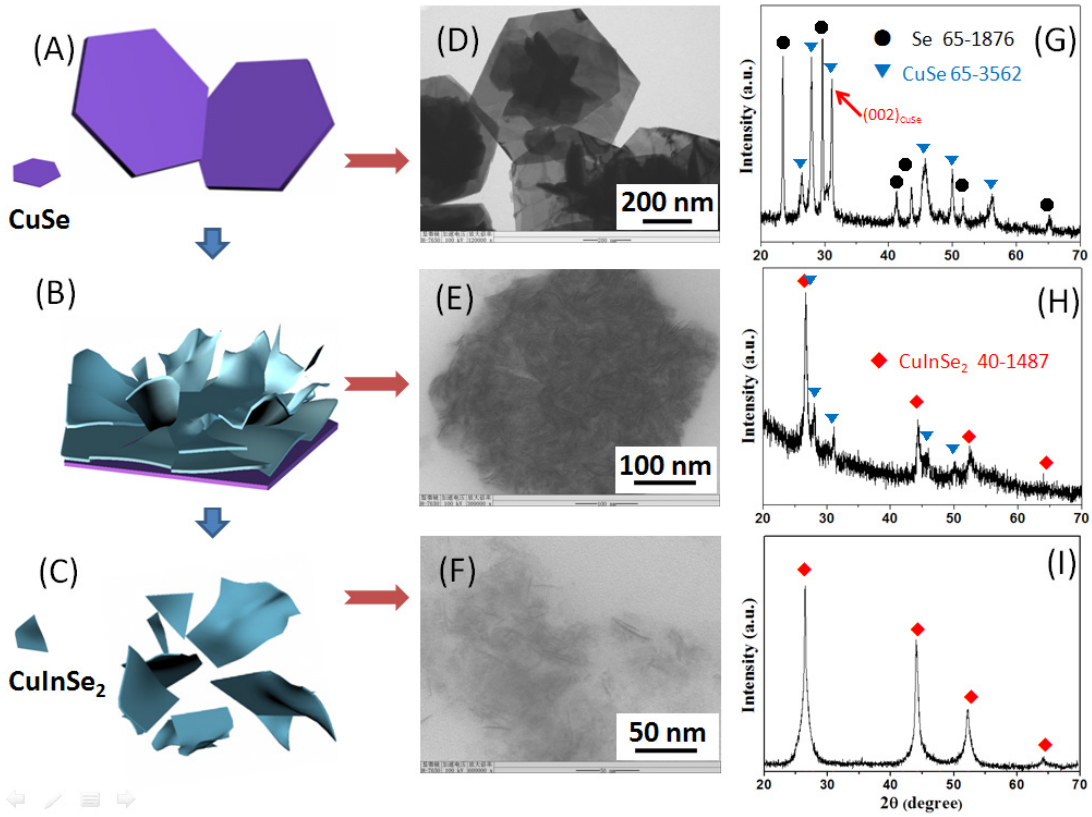


Fig S3. (A-C) Schematic illustration of the time-dependent morphology evolution process for the ultrathin nanoplatelets .(D-F) TEM images of the intermediate product with different reaction time, (D) 140℃ during the heating process, (E) 180℃ 2 h, (F) 180℃ 10 h, respectively. (G-I) The XRD patterns of the corresponding intermediates.

## S4. Characterization of hexagonal CuSe nanoplate

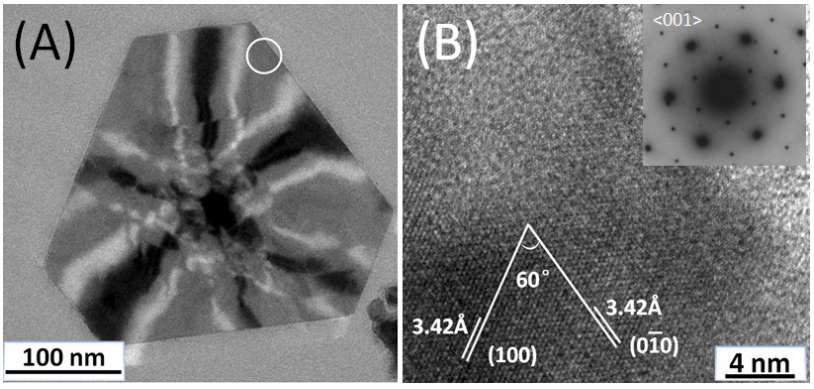


Fig S4 Morphological and structural characterization of hexagonal CuSe nanoplate. (A) Typical transmission electron microscopy (TEM) image at low magnification. (B) HRTEM image and SAED (inset) corresponding to the marked part in the TEM image.

Reference

(1) B. Li, Y. Xie, J.X. Huang and Y.T. Qian, *Adv. Mater*., 1999, **11**, 1456.