Supporting information

# Controlled synthesis of GaSe microbelts for high-gain photodetector induced by the electron trapping effect

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**Materials synthesis and characterization**

GaSe microstructures were synthesized in a horizontal tube furnace. High purity $Ga_2Se_3$ powder (Alfa, 99.99%) and appropriate amount of liquid metallic Ga (99.99%, Alfa) were placed on a quartz boat in the central region of a quartz tube. A piece of pre-cleaned $Si/SiO_2$ substrate was placed downstream, about 12 cm away from the central region to collect the products. The quartz tube was filled with high purity argon (Ar, 99.99%) at a flow rate of 50 sccm after evaluating. The pressure in the tube was kept at 330 Pa. Then the center of the furnace was heated to 960 $^{o}$C at a rate of 15 $^{o}$Cmin$^{-1}$ and then maintained at this temperature for 30 min. After reaction, the furnace was cooled down naturally to room temperature, and silver-gray samples were collected on the substrates.

The morphologies and structures of the as-synthesized GaSe microstructures were investigated using X-ray diffractometer (X'Pert PRO MPD) with Cu Kα radiation, field-emission scanning electron microscopy (FESEM, Philips XL 30 FEG), high-resolution transmission electron microscope (HRTEM, JEOL JEM-2010) equipped with X-ray energy dispersive spectrometer (EDS, Oxford INCA), and Raman spectroscopy (Jobin Yvon HR 800, HORIBA) with a 532nm laser as the excitation source, respectively. The absorption spectrum was recorded on a CARY 5000 UV–NIR spectrophotometer. X-ray photoelectron (XPS) spectra were given by a Thermo

ESCALAB250 X-ray photoelectron spectroscope with an Al Kα monochromatic source.

**Device Fabrication and Analysis**

To fabricate photodetectors, the as-synthesized GaSe nanobelts were firstly dispersed uniformly onto $SiO_2$ (300 nm)/p+Si substrates at a desired density. Then electron-beam evaporation was employed to define the Au (100 nm) electrodes on single microbelt with the help of a lab-made shadow mask. All related optoelectronic characterizations were carried out under ambient conditions at room temperature, using a semiconductor characterization system (Keithley 4200-SCS) equipped with a broadband monochromator (SP 2150, Princeton Co.). Laser diodes with the wavelengths of 450 nm (Thorlabs M450LP1), 530 nm (Thorlabs M530L4) and 660 nm (Thorlabs, M660L4) were used as light sources. The power intensity of all light sources was carefully calibrated using a power meter (Thorlabs GmbH., PM 100D) before measurement.

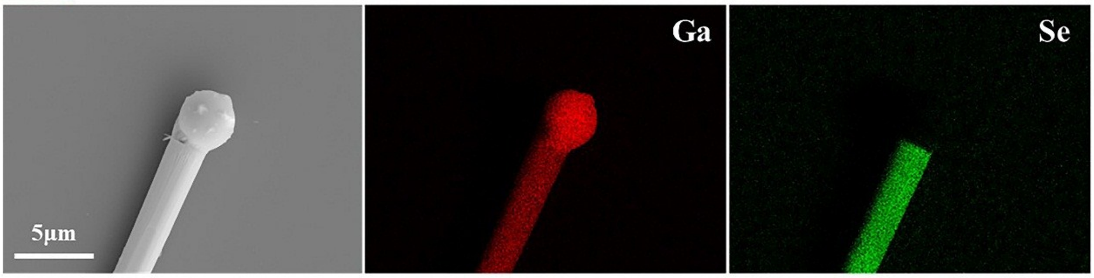


**Figure S1** FESEM image and the corresponding element mapping of a single GaSe microbelt with a spherical particle on the tip.

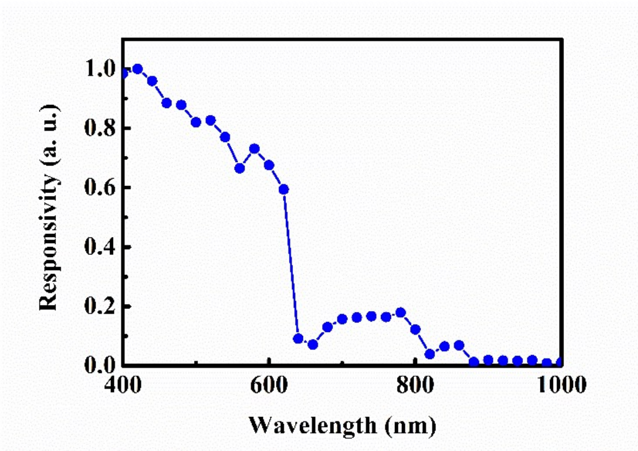


**Figure S2** Spectral response of the single GaSe microbelt-based photodetector in the range of 400-

1000 nm.

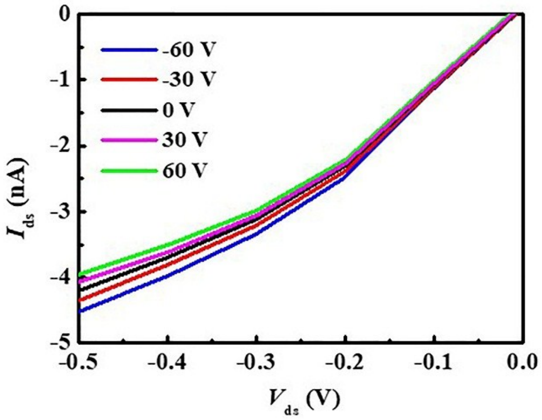


**Figure S3** Current-voltage (*I-V*) curves of an individual GaSe microbelt under different bottom-gate voltage. $I_{ds}$ decreases gradually with the increase of $V_{ds}$, showing the p-type electrical characteristic.

**Table 1** Comparison of key parameters between this work and other GaSe -based photodetectors.

| Photodetector | Preparation method | Measurement conditions | Light intensity | $R$ (AW$^{-1}$) | Ref |
|---|---|---|---|---|---|
| GaSe nanosheet | mechanical exfoliation | 520 nm@5 V | 0.06 mWcm$^{-2}$ | 2.2 | 1 |
| GaSe atomic layers | vapor phase transport | 405 nm @10 V | 50 mWcm$^{-2}$ | 0.017 | 2 |
| GaSe nanosheet | mechanical exfoliation | 410 nm @5 V | 0.01 mWcm$^{-2}$ | 5000 | 3 |
| 2D GaSe crystal | CVD | 532 nm@10 V | ~2.71 μWcm$^{-2}$ | 5 | 4 |
| GaSe nanoribbons | CVD | 350 nm@5 V | 0.02 μWcm$^{-2}$ | 31.1 | 5 |
| GaSe nanobelts | CVD | 520 nm@5 V | 0.067 mWcm$^{-2}$ | 164.4 | 6 |
| GaSe microbelt | CVD | 450nm@2 V | 9.47 μWcm$^{-2}$ | 3866 | This work |

**References**

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