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Supporting information

Single-crystalline GeS nanoribbons for high sensitivity visible-light photodetectors

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1. Synthesis and characterization of nanoribbons

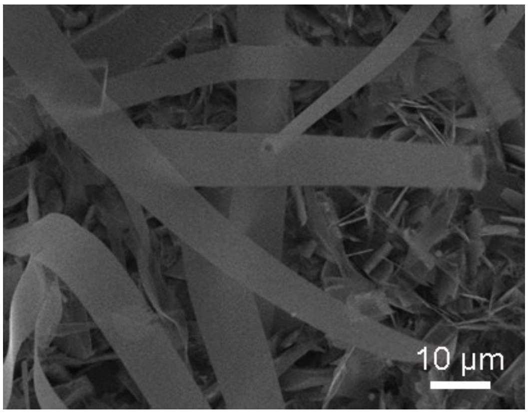

Figure S1. SEM image of the GeS nanoribbons grown on pre-coated GeS microparticles.

The Au film used in the synthesis can facilitate the nucleation of GeS nanoribbons. We found that nanoribbons can also be grown on a substrate pre-coated with GeS microparticles as shown in figure S1 under the similar growth conditions. The yield of nanoribbon grown on Au film is higher but the width of the nanoribbon is narrower than that grown on substrate pre-coated with GeS microparticles. The morphologies of nanoribbons grown on these two kinds of substrate are

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quite similar except that the nanoribbons grown on the substrate coated with GeS microparticle show wider width.

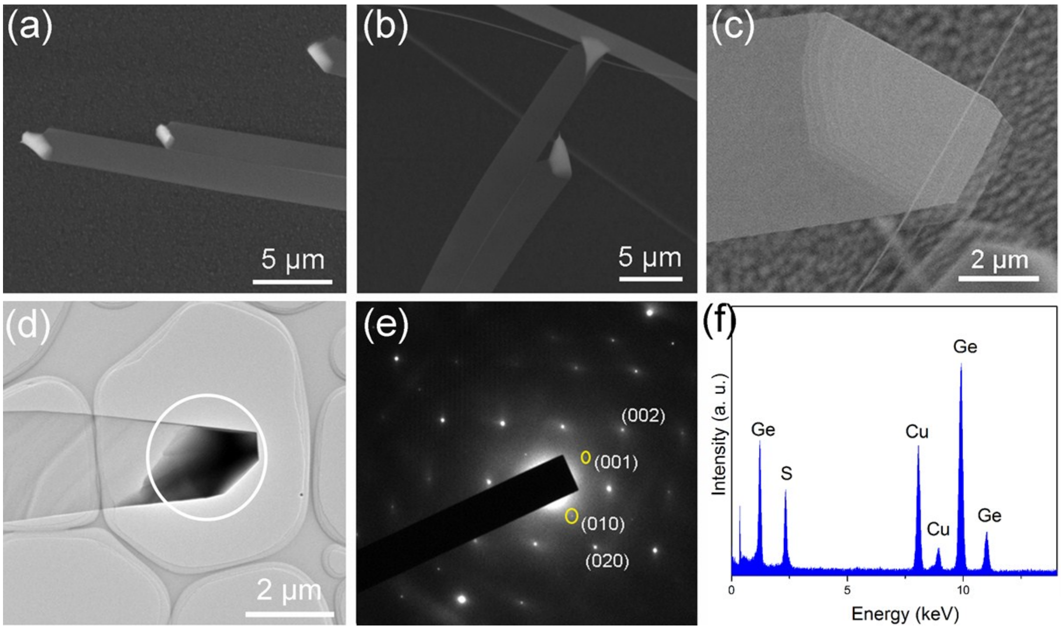

Figure S2. (a), (b), (c) SEM images of the nanoribbon tips. (d) TEM image of a typical nanoribbon tip. Microscale particle attached at nanoribbon tip can be clearly seen. (e) SAED pattern of the marked area in (d), only one set of diffraction pattern corresponding to GeS can be observed, indicating the particle at the tip is still GeS, i.e., no Au particle is involved in the tip. Interestingly, weak (001) and (010) extinction spots can be also observed, as labeled with yellow circles. (f) EDS obtained from the tip shown in (d). Cu signals come from the copper grid.

SEM and TEM observations show that particles are attached at the tips of the GeS nanoribbons as shown in figure S2 (a)-(d). Step structures can be observed at the tip of the nanoribbon from the high magnification SEM image shown in figure S2 (c), indicating layered structure of the tip. This suggests that the tip may be GeS since GeS has a layered crystal structure. To confirm this, SAED pattern from the tip was recorded as shown in figure S2 (e). Only one set of diffraction pattern corresponding to GeS can be observed from the SAED pattern, which confirms the particle is GeS. Interestingly, extinction spots, such as (010) and (001), can be observed from the SAED pattern, which is different from that of the nanoribbon. The observation of the extinction spots may be due to the non-stoichiometry of GeS at the tip. The extinction conditions cannot be strictly met if the crystal is non-stoichiometry. The tip consists only two elements: Ge and S, as indicated by EDS spectrum shown in figure S2 (f), which also confirms that the tip is GeS. So no Au as catalyst got involved in the growth of GeS nanoribbons. From the above discussion, we believed that the growth of GeS nanoribbons can be intuitively attributed to a vapor-solid growth mechanism although detailed analysis is needed to fully elucidate the growth process.

2. Spectrum response of GeS nanoribbon in vacuum

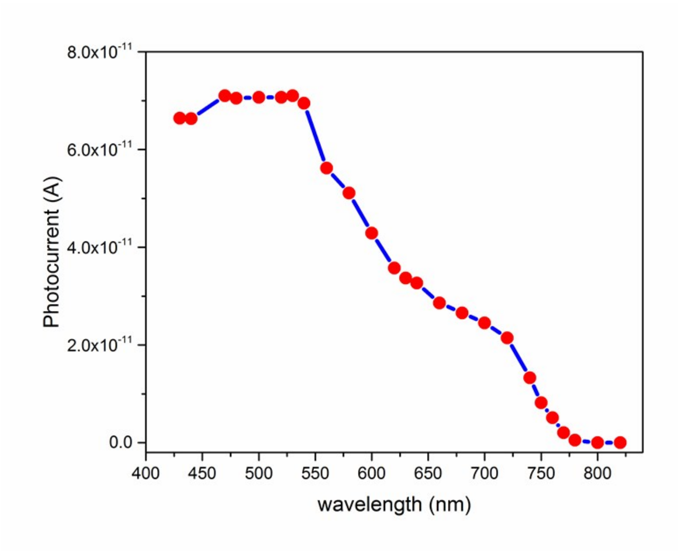

Figure S3. Photocurrent *vs.* wavelength. The bias voltage is 5 V and the light intensity is kept at 8.5 μW/cm^2 for each wavelength.

The spectrum response of the device in vacuum is shown in Figure S3. The photocurrent depends on wavelength and the variation trend is similar to that in air. The difference is that the photocurrent is smaller in vacuum than that in air.

3. Transport properties of GeS nanoribbon.

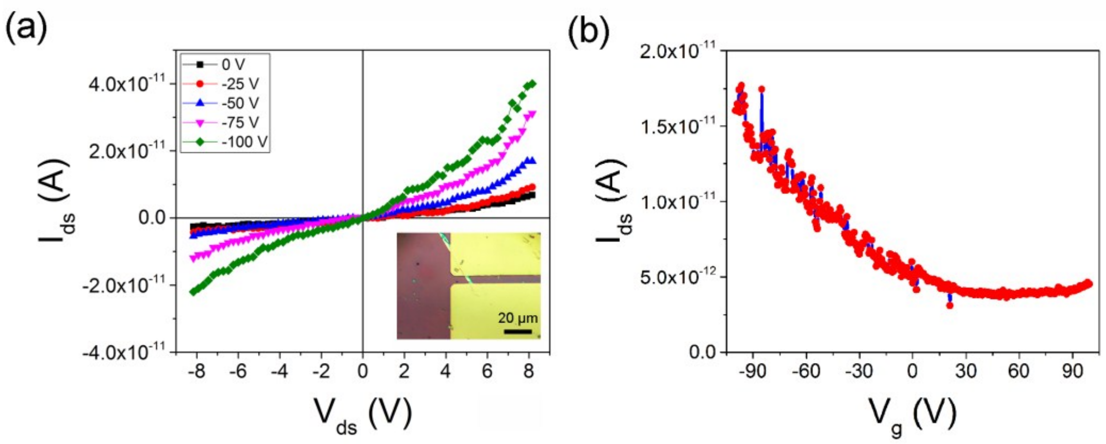

Figure S4. Electric transport properties of a typical GeS nanoribbon. (a) Output characteristic (I_{ds} vs. V_{ds}) curves. The inset is the optical image of the device. (b) Transfer characteristic curve. The V_{ds} is 5 V during the transfer curve measurement.

In order to determine the charge carrier type, electric transport properties of GeS nanoribbons in back gated field effect transistor (FET) were measured in air. The outpout curve shown in figure S4 (a) and transfer curve shown in figure S4 (b) clearly indicate a weak but distinguishable p-type charge carrier transport behavior of the GeS nanoribbon transistor.