Electronic Supplementary Material (ESI) for Materials Horizons.


# Supplementary information

## A Flexible p-CuO/n-$MoS_2$Heterojunction Photodetector with Enhanced Photoresponse by Piezo-phototronicEffect

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**Contents:**

## 1. The diagram of tensile strain loading apparatus.

The photoresponse measurement of p-CuO/n-$MoS_2$ heterojunction photodetector mainly used Raman confocal microscopy and high precision manual translation table, as shown in **Figure S1**. We firstly defined the position of heterojunction photodetector on PET substrate by CCD imaging system under 50×objective lens. Next, the tensile strain was applied by bendingPET substrate using high precision manual translation table and photoresponse characteristic was measured under different strain and laser power conditions.

## 2. The photoresponse of p type CuO film and monolayer $MoS_2$.

The I-V characteristics of p-CuO film along with the increase of tensile strain in dark environment and the charges of current under different optical power intensities are shown in **Figure S1a** and **S2b**. The results indicate the photoresponse of pure p type CuO film is quite small and it has almost no effect on the performance of whole p-n heterojunction photodetector. Monolayer $MoS_2$ photodetector with Cr/Au ohmic contact just performs the piezoresistive effect with increasing tensile strain, as shown in **Figure S2c**. The photosensitivity ($\Delta I/I_{dark}$ ) with changes of tensile strain has an equivalent effect on the device performance under both dark and illumination conditions (**Figure S2d**).

## 3. The operational stability of the photodector.

The time-dependent photoresponse of p-CuO/n-$MoS_2$ heterojunction photodetector to periodical on/off illumination under different tensile strain is shown in **Figure S3**. The device shows a good stability in a long time on/off illumination cycles.

## 4. The relationship between photoresponsivity and light powers under different external tensile strain.

The photoresponsivity(R) of p-CuO/n-$MoS_2$ heterojunction photodetector is calculated with the formula $R=(I_{ph}-I_{dark})/P$, where $I_{ph}$ is photocurrent, $I_{dark}$ is dark current and P is the light power density. The result in **Figure S4** shows the photoresponsivity reach to the maximum value 11.4 mA/W under the highest strain 0.65 % and low illumination 2.66 mW/$cm^2$.

## Figures in supplementary information

## Figure S1

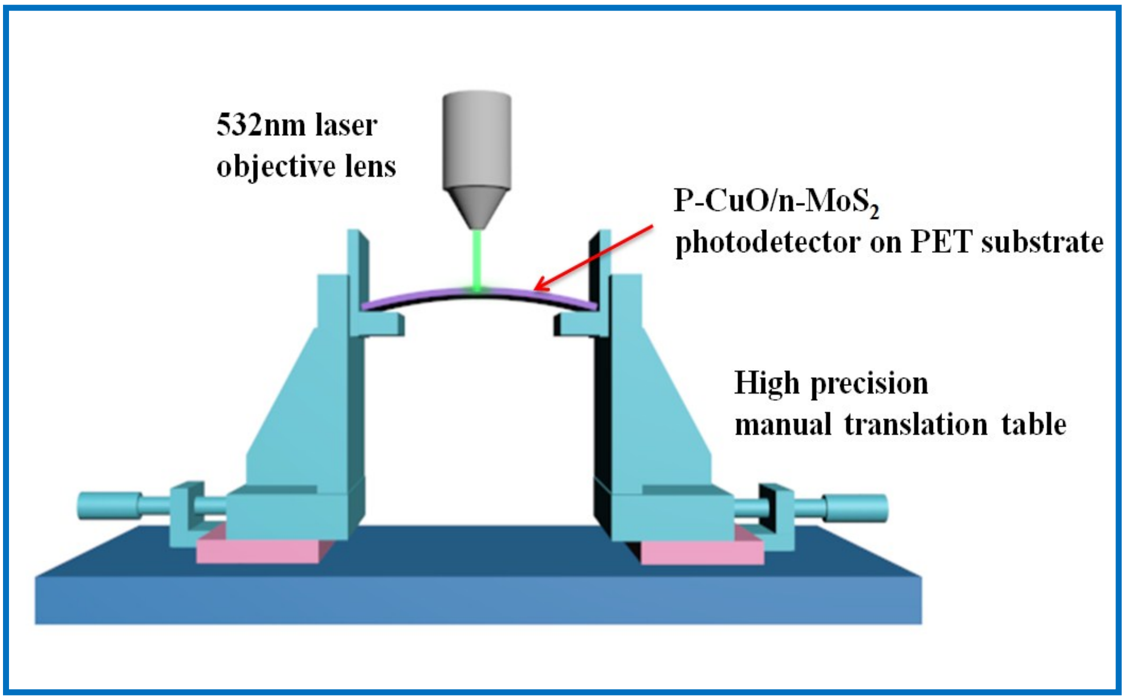


**Figure S1.** The diagram of tensile strain loading apparatus.

**Figure S2**

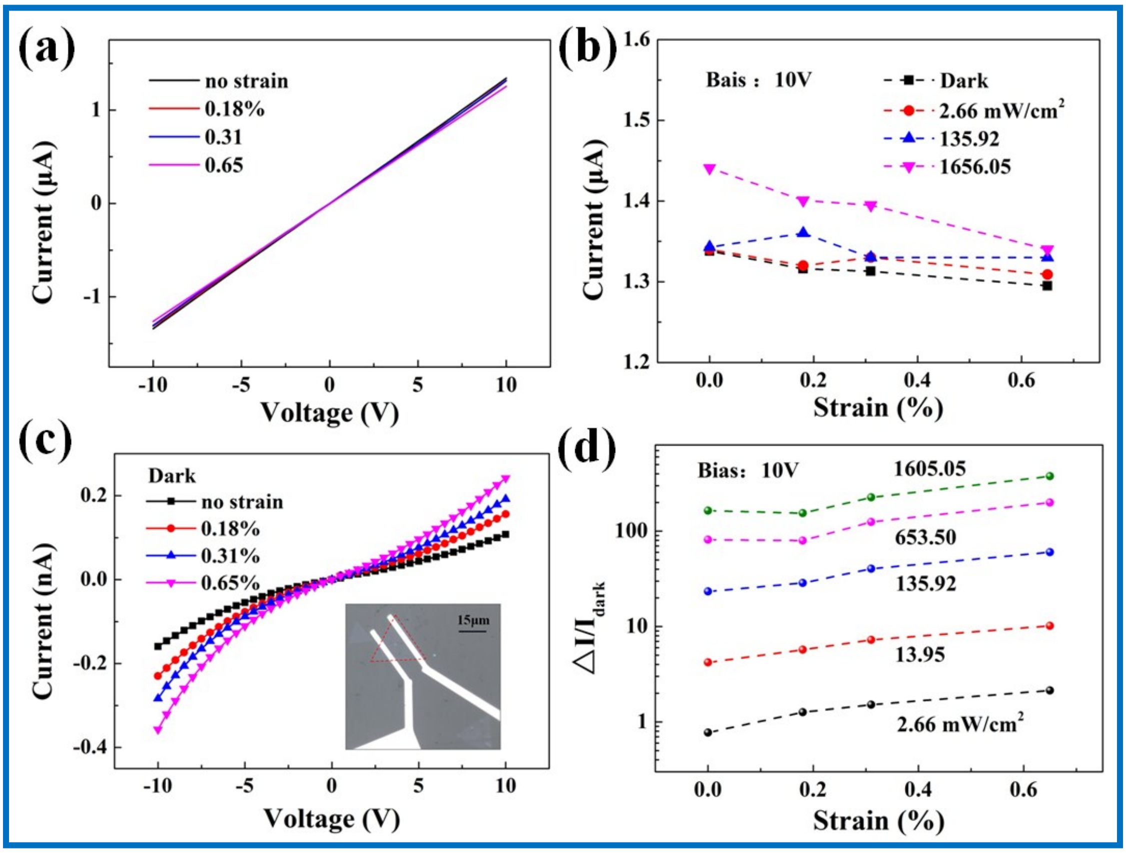


**Figure S2.**The photoresponse of photodetectors made of pure p-CuO film and monolayer n-$MoS_2$ upon tensile strain. (a) I-V chatacteristics of p-CuO film with the increase of tensile strain. (b) The changes of current of p-CuO film with increasing tensile strain under different optical power intensity at a bias of 10 V. (c) I-V chatacteristics of monolayer $MoS_2$ with the increase of tensile strain. (d) The changes of photosensitivity ($\Delta I/I_{dark}$) of monolayer $MoS_2$ with increasing tensile strain under different optical power intensity at a bias of 10 V.

**Figure S3**

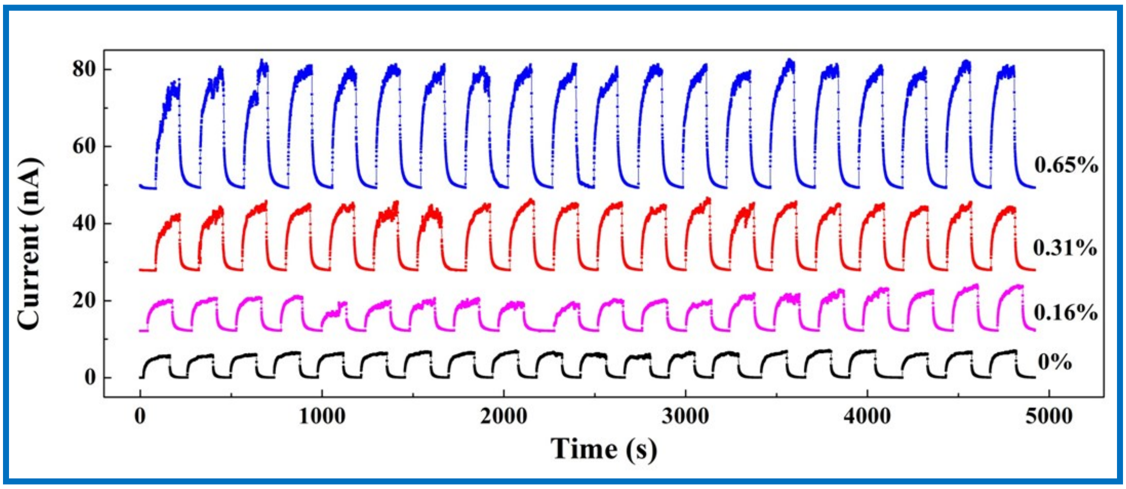


**Figure S3.**The time-dependent photoresponse of p-CuO/n-$MoS_2$ heterojunction photodetector to periodical on/off illumination under different tensile strains at bias of 10 V.

**Figure S4**

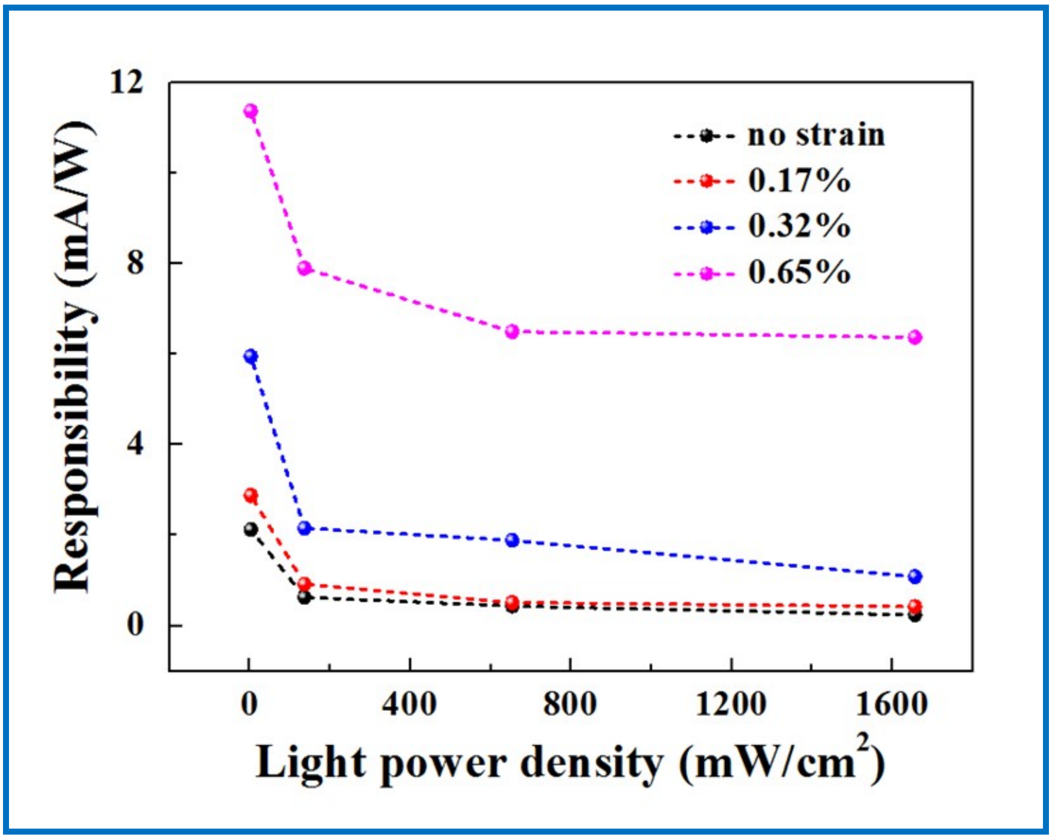


**Figure S4.**The photoresponsivity of p-CuO/n-$MoS_2$ heterojunction photodetector under different tensile strains.