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Flexible Ultraviolet Photodetectors with Broad Photoresponse Based on Branched ZnS-ZnO Heterostructure Nanofilms

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INTRODUCTION:

❖One dimentional nano/heterostructures service as building blocks which play a key role to tailor some specific properties in nanoelectronic and optoelectronic devices.

❖Particularly branched heterostructures consisting of two components exhibit unique and enhanced performances.

❖ZnO and ZnS are semiconductors with band-gaps of 3.37 and 3.67 eV respectively, have been studied as visible-blind UV photodetectors.

❖However as the UV light photodetector, ZnS nanostructures show weak photocurrent and less stability.

❖Again ZnO nanostructures have a slow response and poor photocurrent stability due to natural defects.

❖But it also should be noted that ZnS based photodetectors have fast response and ZnO has good contacts with electrodes and possess large photocurrent.

In this paper……..

- So, in this paper they have combined the unique properties of individuals constituents.

- They have prepared hybrid ZnS-ZnO nanostructures including high sensitivity, fast response speed and broad UV range photoresponse.

SYNTHETIC PROCEDURE:

❖So here they have prepared branched ZnS-ZnO nanostructures by combining a facile thermal evaporation process and a hydrothermal growth.

❖ZnS nanowires were prepared by thermal evaporation method by using ZnS powder as the source material in a tube furnace at 1000 °C.

❖Then ZnS nanowires were coated with ZnO nanoparticles by a dip-coating method.

❖After that hydrothermal process was conducted at 95 °C for 8 h and then substrates were removed and washed with deionized water followed by drying in an Ar flow.

CHARACTERIZATION:

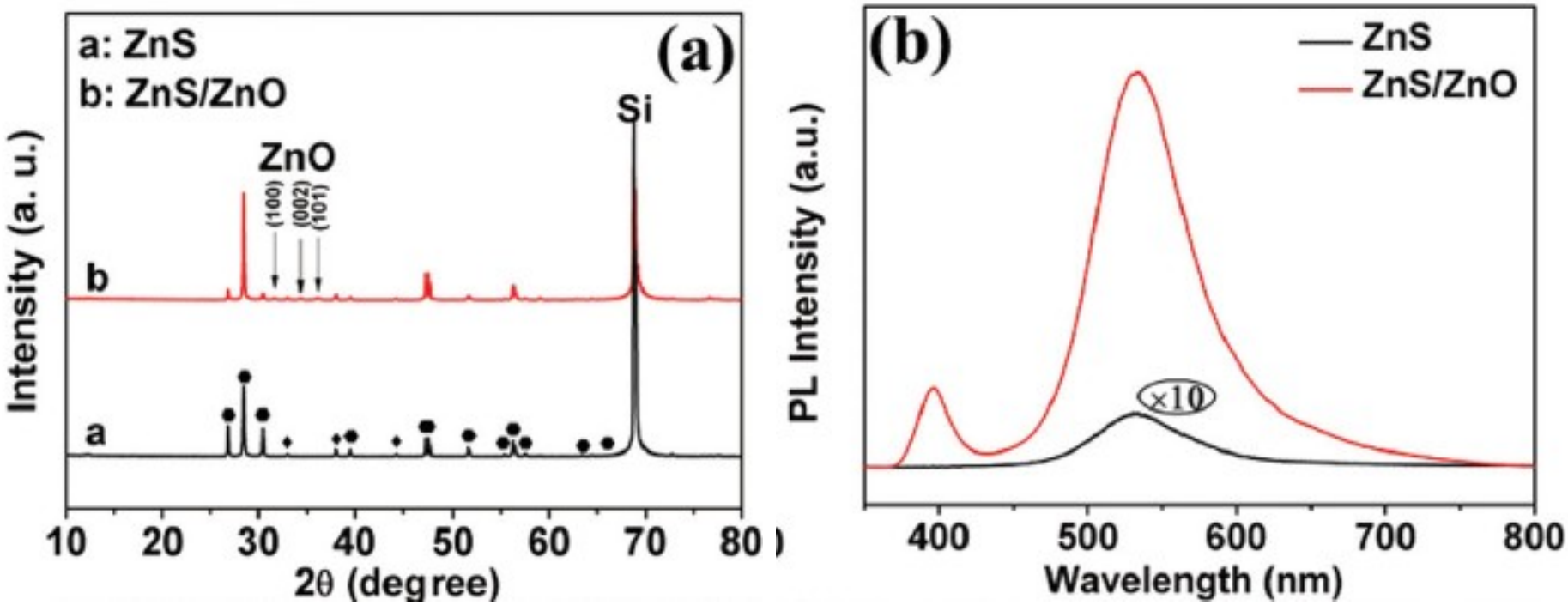

Fig:1 a) X-ray diffraction (XRD) patterns of primary ZnS nanowires and branched ZnS-ZnO heterostructures.
b) Room temperature PL spectra of the ZnS nanowires and branched heterostructures measured in a spectral range of 325–800 nm.

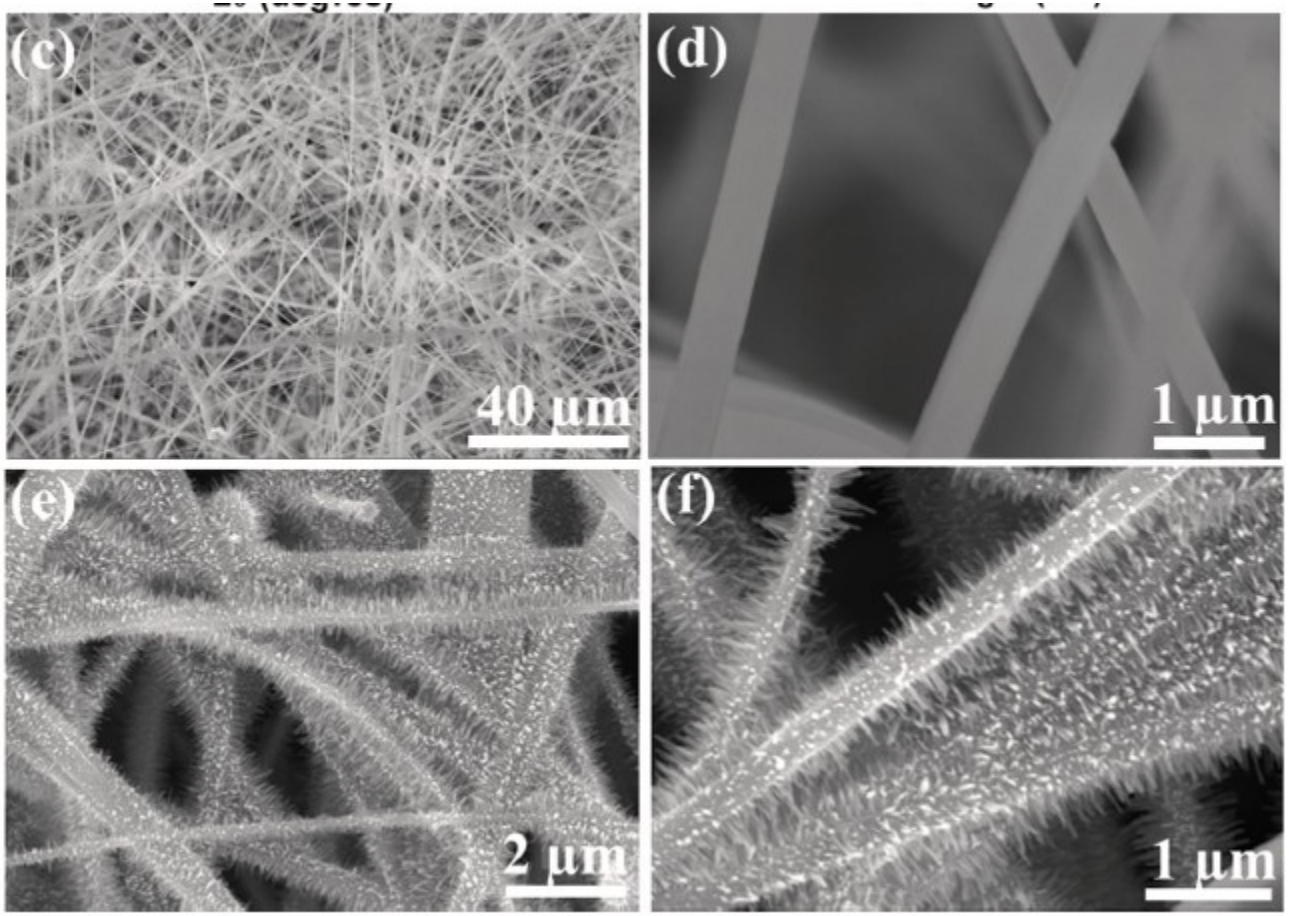

Fig: 2 c, d)SEM images of ZnS nanowires. e, f) SEM images of the branched heterostructures.

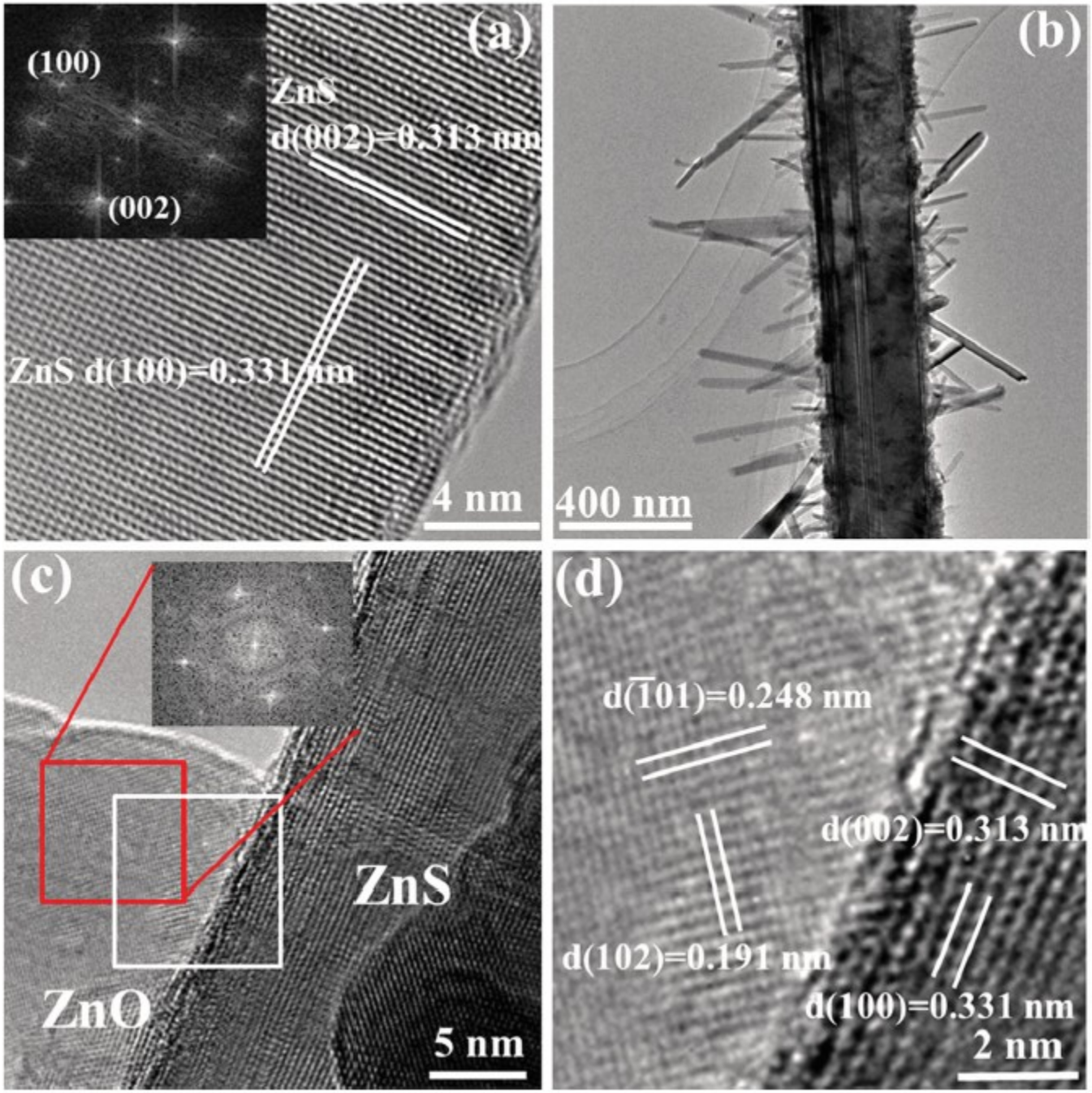

Fig: 3

a) HRTEM image of a ZnS nanowire. The inset is the corresponding FFT pattern.

b) Typical TEM image of an individual ZnS-ZnO branched nanostructure.

c) HRTEM image of a ZnS-ZnO branched nanostructure.

d)The interface between ZnS and ZnO phases.

DEVICE MEASUREMENTS:

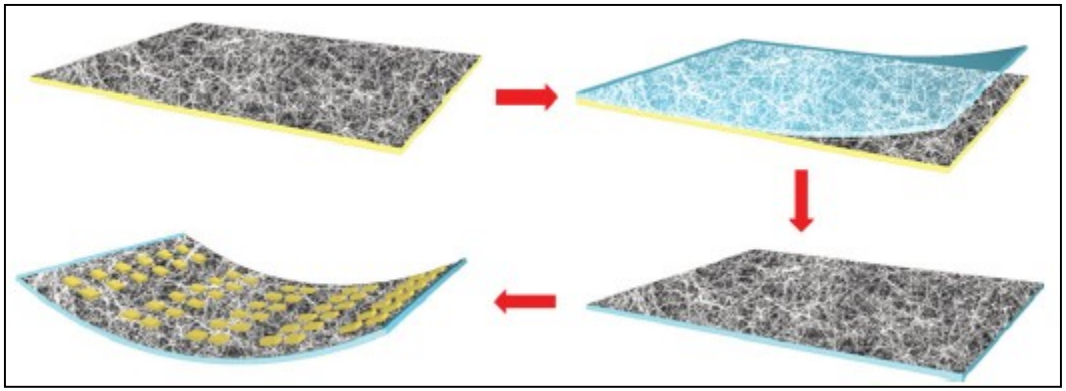

Fig: 4 Schematic illustration of nanowire film transfer onto PET substrate and an overall device structure

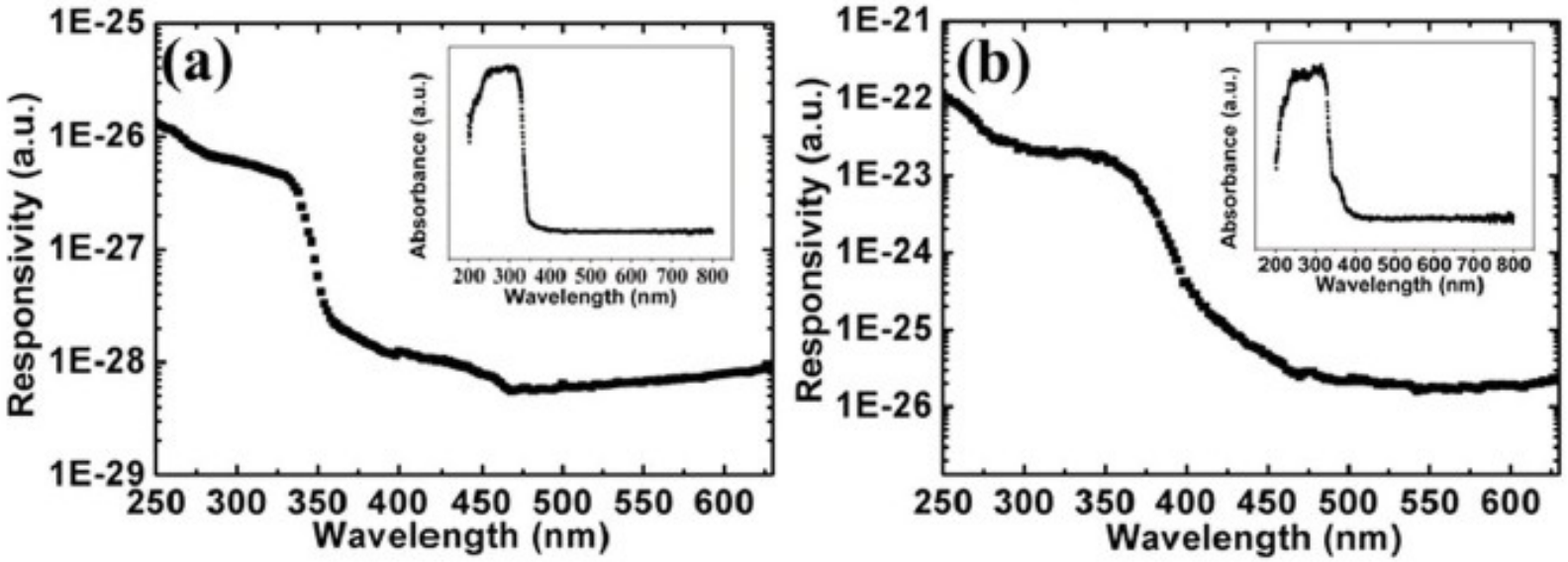

Fig: 5 Spectroscopic photoresponses of **a)** ZnS and **b)** ZnS-ZnO devices measured at a bias of 5.0 V at different wavelengths ranging from 250 to 630 nm. The inset is the optical absorption spectrum.

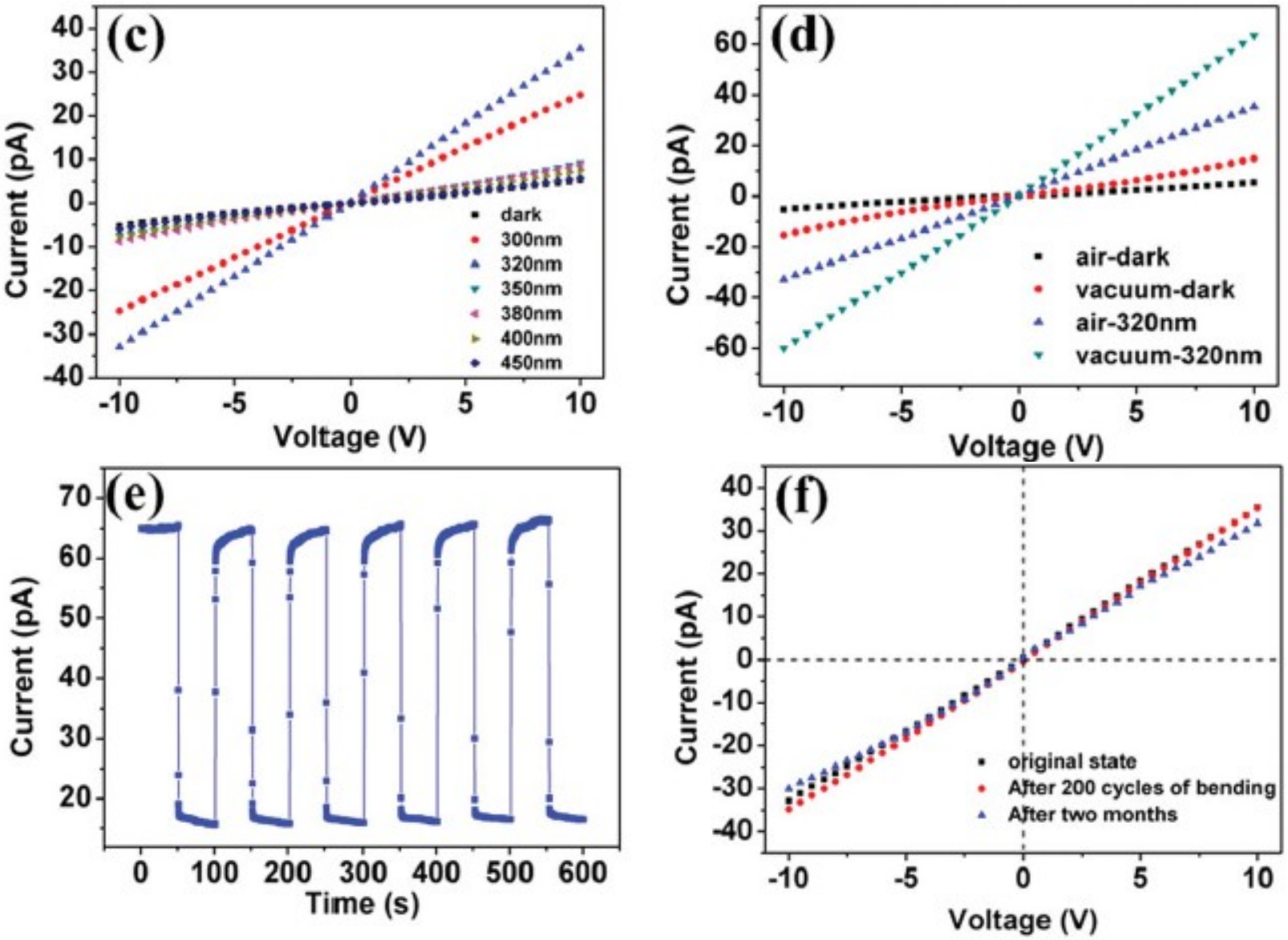

Fig: 6 c) I–V curves of the ZnS-ZnO device. **d)** I–V curves of the device illuminated at 320 nm wavelength. **e)** Time-dependent response of the device measured in vacuum conditions at a bias of 10.0 V. **f)** *I–V curves of the device* at initial stage, after 200 cycles of bending and stored in air for two Months.

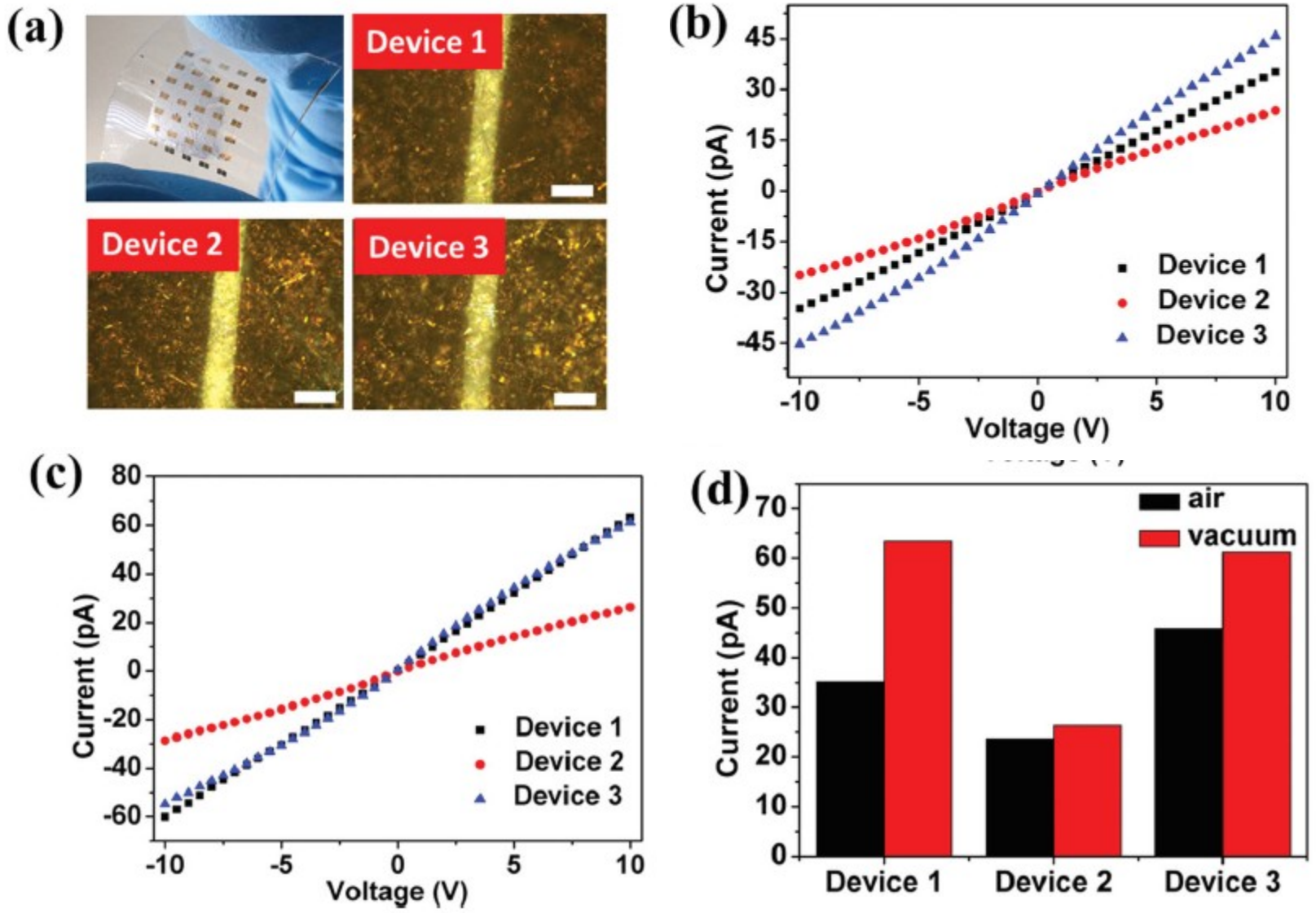

Fig: 7 a) An optical image of the ZnS-ZnO devices on a PET substrate and micrographs of three as-fabricated devices. **b, c)** *I–V curves under 320* nm light illumination in air and vacuum for all measured devices. **d)** The bar chart *of the* photocurrent in air and vacuum for all measured devices.

CONCLUSIONS:

- So, they have developed a novel nanofilm-based photodetectors from ZnS-ZnO branched nanostructures.

- The photodetectors exhibit high spectral selectivity and wide-range photoresponse for UV light.

- The optimized performance of this hybrid photodetector is much better than that of pure ZnS or ZnO nanostructures.

- Again this technique is an attractive alternative to standard semiconductor processing techniques.

- It have a great potential as optoelectronic and photoelectronic switches.

FUTURE DIRECTIONS……..

Can we combine the electrospinning and electrospray to form this type of structure which can acts as a sensor ?

THANK YOU