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Supplementary information

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# Solvent-free fabrication of broadband $WS_2$ photodetectors on paper

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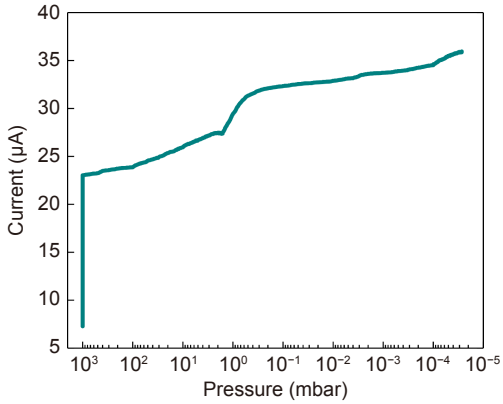


**Fig. S1 | Current as a function of pressure for the paper-based $WS_2$ photodetector (device A) at a constant bias voltage of 10 V during the vacuuming process.**

**Effect of oxygen molecules on the electrical conductivity of the $WS_2$ photodetector:** The $WS_2$ device soldered with longer copper wires was placed in a glass sealing jar filled with many oxygen absorbers. In this case, the sealing jar creates an oxygen-free environment (but does not remove the $N_2$) quickly when closed, and returns to the air environment immediately once opened. The current vs. voltage (IV) characteristics of the $WS_2$ device in oxygen-free and air environments were measured by closing and opening alternately the sealing jar.

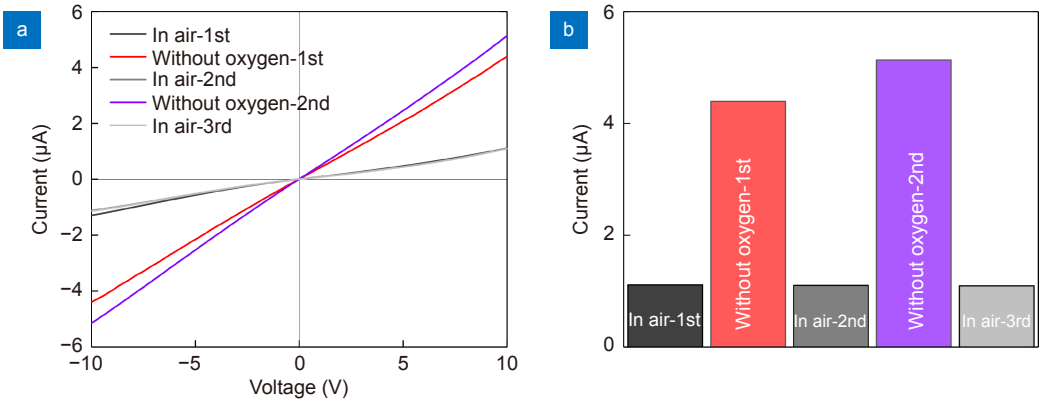


**Fig. S2 | Electrical properties of the paper-based $WS_2$ photodetector (device D) in different environments.** (**a**) IV curves measured in the alternatively changing oxygen-free and air environments. (**b**) Comparison of the obtained current values. The result demonstrated that the electrical conductivity of the $WS_2$ device is strongly affected by the oxygen molecules.

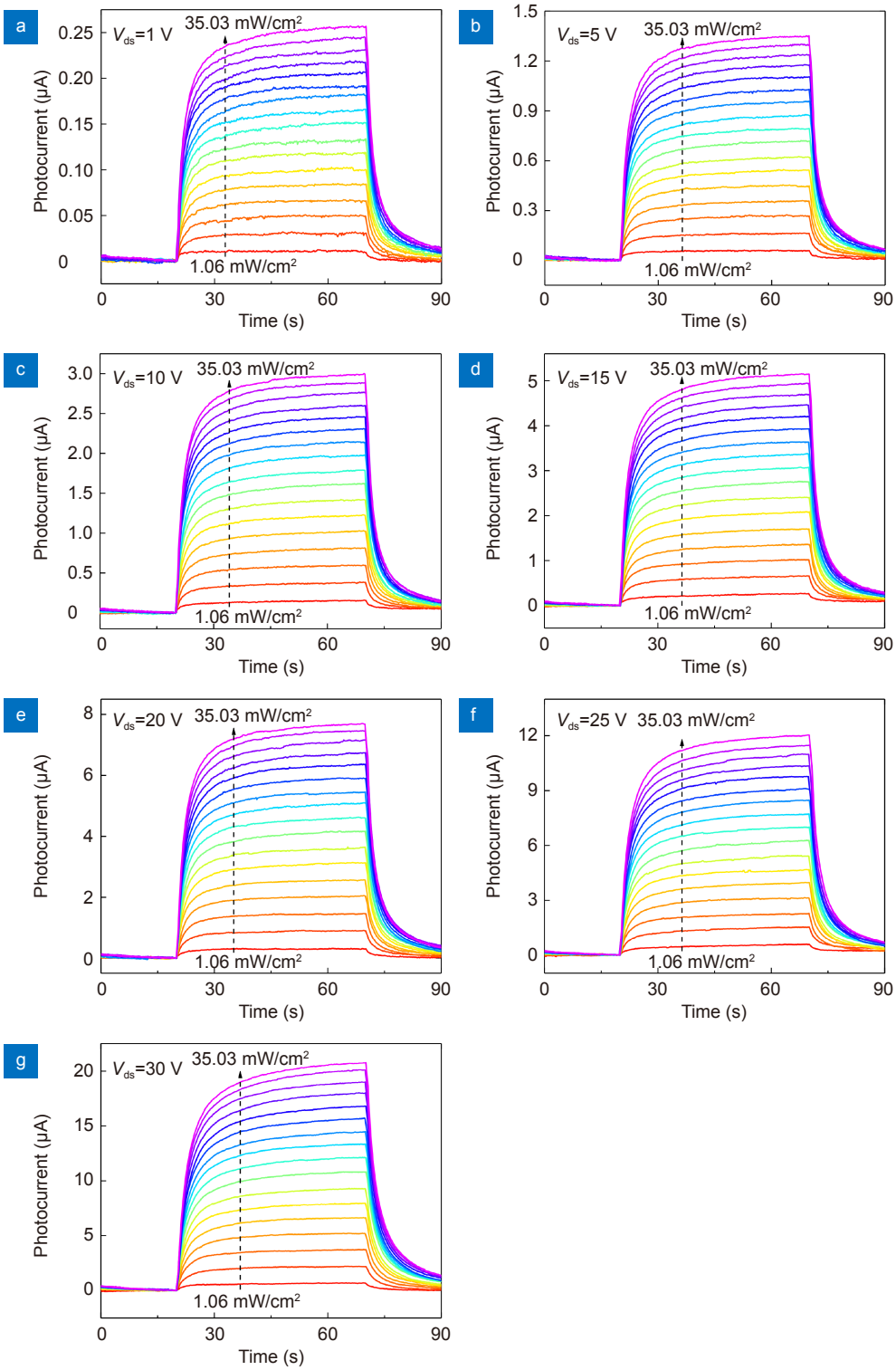


**Fig. S3 | Photocurrent of $WS_2$ photodetector on paper (device B) under different power intensities (wavelength, 617 nm) at increasing bias voltages from 1 V to 30 V.**

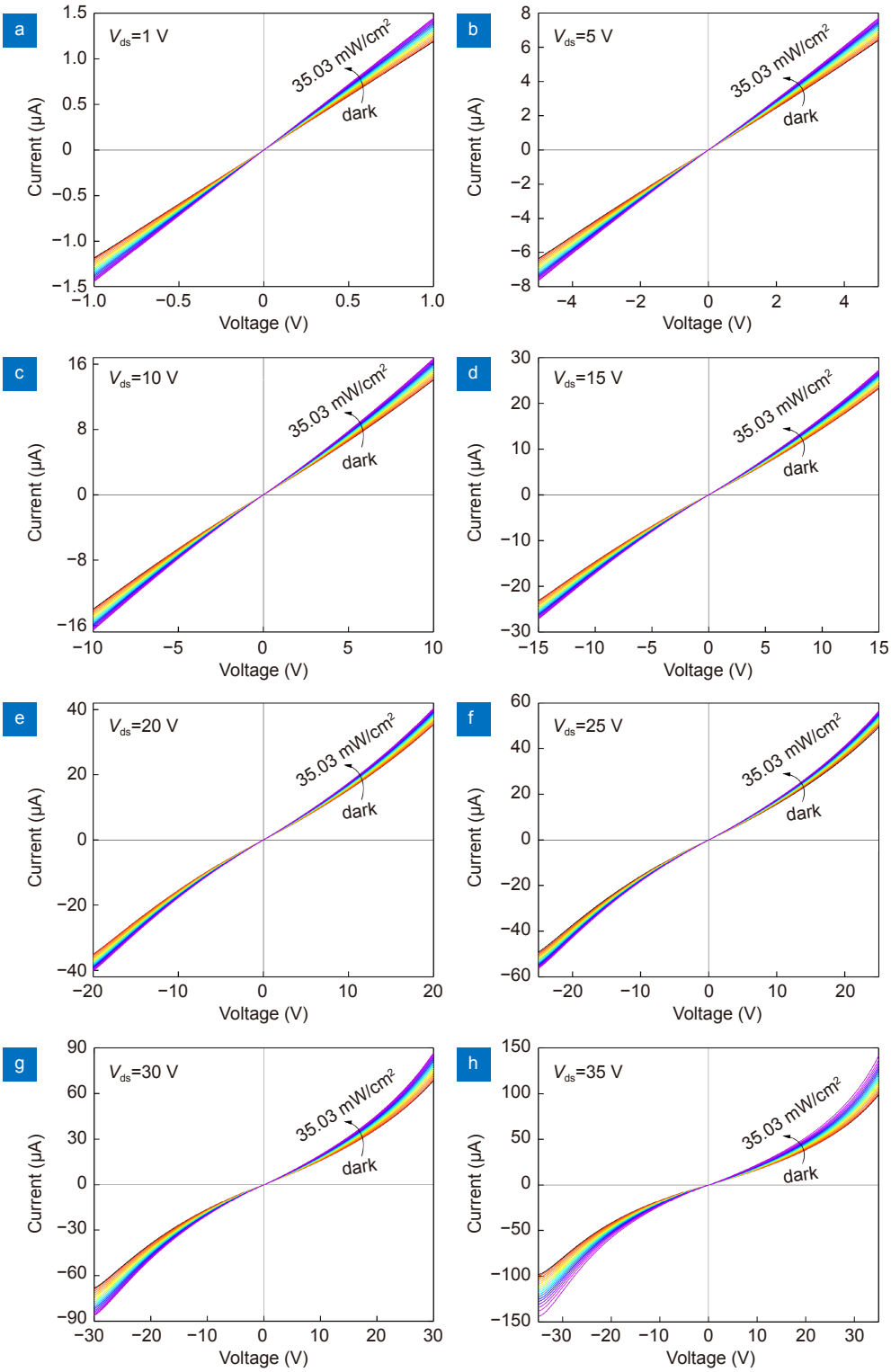


**Fig. S4 | Current vs. voltage characteristics of $WS_2$ photodetector on paper (device B) under different power intensities (wavelength, 617 nm) at increasing bias voltages from 1 V to 35 V.**

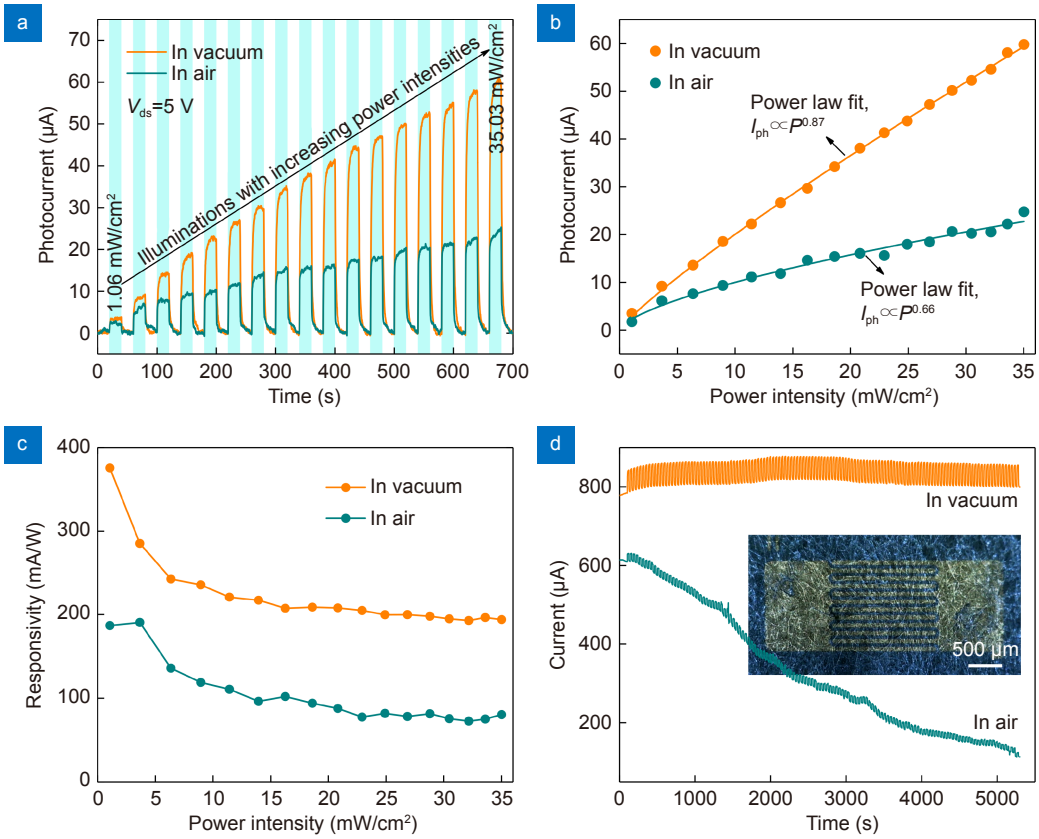


**Fig. S5 | Paper-based $WS_2$ device with interdigitated Au electrodes.** (**a**) Temporal photocurrent of the interdigitated $WS_2$ device as the incident power intensity increases from 1.1 mW cm$^{-2}$ to 35 mW cm$^{-2}$. (**b**) The measured photocurrent as a function of power intensity. (**c**) The measured responsivity as a function of power intensity. (**d**) Variation of current of the interdigitated $WS_2$ device under a periodic ON/OFF switching of illumination with 35 mW cm$^{-2}$ power intensity. Inset shows the optical micrograph of a paper-based $WS_2$ device with interdigitated Au electrodes. Note: Measurements are carried out at a bias voltage of 5 V and a selected wavelength of 617 nm.

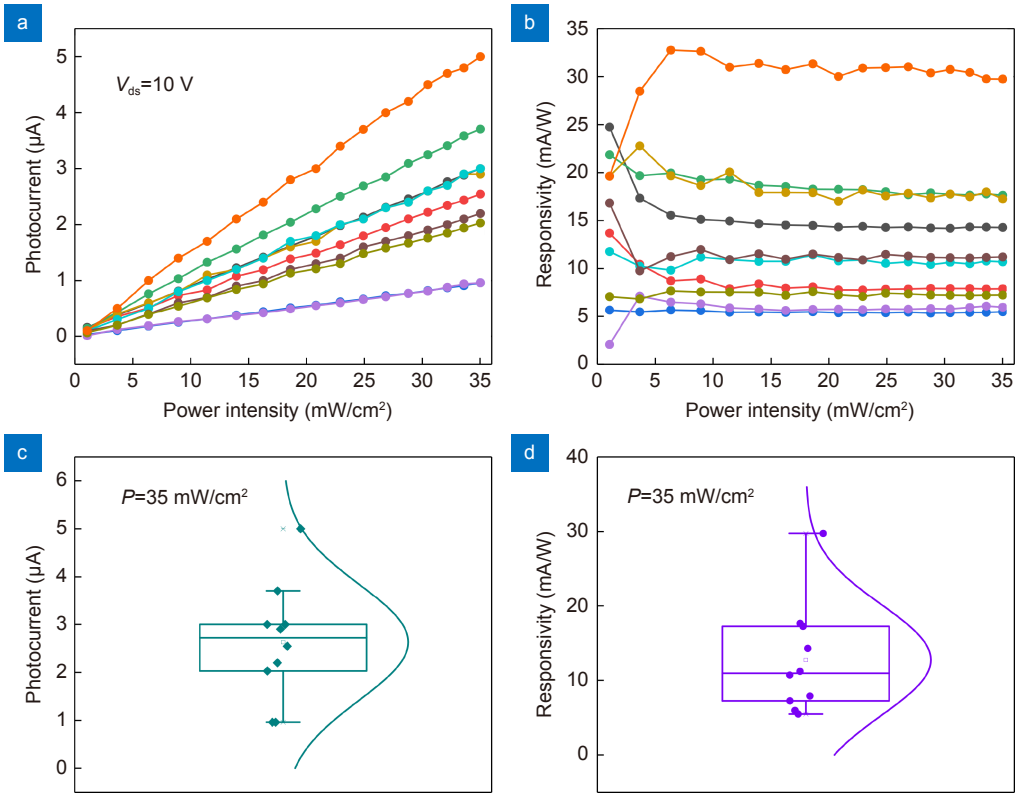


**Fig. S6 | Device-to-device variation of paper-based $WS_2$ photodetectors.** (**a**) Photocurrent and (**b**) responsivity as a function of power intensity measured on 10 $WS_2$ devices. Box plots summarizing (**c**) photocurrent and (**d**) responsivity values. Note: Measurements are carried out at a bias voltage of 10 V and a selected wavelength of 617 nm.

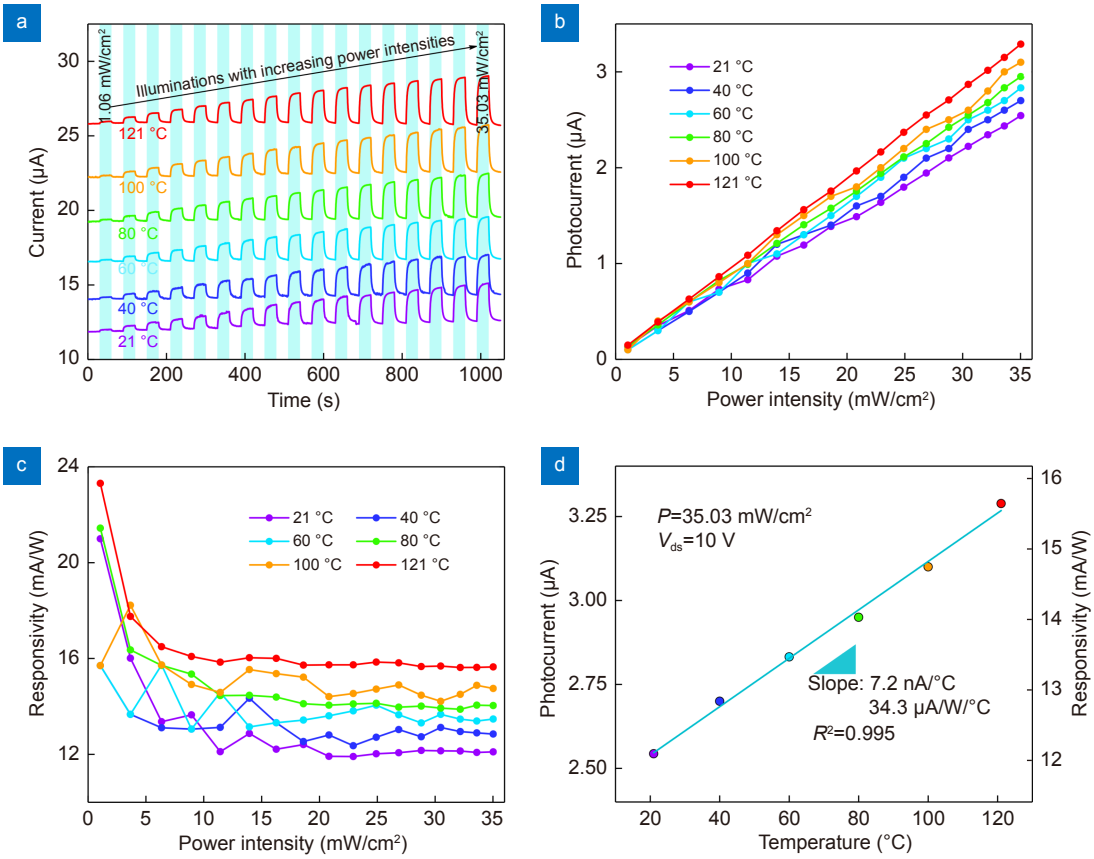


**Fig. S7 | Temperature-dependent photoresponse of the paper-based $WS_2$ photodetector (device E) under the illumination of 617 nm in vacuum condition.** (**a**) Temporal current of the $WS_2$ photodetector under illumination with various power intensities collected at different temperatures ranging from 21°C to 121°C. (**b**) The measured photocurrent as a function of power intensity. (**c**) The measured responsivity as a function of power intensity. (**d**) The measured photocurrent and responsivity as a function of temperature at a fixed power intensity of 35 mW $cm^{-2}$. Note: Measurements are carried out at a bias voltage of 10 V.