

All-dry fabrication of WS₂ photodetectors on paper

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Given the high flexibility, biocompatibility, and biodegradability, paper-based devices are particularly suitable for the next generation of flexible electronics applications. However, fabricating electronic devices on paper remains a challenge due to the rough, fibrous, and permeable features of cellulose paper.^[1] Up to now, inkjet printing of functional inks prepared by liquid-phase exfoliation of van der Waals (vdW) materials is probably the most common method, but the dispersion of the active material in the solvent and the removal of residual solvents are issues. The all-dry abrasion-induced deposition method based on the erosion of the vdW materials is a new promising approach to depositing vdW materials on paper substrate.^[2]

As a typical class of vdW materials, transition metal dichalcogenides (TMDCs) such as WS₂ and MoS₂, are being used in various optoelectronic devices, which benefit from their remarkable electrical and optical properties.^[3] Herein, we fabricated the high-performance WS₂ photodetection devices on the paper substrate by the all-dry abrasion deposition of the WS₂ thin film as the photoactive channel. We demonstrated that the frictional forces generated during the abrasion process are powerful to break the weaker vdW bonds between the layers, thus cleaving the WS₂ crystals to form the dense thin films. The high light-absorption efficiency of the WS₂ materials greatly enhances the photoresponsivity of optoelectronic devices. Importantly, the high surface roughness and porosity of cellulose fibers could provide a wider area of photoactivity for WS₂ photodetection devices compared to traditional flat substrates. The as-prepared WS₂ devices exhibit excellent photodetection performance over a broad wavelength range spanning from ultraviolet to near-infrared.

References

- [1] S. Conti *et al.* Nature Communications 11 (2020), 3566
- [2] W. Zhang *et al.* Applied Materials Today 23 (2021), 101012
- [3] A. Mazaheri *et al.* Nanoscale 12 (2020), 19068-19074

Figures

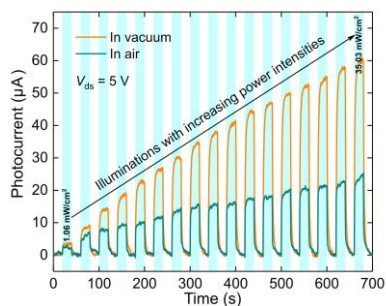


Figure 1: Optical micrograph of a WS₂ photodetector on paper. Figure 2: Photoreponse performance of the WS₂ device.