Influence of sulphur vacancies on ultrafast charge separation in WS_2-graphene heterostructures

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Ultrafast charge separation following photoexcitation, commonly observed in van der Waals heterostructures, is a key process for future optoelectronic devices that rely on the conversion of light into electricity. While electron and hole transfer rates are largely determined by band alignment and interlayer hybridization, recent experiments have revealed that defects critically affect the lifetime of the charge-separated state [1][2]. A microscopic understanding of defect-assisted charge transfer, however, remains elusive.

We disentangle the role of sulphur vacancies on ultrafast charge separation and recombination in WS_2-graphene heterostructures by (i) systematically increasing the defect density [3] and (ii) switching the defect-assisted charge transfer channel on and off.

Using time-resolved ARPES, we probe the resulting charge-transfer dynamics on ultrafast time scales directly in the band structure.

References:
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[2] S. Fu et al., Sci. Adv. 8 (2021) eabd9061.
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