Interlayer excitons in non-uniformly strained 2-dimensional heterostructures

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The search for efficient and flexible solar cells is an important research area with highly sought applications. Two-dimensional transition-metal dichalcogenides (2D TMDs) are natural candidates for such an approach, due to their flexibility and unique electronic properties, making them ideal for flexible photovoltaic applications[1].
A single TMD monolayer is a three atoms thick layer with weak van der Waals interactions between adjacent layers. The weak interlayer coupling makes it possible to create heterostructures by stacking different TMDs layers on top of each other, leading to a plethora of novel materials with tunable electronic and optical properties[2–5].
One intriguing property of TMD heterostructures is the emergence of interlayer excitons, bound electron-hole pairs where the hole and electron reside in different layers. Following the inherent charge separation of the interlayer excitons, they have a relatively long lifetime, which allows them to be transport efficiently using non-uniform strain[6]. In this work, we present the details of the fabrication and methodologies applied to achieve our goal - to increase the efficiency of a proof-of-concept solar cell based on heterostructures of TMDs. The non-uniform strain creates a spatial potential that transport the interlayer excitons into a small area, allowing efficient extraction of the charge carriers.

References

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Figures

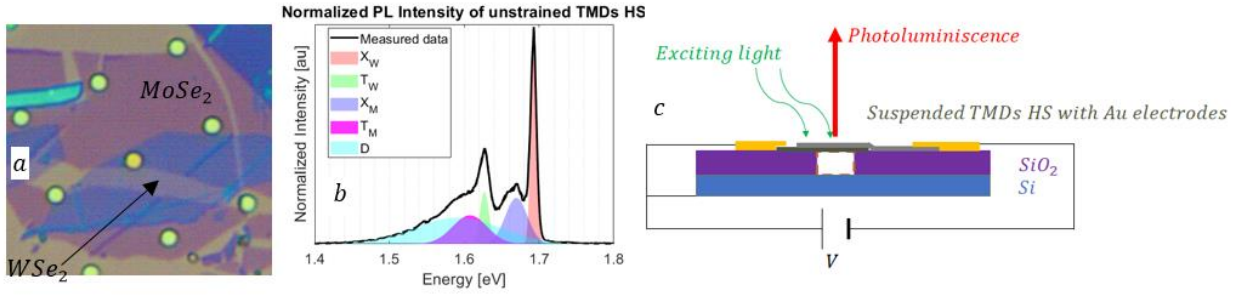

Figure 1: a) Suspended $MoSe_2/WSe_2$ Heterostructure (HS) on ϕ=3 μm hole. b) Normalized Photoluminescence of unstrained TMDs HS irradiated by 532 nm CW laser in Temperature of 5K with five visible emission lines:WSe_2 exciton (XW) and trion (TW), $MoSe_2$ neutral exciton (XM) and trion (TM), and defect-bound excitons (D). c) Schematic description of the experimental setup.