

Room Temperature Brightening of Dark exciton in Multilayer WS₂

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In addition to the optically accessible bright excitons, the rich multivalley band structure of transition metal dichalcogenides (TMDCs) also allows for the formation of dark excitons. The long lifetimes of dark excitons are ideal for exciton storage and long-range transport applications. The dark excitons in TMDCs are not readily accessible; their activation requires the application of external magnetic and electric fields, strain engineering, or high numerical aperture collection. Most reports on dark excitons in monolayer TMDCs are recorded at cryogenic temperatures and fail to survive to room temperature [1]. In our work, we have brightened the momentum dark exciton in trilayer WS₂ at room temperature, utilising tensile strain. We found that the dark exciton in multilayer WS₂ survives till room temperature, while that in monolayer diminishes above 150 K. We also saw the importance of LA phonon in the intervalley scattering leading to the brightening of dark excitons by a thorough examination of the temperature evolution of photoluminescence of the system. The thermally stable dark exciton paves the way for utilising them in practical exciton-based devices for quantum technologies.

References

[1] T. Chowdhury et al., Phys Rev B 110 (2024), L081405.

Figures

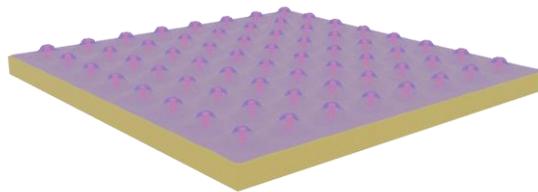


Figure 1: Schematic of the WS₂ transferred onto the nanopillar array

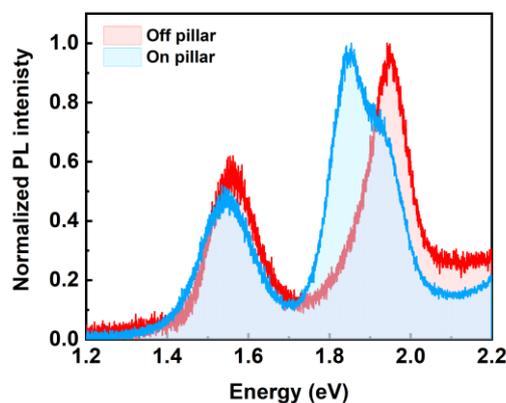


Figure 2: Comparison of normalized PL spectra collected from on pillar (shown in blue colour) and off pillar (shown in red colour) at room temperature