Exploring Quantum Emission in Bilayer WSe_2: Strain Effects from Nanopillars

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2D semiconductors are rapidly emerging as potential single photon emitters (SPEs) attributed to the unique and attractive features such as sharp and narrow emission lines owing to the localized excitons. They offer flexibility in the choice of substrate for transfer, enabling easy integration into photonic devices. Additionally, they possess a valley degree of freedom that can be exploited for quantum state encoding. Their brightness and photon purity are comparable to the quantum dots and diamond-based SPEs when coupled with photonic and plasmonic cavities, among many other advantages [1-3]. Apart from intrinsic atomic defects, quantum emitters in transition metal dichalcogenides (TMDs) can be intentionally introduced through local strain field engineering and electron/ion beam irradiation [4]. A significant strain gradient is achieved by transferring TMD monolayers on nanopillars, nanobubbles, waveguides, and indentations, which facilitate the localized quantum emitters near the edges of these structures and/or bends in monolayer.

Here, we present enhanced quantum emission from bi-layer WSe_2 subjected to local strain induced by dielectric nano-pillars underneath. We observe spectrally narrow and bright PL with anti-bunched photon emission statistics comparable to that from monolayer WSe_2. A robust second order correlation parameter of value 0.11 is obtained indicative of strong antibunching within the system. The results demonstrate promising potential for future applications leveraging the controlled strain environment provided by nanopillar arrays to manipulate and enhance quantum emission in TMD bilayers.

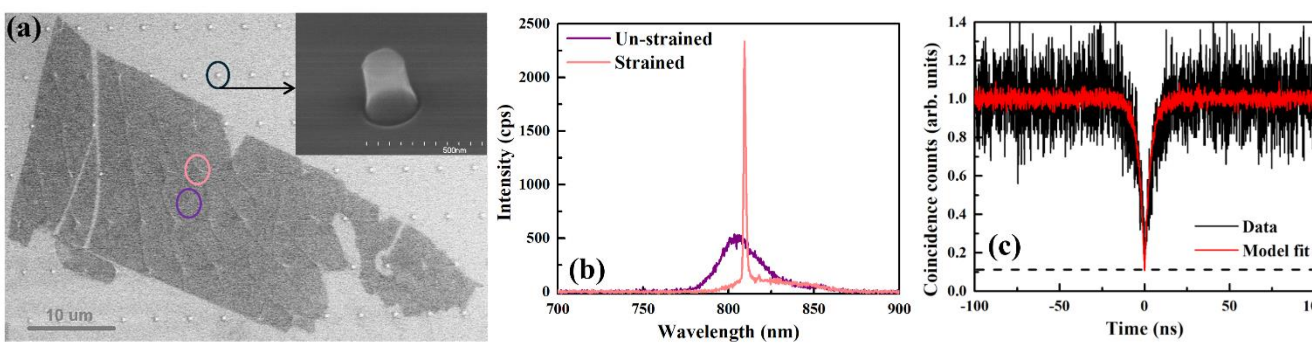

Fig. 1. (a) SEM image of a bilayer of WSe_2 on an array of pillars. Inset shows the SEM image of a SiO_2 pillar. (b) PL spectra of an un-strained and a strained bilayer at 4 K using CW excitation at 520 nm laser and a power of 30 µW from the regions marked with respectively colour circles in (a). (c) Second order auto-correlation measurement of the narrower peak in (b) at 810 nm. Model fit is generated using a stochastic model described in [5].

References

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