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Controlling the polarization of highly pure SPSs on monolayer WSe2 via strain and defect engineering

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A high-quality single-photon source (SPS) is one of the most critical components in photonic quantum information technologies (e.g. QKD, cryptography, linear quantum computing, etc.) where qubits are encoded within individual photons[1]. Moreover, the scalability of these technologies relies heavily on their integration into existing photonic systems, so controlling their quantum properties is crucial. Besides their advantages, current material platforms present limitations due to their complex fabrication procedures and inherent attributes[2]. In the search for reliable SPSs, Transition Metal Dichalcogenides (TMDCs) have emerged as a promising platform[1]. Despite the recency of the field, they have exhibited satisfactory integration potential into photonic cavities[3], purity close to the state-of-the-art[4], and the ability to be used in quantum information protocols[5].

The poster presents on-chip quantum emitters from monolayer WSe_2 with controlled polarization and high purity, via strain and defect engineering. We explain the drawbacks of current nanopillar designs for strain application, which we use to justify the new proposed geometries. Moreover, we analyze the entire fabrication process from the structure fabrication, the flake exfoliation and transfer, to the defect introduction through electron beam irradiation. Finally, we characterize the samples with different imaging techniques and present the properties of the produced quantum emitters.

References

[1] Montblanch, Alejandro R-P., et al. "Layered materials as a platform for quantum technologies." Nature Nanotechnology : 1-17 (2023).

[2] H. Ollivier et al. "Reproducibility of high-performance quantum dot single-photon sources." ACS photonics 7.4 : 1050-1059(2020).

[3] Drawer, Jens-Christian, et al. "Monolayer-Based Single-Photon Source in a Liquid-Helium-Free Open Cavity Featuring 65% Brightness and Quantum Coherence." Nano Letters 23.18 : 8683-8689(2023).

[4] Branny, Artur, et al. "Deterministic strain-induced arrays of quantum emitters in a two-dimensional semiconductor." Nature communications 8.1 : 15053(2017).

[5] T. Gao et al. "Atomically-thin single-photon sources for quantum communication." npj 2D Materials and Applications 7.1 : 4(2023).