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On-Chip Transition-Metal Dichalcogenide Platforms for Quantum Information Technology

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Photonic quantum information technologies, such as linear optical quantum computing and quantum communications, can be implemented using efficient single-photon sources, detectors, and ordinary linear optical elements to manipulate qubits, which are encoded onto single photons. Scalable quantum computing and communications with millions of qubits require many efficient sources providing indistinguishable and pure single-photon states to obtain entanglement and maximize security without additional protocol complexity. However, this has been proven to be very challenging due to the limitations of both the material platforms and the fabrication complexity [1]. Transition-metal dichalcogenide (TMDC) flakes are among the most recently discovered platforms for quantum information. Still, they have already shown promising results in terms of single-photon emission purity of strained monolayers [2], deterministic integration of the single-photon emitters in nanophotonic devices [3], and competitive performance with other single-photon emitters for quantum key distribution [4].

In this poster, we present our advancement toward generating, manipulating, and collecting single-photon states in photonic chips with TMDC devices on silica-on-silicon substrates. First, we justify and support the chosen designs with the results obtained with finite-difference numerical modeling. We then illustrate our nanofabrication process for the development of WSe_2 and $MoTe_2$ single-photon emitters, WS_2 linear optical components (e.g., waveguides, beam splitters, and interferometers), and photonic crystal nanobeam cavities toward the efficient manipulation of pure and indistinguishable single photons. Finally, we report our preliminary results from the optical characterization experiments carried out so far.

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