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Towards integrating superconducting nanowire single photon detectors on lithium niobate waveguides

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Abstract

We report on the integration of superconducting nanowire single photon detectors (SNSPDs) on lithium niobate waveguides. In particular, we discuss challenges during the fabrication process, characterization methods and efficiency optimization.

Lithium niobate is an interesting platform for quantum optics. Waveguide-integrated devices provide a versatile toolbox for complex optical circuits, due to their low-loss waveguiding of TE- and TM-polarization modes, electro-optic properties, and high second order susceptibility [1]. Many different tools for quantum optics applications have been realized on this platform including single-photon sources, couplers, switches and modulators. In addition, highly-efficient fiber-coupling can be achieved by direct end-face pigtailing due to an optimized mode overlap with the titanium in-diffused waveguides. However, the integration of single-photon detectors on these waveguides is challenging [2, 3, 4].

State-of-the-art single photon detectors at optical or telecom wavelength use the breakdown of superconductivity and a resulting electric response to measure impinging single photons. These detectors provide outstanding quantum efficiency and low noise. On the other hand they require cryogenic temperatures around 1 K. Superconducting nanowire single photon detectors (SNSPDs) made of amorphous tungsten silicide (a-WSi) offer high internal quantum-efficiency above 90 % at 1550 nm wavelength and low timing jitter as well as fast recovery times [5]. These detectors were demonstrated on various substrates including waveguide circuits. Our goal is the integration of a-WSi-SNSPDs on lithium niobate waveguides which enables the combination of highly-efficient nonlinear optics and on-chip detection for new complex quantum experiments. We have already shown successful deposition and saturated internal quantum-efficiency of our on-chip detectors [3]. Now we are working on the evanescent coupling from a waveguide to the detectors including manipulation of the optical mode to increase the system efficiency.

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