Integrated transition edge sensors on lithium niobate waveguides

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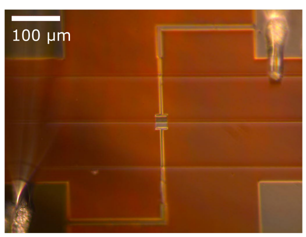
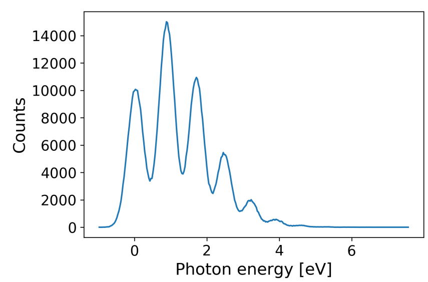
Lithium niobate is a versatile platform for integrated quantum optics due to its low-loss waveguiding of TE- and TM-polarization modes, a high second order susceptibility and its electro-optic properties [1]. Many different tools for quantum optics applications have been realized on this platform including single-photon sources, couplers, switches and modulators. In addition, high-efficient fiber-coupling can be executed 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]. Superconducting single photon detectors combine high detection efficiency at telecom wavelength with outstanding signal-to-noise ratio [4]. In particular, transition edge sensors (TESs) combine these abilities with an intrinsic photon-number resolution and negligible dark counts [5]. Combining these detectors and the lithium niobate platform enables a new variety of complex on-chip experiments.
Recently, we were able to show in a first proof-of-principle-experiment the evanescent detection of single photons with on-chip TESs on a lithium niobate waveguide. In addition to the photon-number resolution, we saw a high polarization sensitivity for the evanescent coupling, which was predicted by earlier room-temperature loss-measurements and simulations [3]. Also, we investigate different detector geometries to optimize the detector efficiency in future.



(a)



(b)

Figure 1: (a) Microscope image and (b) histogram of an on-chip TES on a lithium niobate waveguide showing multiple peaks corresponding to different photon numbers

References

[1] P. R. Sharapova, K. H. Luo, H. Herrmann, M. Reichelt, T. Meier, and C. Silberhorn, "Toolbox for the design of LiNbO3-based passive and active integrated quantum circuits", New Journal of Physics **19**, 123009 (2017).
[2] M. G. Tanner, L. San Emeterio Alvarez, W. Jiang, R. J. Warburton, Z. H. Barber, and R. H. Hadfield,, "A superconducting nanowire single photon detector on lithium niobate", Nanotechnology **27**, 505201 (2012).
[3] J. P. Höpker, M. Bartnick, E. Meyer-Scott, F. Thiele, S. Krapick, N. Montaut, M. Santandrea, H. Herrmann, S. Lengeling, R. Ricken, V. Quiring, T. Meier, A. E. Lita, V. Verma, T. Gerrits, S. W. Nam, C. Silberhorn, and T. J. Bartley, in *Proceedings of SPIE: Quantum Photonic Devices 10358*, 1035809, arXiv:1708.06232 (2017)
[4] A. Migdall, S. V. Polyakov, J. Fan, J. C. Bienfang, in *Single-Photon Generation and Detection Vol. 45*, Ch. 6, (Academic Press, 2017)
[5] A. E. Lita, A. J. Miller, and S. W. Nam, "Counting near-infrared single-photons with 95% efficiency", Optics Express **16**, 5 (2008).