Light conversion in integrated silicon nitride photonics

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Photonics technologies, such as lasers, optical fibers, electro-optical devices and light detectors to name a few, have seen an unprecedented growth and widespread utilization within the recent decades, and currently are an indispensable part of modern world. Integrated photonics, where optical elements are fabricated as integrated structures on flat surfaces (or chips), is one of the most rapidly advancing branch of photonics. The successful integration of different optical functionalities on a single chip is crucial for getting compact and low power devices that ought to have a broad range of applications ranging from telecommunication and metrology, to quantum optics [1].

In this presentation silicon nitride photonics will be shown as a platform enabling various second-order nonlinear optical phenomena which include frequency up-conversion, generation of entangled photons as well as phase-modulation, all clearly relevant for applications named above. While the considered effects are not available in the platform after device fabrication due to amorphous nature of employed material, an effective nonlinearity can be induced using optical and electrical fields. The former is made possible due to charge carriers available in the waveguide core. Electrical and optical control of currents in the waveguides have recently paved way for some exciting fundamental research as well as allowed for demonstration of state-of-the-art nonlinear devices. This talk will concentrate on discussing the process of inducing second-order effective nonlinearity and techniques for its characterization in addition to showcasing the nonlinear optical performance of silicon nitride waveguides and microresonators (see Fig 1).

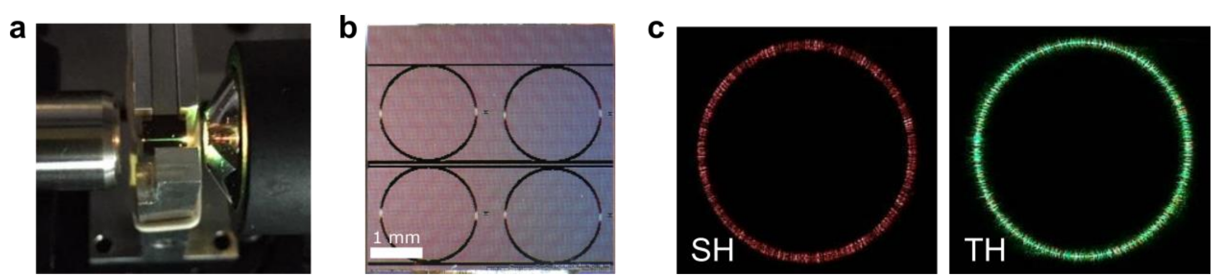

Fig. 1. a. Generation of broadband light in a straight silicon nitride waveguide. **b.** A top-view of silicon nitride chip with four large free spectral range microresonators. **c.** Light up-conversion in a silicon nitride microresonator via second-harmonic (SH) and third-harmonic (TH) generation process.

[1] J. Leuthold, C. Koos, W. Freude, 'Nonlinear Silicon Photonics,' Nature Photonics 4, pp. 535-544, 2010