Single-photon collection efficiencies into silicon photonic waveguides for NIR quantum communication sources

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Abstract

Development of efficient single-photon sources based on quantum emitters, requires the enhancement and the effective collection of the radiation emitted by the emitters. Plasmonic waveguides supporting surface plasmon-polaritons (SPP) modes provide an effective route to reduce by an order of magnitude the effective mode volume, therefore increasing the emission rate of quantum emitters, while improving collection efficiency as well. Realization of on-chip devices compatible with silicon photonics platform adds a key functionality and provides opportunities for on-chip signal processing, and communications.

Introduction

To explore different configurations to achieving efficient coupling between quantum emitters and plasmonic modes supported by integrated plasmonic structure in order to implement highly efficient single-photon sources.

Objective

We recently reported the design, implementation, and experimental demonstration of efficient light nanofocusing in an on-chip hybrid photonic-plasmonic light concentrator (PLC) vertically integrated on a Si waveguide [1]. The vertical integration of the PLC with the photonic waveguiding structure is compatible with the dense integration of different photonic and plasmonic functionalities on the same chip.

Background

To characterize the performance of the hybrid photonic-plasmonic device for the focusing of light at nanoscale, we used a near-field scanning optical microscope (NSOM). Both characterizations were performed on our device: (1) measurement of the near-field pattern around plasmonic nanotaper of the PLC, and (2) experimental mode analysis of the photonic modes in the regions of the bare waveguide and after the plasmonic nanotaper region.

References


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Conclusions

Recent simulations show that the efficient light nanofocusing in an on-chip hybrid PLC, vertically integrated on a Si waveguide could successfully be used as a highly efficient single-photon source. Several geometries were explored and a complete parametric study was carried on, showing that the Purcell effect grows with the complexity of structures, the polarization and the position of the emitter along X axis. Achieving up to 800 times enhancement into the TEM coupled mode of the Si waveguide. SNOM measurements and experimental demonstration are in progress.