Parametric nonlinear interactions in silicon photonics

High optical confinement waveguides on integrated platforms enable nonlinear optical interactions with low power levels.The third-order nonlinear susceptibility, a modification of a material’s permittivity due to an applied optical field, exists in all materials, and is an intensity-dependent process leading to third-order parametric effects. Harnessing the high optical intensities enabled by high confinement waveguides allows standard semiconductor materials to become power-efficient parametric nonlinear optical devices that can operate with powers in the mW range. The optical confinement of a waveguide also enables control over the waveguide’s dispersion, allowing for phase-matching of the parametric processes thereby improving its operating bandwidth. In this talk, we will discuss a variety of parametric nonlinear optical demonstrations in silicon-based waveguides including optical parametric amplification and oscillation, phase-sensitive amplification, and frequency conversion and comb generation. Furthermore, we will discuss these devices for a variety of applications including optical signal processing, spectroscopy, and security.