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Efficient ultrafast optical parametric amplification and wavelength conversion based on four-wave mixing in silicon waveguides

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Silicon waveguides with micro-nano structures offer a variety of nonlinear effects that can be used to process optical signals at speeds of 100 Gbit s^{-1} and beyond, detect signals at unprecedented sensitivities for novel sensing applications and enable broadband electro-optic modulation. Compared with fibers, the silicon waveguides with micro-nano structures have inherent advantages due to the large values of Kerr parameter, Raman gain coefficient and the tight confinement of optical mode. Efficient ultrafast optical parametric amplification and wavelength conversion via four-wave mixing (FWM) in silicon waveguides are demonstrated. In the ultrafast FWM process, the spectra are greatly broadened, and it is difficult to achieve efficient wavelength conversion and parametric amplification when the pump and signal pulse widths are close to or less than 100 fs because of the spectral overlap. The spectral overlap can be suppressed by tailoring the dispersion profiles of the silicon waveguides, and separable spectra are obtained for parametric amplification with 200 fs pulses. On-chip parametric gain as high as 26.8 dB and idler conversion gain of 25.6 dB is achieved with a low pump peak power over a flat bandwidth of 400 nm in a 10-mm-long dispersion engineered silicon waveguide. In addition, the impact of initial chirp on the wavelength conversion is also investigated, and relative narrower FWM spectra with most of the energy remain in the central peak can be obtained using appropriate initial chirp. The conversion bandwidth greater than 500 nm with peak conversion efficiency of -1.6 dB can be obtained.

Biography

Hongjun Liu was born in China in 1972. He received his doctor degree of science from Graduate School of Chinese Academy of Sciences (CAS) in 2002. Now, he is a Professor and doctoral supervisor of University of CAS. He leads the optical parametric technology group at the State Key Laboratory of Transient Optics and Photonics Technology, Xi'an Institute of Optics and Precision Mechanics, CAS. Until now, he has published more than 110 research papers, and applied 13 items of state invention patents. Currently, he is engaged in the generation and amplification of ultrashort pulse, optical parametric imaging technology, terahertz technology, fiber laser technology and nonlinear silicon photonics.

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