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Improvement of Raman amplifier bandwidth by means of slow light in photonic crystal based waveguide structure

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Abstract In this paper, we investigate the enhancement of Raman amplification bandwidth with self phase modulation (SPM) effect in silicon based photonic crystal waveguides. The Maxwell equations are solved using finite difference time domain method considering two photon absorption, free carrier absorption, Kerr and SPM effects. We also study the effects of shape, width and average power on the Raman amplification bandwidth. Then by changing the photonic crystal geometrical parameters, pump and signal group velocity are reduced to achieve higher Raman bandwidth.

Keywords Raman amplification · Photonic crystal · SPM · Two photon absorption · Free carrier absorption

1 Introduction

Silicon photonics is turning out as low-cost optoelectronic solutions for a variety of applications from telecommunications and interconnects to optical sensing and biomedical applications. In recent years, we have witnessed salient progress in developing of silicon (Si) based fast modulators, photo-detectors, optical amplifiers and sources. Stimulated Raman scattering has been demonstrated as a successful approach for acquiring amplification and lasing phenomena in Si (Rong et al. 2007).

Silicon based photonic crystal (PhC) waveguides provide strong mode confinement and low-group velocities due to confinement through structural Bragg reflections. Such properties account for enhancing nonlinear optical phenomena such as Raman scattering. The slow group velocity, caused by multiple coherent scattering inside the photonic crystal structure, increases the light-matter interaction which in turn leads to higher probability of Raman scattering (McMillan et al. 2008a,b). The main challenge for Si Raman amplifiers is their

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