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Simulation of Mid Infrared Supercontinuum Generation in Silicon Germanium Photonic Waveguides for Gas Spectroscopy

Authors : Proficiency Munsaka, Peter Baricholo, Erich Rohwer

Abstract : Pulse evolutions along the 5 cm long, 6.0 ×4.2 μm² cross-section silicon germanium (SiGe) photonic waveguides were simulated and compared with experiments. Simulations were carried out by solving a generalized nonlinear Schrodinger equation (GNLSE) for an optical pulse evolution along the length of the SiGe photonic waveguides by the split-step Fourier method (SSFM). The solution obtained from the SSFM gave the pulse envelope in both time and spectral domain calculated at each distance step along the propagation direction. The SiGe photonic waveguides were pumped in an anomalous group velocity dispersion (GVD) regime using a 4.7 μm, 210 fs femtosecond laser to produce a significant supercontinuum (SC). The simulated propagation of ultrafast pulse along the SiGe photonic waveguides produced an SC covering the atmospheric window (2.5-8.5 μm) containing the molecular fingerprints for important gases. Thus, the mid-infrared supercontinuum generation in SiGe photonic waveguides system can be commercialized for gas spectroscopy for detecting gases that include CO_2, CH_4, H_2O, SO_2, SO_3, NO_2, H_2S, CO, and NO at trace level using absorption spectroscopy technique. The simulated profile evolutions are spectrally and temporally similar to those obtained by other researchers. Obtained evolution profiles are characterized by pulse compression, Soliton fission, dispersive wave generation, stimulated Raman Scattering, and Four Wave mixing.

Keywords : silicon germanium photonic waveguide, supercontinuum generation, spectroscopy, mid infrared
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