Analytic description of four-wave mixing in silicon-on-insulator waveguides - DTU Orbit (02/01/2019)

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We develop an analytic description of continuous-wave four-wave mixing in silicon-on-insulator (SOI) waveguides including linear loss, two-photon absorption, and free-carrier absorption. Under the undepleted pump approximation, the pump equation decouples from the signal and idler equations and becomes a nonlinear differential equation that we solve analytically without further approximations. The signal and idler equations have no known solutions for arbitrary pump power evolution, but we calculate approximate field expressions based on a Magnus expansion, which has been used to study time-ordering effects in quantum optics. Lastly, we show that the phase-matching condition changes through the waveguide and that this explains the shape of the wavelength-conversion-efficiency spectrum in SOI waveguides and why it differs from that of highly nonlinear silica fibers.

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