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A silicon nanowire factorable photon pair source

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Abstract We propose a scheme for generating pairs of de-correlated photons in silicon nanowire waveguides. By properly engineering the geometrical dispersion of nanoscale waveguides we achieve both four-wave-mixing and group velocity matching. Factorable pure photon states are found that do not require spectral filtering. Highly anti-correlated two-photon states can be realized far from the Raman background of the waveguide. Our results hold promise for the realization of an integrated single photon source.

Keywords Quantum optics · Nonlinear optics · Integrated optics · Micro-optical devices

1 Introduction

The generation of photon-pairs is a crucial requirement for realizing various quantum information processing protocols such as quantum teleportation (Marcikic et al. 2003; Bouwmeester et al. 1997) and quantum cryptography (Gisin et al. 2001). Single photon states can be prepared from a photon pair source by detecting one of the photons (Fiorentino et al. 2002), also referred to as heralding single photons. Pair generation has been achieved in optical fibers (Li et al. 2004; Fiorentino et al. 2002; Fulconis et al. 2007), photonic crystal fibers (Mosley et al. 2008; Tanzilli et al. 2001) and non-linear media (Grice et al. 2001) by means of parametric down-conversion (PDC) or alternatively spontaneous four-wave-mixing (SFWM). In SFWM processes two pump photons are converted to a pair of signal and idler photons that obey energy and momentum conservation laws. Phase-matching with simultaneous momentum conservation can be obtained over a relatively large bandwidth, thus sophisticated filtering techniques are required to yield frequency related photon pairs. Such filtering requirements can be conveniently met by employing fiber-based equipment developed for the telecommunications industry in the wavelength range around 1,550 nm.

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