General of high-purity single photos via spontaneous four-wave mixing in multiplexed system of optical nanofibers

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The development of heralded single-photon sources remains an important task in the field of optical quantum technologies [1]. One of the promising approaches to the problem is to use nonlinear optical effects such as spontaneous four-wave mixing (SFWM), which can be observed in various promising systems like microring resonators, photonic crystal fibers and micro-/nanofibers (MNF). In particular, MNFs seem to be very promising nonlinear materials [2] that have a number of unique features due to the small mode diameter, significant evanescent field, small weight and size. Compared to standard optical fibers, MNFs provide higher nonlinearity, which allows one to reduce the fiber length. At the same time, adiabatic fiber tapers are characterized by very small losses so that MNFs also perfectly match optical communication lines.

In paper [3], a heralded single-photon source based on SFWM in a MNF was demonstrated with 100-ps pulsed pump. In this experiment, pairs of photons were generated at wavelengths of 880 nm and 1310 nm, and the emission rate of heralded photons at 880 nm was of 4 Hz. The measurement of joint spectral intensity of the biphoton field [3] allows us to conclude that high spectral purity of the emitted photons can be achieved by using additional spectral filtering, which significantly reduces the generation rate. For the latter to be increased, we can take advantage of spatial multiplexing, which has been demonstrated recently with a system of photonic crystal fibers [4].

In this paper, we present some preliminary experimental results towards realization of a SFWM-based single-photon source with high purity and high generation rate by using spatially multiplexed system of MNFs. Compared to [3], we use fs pulsed pump, which allows us to increase the efficiency of the SFWM process and to reduce spectral correlations between the emitted photons by using broadband spectral filters. In addition, we use a system of identical MNFs to increase the generation rate without increasing the pump power via spatial multiplexing technique. In this respect, an important advantage of MNFs is providing high coupling efficiency with the output fiber and full compatibility with the existing telecommunication switching and routing technology.

References

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