Room-temperature single photon emission from carbon nanotubes

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Single-walled carbon nanotubes are a promising material as quantum light sources at room temperature and as nanoscale light sources for integrated photonic circuits on silicon. Here we discuss the use of carbon nanotubes as room-temperature single photon emitters from two different approaches. The first is where efficient exciton-exciton annihilation process [1] is used to reduce the number of mobile excitons. We investigate photon statistics in as-grown individual air-suspended carbon nanotubes and perform theoretical analysis to show that diffusion-driven annihilation of mobile excitons can produce high-purity single photons [2]. In the second approach where exciton trapping sites are created to localize excitons [3], we demonstrate integration of carbon nanotube dopant states to silicon photonic crystal microcavities [4]. The coupling of the dopant emission to the microcavity results in an increase of photoluminescence by a factor of ~100, corresponding to a single-photon emission rate of 1.7 x 10^7 Hz which is the highest reported for room-temperature operation of nanotube single photon sources. Our results show that both diffusive (1D) and localized (0D) excitons in carbon nanotubes can produce high quality single photons at room temperature, opening up a pathway to quantum light sources with additional functionality and flexibility.

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