Amplified spontaneous emission from a microtube cavity with whispering gallery modes

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We present a detailed study of the photonic modes in aluminosilicate microtube cavity of ~ 7-8 μm outer diameter that can act as micron-scale optical cylindrical resonator. We demonstrate a new route to the fabrication of individual microtubes with the maximum length of 200 μm, using a vacuum assisted wetting and filtration through a microchannel glass matrix. The microtubes were studied using micro-photoluminescence spectroscopy and luminescence lifetime imaging confocal microscopy. In the emission spectra of the microresonators we find periodic very narrow peaks corresponding to the whispering gallery modes of two orthogonal polarizations with quality factors upto 3200 at room temperature. In order to identify the peaks in the observed mode structure, we have adopted the boundary-value solution to the problem of scattering of electromagnetic waves by a dielectric micro-cylinder. A strong enhancement in photoluminescence decay rates at high excitation power suggest the occurrence of amplified spontaneous emission from a single microtube. The optical modes were probed by the photoluminescence of CdSe nanocrystals deposited onto the tube's walls. The observed spectral structures originate from the coupling of the electronic transitions in nanocrystals and the photon states of microtube cavity. The evanescent field in these photonic structures extends a couple of micrometers into the surroundings providing the possibility for efficient coupling to an external photonic device. The resonantly enhanced optical response make these high-Q microcavities attractive as novel building blocks for photonic devices with strongly polarized emission. The cylindrical cavity format is also compatible with a large variety of sensing modalities such as immunoassay and molecular diagnostic assay.

(a) (b)

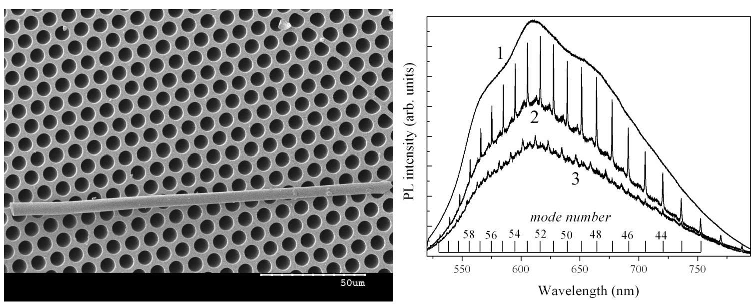

Fig. 1 (a) SEM image of aluminosilicate microtube. (b) Room-temperature PL spectra of single microtube accommodated in matrix (1) and free-standing microcavity with polarizer orientation parallel to the microtube axis (2) and polarizer rotated by 90^0 (3).