Simulations of Rolled-up Optical Microcavities Using COMSOL Multiphysics® Software

Shilong Li[1]

[1]Shanghai Institute of Technical Physics (SITP)

Abstract

By using a combination of top-down and bottom-up strategies (see Fig. 1), rolled-up optical microcavities have gained considerable attention owing to their excellent customizability [1]. For example, the resonant spectrum of a rolled-up optical microcavity is well defined by simply tailoring the rolling length before it rolls [2], as shown in Fig. 2. In order to have a good visualization for the electric field of resonant modes, a 3D rolled-up microcavity was simulated using the RF Module of COMSOL Multiphysics® software[3]. As seen in Fig. 3, the geometry of rolled-up structures is firstly simplified as a cylindrical ring with an inhomogeneous refractive-index distribution. Then, light is introduced through a near-field optical fiber with a Port Boundary Condition, and the far-field is terminated by a Perfect Matched Layer (PML). In the end, the electric field of a resonant mode in this simplified rolled-up optical microcavity is clearly visible. Moreover, we used COMSOL Multiphysics® software and the LiveLink™ for MATLAB® to create a precise rolled-up structure (see Fig. 4) so that the simulated electric field of resonant modes becomes more realistic.

Reference

1. T. Kipp et al., Optical modes in semiconductor microtube ring resonators, Phys. Rev. Lett. 96, 077403 (2006).
2. S. Li et al., Dynamic axial mode tuning in a rolled-up optical microcavity, Appl. Phys. Lett. 101, 231106 (2012).
3. S. Böttner et al., Polarization resolved spatial near-field mapping of optical modes in an on-chip rolled-up bottle microcavity, Appl. Phys. Lett. 105, 121106 (2014).

Figures used in the abstract

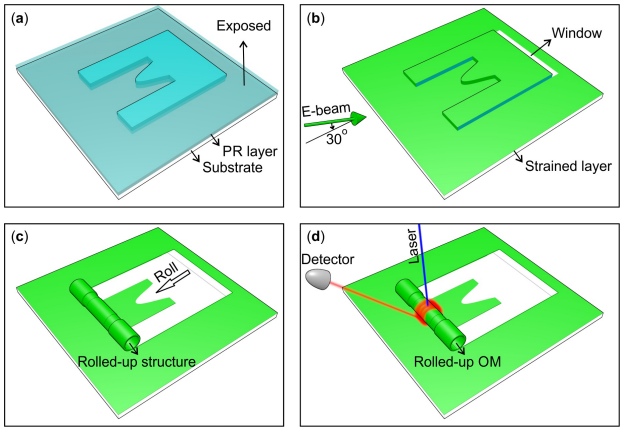

Figure 1: Sketch of the fabrication of rolled-up optical microcavities.

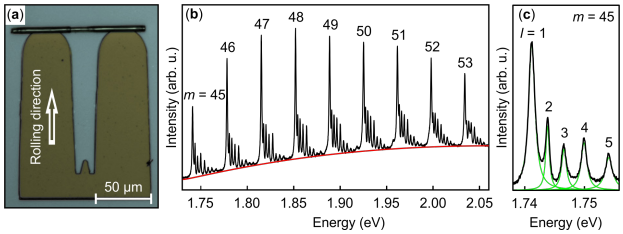

Figure 2: Experimental results of a rolled-up optical microcavity.

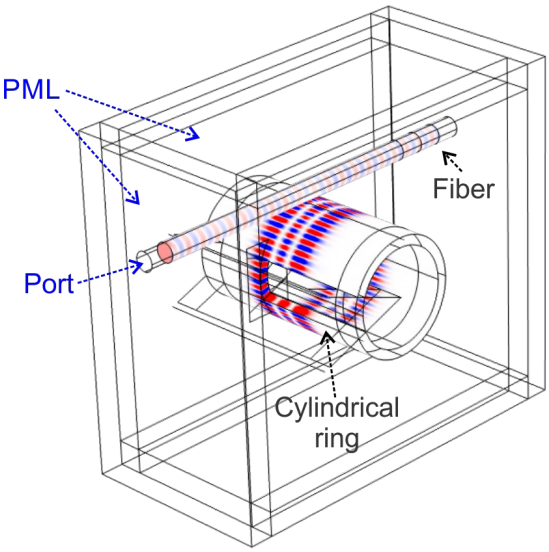

Figure 3: Simulation results of a rolled-up optical microcavity based on a simplified cylindrical ring geometry.

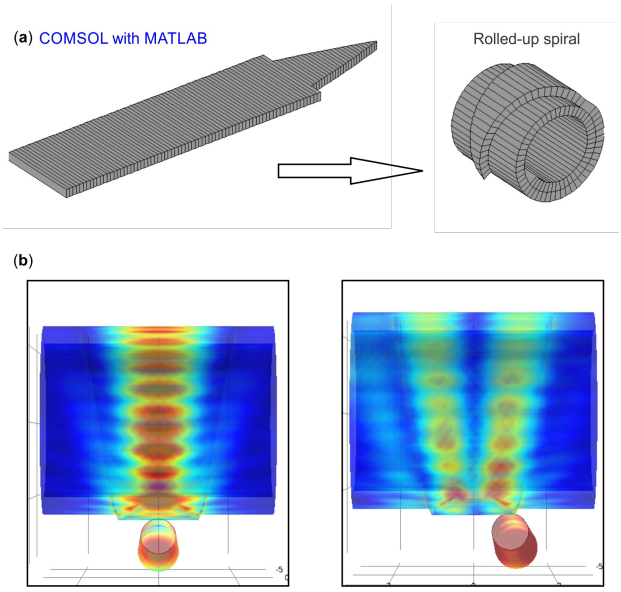

Figure 4: Simulation results of a rolled-up optical microcavity based on a complex rolled-up geometry.