We demonstrate optical applications of self-assembled smectic liquid crystal tubes grown in an aqueous micellar medium [1]. The tubes consist of smectic layers arranged in a cylindrical fashion around a topological line defect existing along the core of the tube. The smectic tubes can be seen as a new class of soft matter optical fibers [2], possessing a highly uniform diameter and a large birefringence. We demonstrate guiding of light along the fiber and Whispering Gallery Mode (WGM) lasing in a plane perpendicular to the fiber. The light guiding as well as the lasing threshold are significantly dependent on the polarization of the excitation beam. The observed threshold for WGM lasing is very low (≈ 75 µJ/cm²) when the pump beam polarization is perpendicular to the direction of the laser dye alignment and is similar to the lasing threshold in nematic droplets. The smectic fibers are soft and flexible and can be manipulated with optical tweezers, thereby demonstrating—together with nematic and cholesteric microdroplets [3,4]—a promising approach for the realization of soft photonic circuits.

Most results of our work were obtained from smectic-A liquid crystals but we will also present preliminary results concerning other liquid crystal phases, e. g., cholesteric and chiral smectic-C* phases, from which we also could grow tube-like structures.

Figure 1: Light guiding in a smectic-A fiber (diameter ≈ 20 µm) of the compound 8CB doped with 0.1 weight% of the fluorescent dye Nile red. The beam of an Ar⁺ laser is positioned at different points on the hemispherical cap at the end of the fiber, resulting in different spiral-shaped trajectories of the guided light in the fiber.

References:

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