Electrically Tunable Liquid Crystal Optical Microresonators

M. Humar[a], S. Pajk[a,b], I. Muševič[a,c]

a J. Stefan Institute, Jamova 39, SI-1000, Ljubljana, Slovenia
b Faculty of Pharmacy, University in Ljubljana, Aškerčeva 7, SI-1000, Ljubljana, Slovenia
c Faculty of Mathematics and Physics, University in Ljubljana, Jadranska 19, SI-1000, Ljubljana, Slovenia

Spherical LC microdroplets embedded in a supporting polymer matrix were used as electric-field tunable optical microcavities. They were prepared by mixing a small amount of fluorescently labeled nematic liquid crystal E12 and polydimethylsiloxane (PDMS). Single microresonators were excited under a microscope using an Ar^+ laser. A series of well resolved peaks were observed in the spectrum of the fluorescent light, corresponding to whispering-gallery-mode (WGM) resonances (1).

As with applications of PDLCs we also applied an external AC electric field to the thin layer of PDMS containing LC microresonators. The field changes the internal structure of the LC droplet thus also altering the refractive index for the light circulating around the droplet. The change in the refractive index resulted in large shift of WGM resonances towards shorter wavelengths. The WGM shift is of the order of 20 nm at 2.6 V/μm in 17 μm diameter droplets. This value is one to two orders of magnitude larger compared to already published values for electrical tuning (2,3,4). More importantly the spectral shift exceeds the free spectral range, meaning that the resonator frequencies can be shifted to any value. The tuning is also almost linear with voltage and without hysteresis.

Electrically tunable liquid crystal optical microresonators could be used as active optical microcomponents such as tunable laser sources, active filters and switches.

References

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