

Temperature and Electric Field – Stimulated Laser Tuning from Cholesteric Liquid Crystal Microdroplets

Nino Ponjavidze, Gia Petriashvili, Ketevan Chubinidze, Andro Chanishvili, Salome Petriashvili
Institute of Cybernetics of the Georgian Technical University, Z. Andzaparidze str. 5, 0186, Tbilisi
*Corresponding author e-mail: nino.ponjavidze778@gmail.com

Cholesteric Liquid crystals (CLCs) in complex shapes, especially in the form of droplets and shells, have garnered significant interest. In CLC, rod-like molecules are aligned with their axes parallel to one another, forming a structure known as the director. By using CLCs as a non-miscible, oil-like soft matter, it is possible to spontaneously form a spherical microcavity with a radial variation in the refractive index. CLC microdroplets are particularly attractive because of their perfect rotational symmetry in three dimensions, which means that the photonic band gap (PBG) remains consistent regardless of the light's propagation direction. The CLC microdroplets exhibit various orientational structures that change when an electric or thermal field is applied [1, 2]. Notably, the stimulated laser emission from luminescent-dye-doped CLC microdroplets provides stable, reversible, and tunable laser outputs. In this study, we present a method for achieving three-dimensional, omnidirectional tunable lasing controlled by both thermal and electric fields. This method uses luminescent dye-doped CLC (DDCLC) microdroplets with diameters of 30-50 μm . These microdroplets are suspended in an isotropic carrier fluid and spontaneously self-assemble within fractions of a second when a dilute CLC phase is dispersed into an immiscible host fluid, such as a water-polyvinyl alcohol (PVA) mixture. When excited with a nitrogen laser, we achieve stable, reversible tuning of the laser emission lines, controlled by temperature and the electric field (Fig. 1).

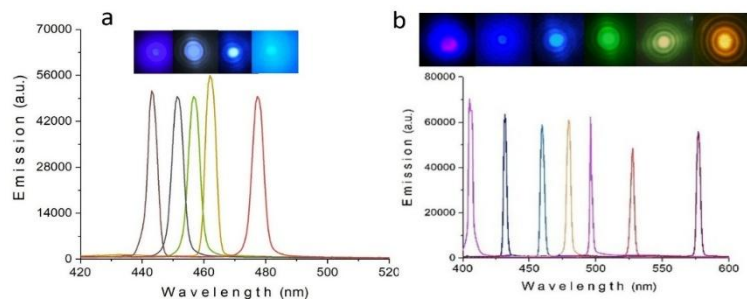


Fig. 1. Temperature (a) and electric field (b) controlled tuning of laser lines from DDCLC microdroplets

Various applications of DDCLC microlasers controlled by temperature and electric fields include smart optics, sensors, telecommunications, optical computing, displays, holography, programmable photonic devices, and medical imaging.

References

- [1] Y. Shang, J. Wang, J. Liu, Chemistry-An Asian Journal **20**, 24 e0093 (2025), <https://doi.org/10.1002/asia.202500932>
[2] G. Petriashvili, A. Chanishvili, Ts. Zurabishvili, K. Chubinidze, N. Ponjavidze *et al.*, OSA Continuum, **2**, 11 (2019) <https://doi.org/10.1364/OSAC.2.003337>

Acknowledgments This work was supported by the Shota Rustaveli National Science Foundation of Georgia, project number YS-24-783