Organic Chromophores and Liquid Crystals as Systems for Nonlinear Optics and Molticolor Laser Light Appications

Jaroslaw Mysliwiec

Soft Matter Optics Group,
Wroclaw University of Science and Technology, Poland
e-mail: jaroslaw.mysliwiec@pwr.edu.pl

Abstract

The search of materials for luminescence, amplified spontaneous emission, lasing, generation of second harmonic of light or two photon fluorescence is one of the important subjects of modern photonics and nanotechnology. Such materials of potential use in construction of photonics devices should exhibit also several other properties, like excellent optical quality, ease of processing, cost effectiveness and they should be environmentally- and bio-friendly, etc... Dye-doped organic mono and hybrid systems in nano- and micro scale find many applications in photonics. Interest in these systems is focused not only on investigations of their macroscopic fundamental physicochemical properties (including spectroscopic measurements – like absorption and fluorescence excitation), but also nanoscopic ones. Tunability is also an important aspect of lasers [1]. Nowadays there are many possible ways to achieve this advantageous property; however, dynamic tuning is limited. Red to InfraRed emissive dyes allow a direct visualization of molecular interactions, through deep tissue penetration, along with minimal tissue damage. In our studies we use simple systems based on dye-doped polymeric or liquid-crystal thin films, for distributed feedback (DFB) and random lasing (RL) investigations.

As active compounds we have applied novel *push-pull* organic molecules which contain an electron donor (D) and an electron acceptor (A) units that are covalently linked by a π-conjugated bridging group (D-π-A systems) exhibiting an intramolecular charge transfer (ICT) states. Also Excited-State Intramolecular Proton Transfer (ESIPT) compounds, have attracted our considerable attention, due to their unique optical properties. Such structure enabled real-time red-green-blue (RGB) switching of emission, both in solution and solid-state, providing white laser light emission. We show strong dependence on environment polarity, as well as Aggregation-Induced Emission Enhancement (AIEE) properties, and successful implementation of ESIPT molecules in DFB lasing, both in solution and solid-state.

Finally, we show that using organic dyes, doped liquid crystalline systems or multifunctional phase-separation systems based on polymer matrix encompassing liquid crystals, ionic liquids and multiple organic chromophores, we can get muclitoclor (including white) lasing emission. [2-5]

References

[1] J. Mysliwiec, A. Szukalska, A. Szukalski, L. Sznitko (2021) *Nanophotonics,* 10(9), 2309.
[2] A. Adamow, A. Szukalski, L. Sznitko, L. Persano, D. Pisignano, A. Camposeo, J. Mysliwiec (2020) *Light Science and Applications*, 9, 19.
[3] A. Szukalska, A. Szukalski, M. Adaszynski, J. Mysliwiec (2023) *Adv. Opt. Mater.,* 2300266.
[4] A. Szukalska, J. Mysliwiec (2023) *J. Mater. Chem. C*, 11, 8724.
[5] A. Szukalska, M. Czajkowski, J. Cybinska, J. Mysliwiec (2024) *Adv. Funct. Mater.,* 2401288.