Žemo slenkščio sustiprinta savaiminė spinduliuotė organiniuose fluoreno darinių kristaluose

Low threshold amplified spontaneous emission in organic crystals based on fluorene derivatives

Gediminas Kreiza[1], Paulius Baronas[1], Edvinas Radiunas[1], Povilas Adomėnas[1], Chihaya Adachi[2], Karolis Kazlauskas[1], Saulius Juršėnas[1]

[1]Institute of Applied Research, Vilnius University, Saulėtekio al. 3, LT-10222 Vilnius, Lithuania

[2] Center for Organic Photonics and Electronics Research (OPERA), Kyushu University, 744 Motooka, Nishi, Fukuoka 819-0395, Japan

gediminas.kreiza@tmi.vu.lt

Organic single crystals have attracted a lot of interest in recent years for solid-state laser applications because of their high chemical purity and long range order [1]. High fluorescence quantum yield values and high radiative decay rates are one of the main factors determining amplified spontaneous emission (ASE) threshold. At this point controlling of these properties in crystalline state not only by molecular design but also by intermolecular interactions becomes of crucial importance [2].

In this work two fluorene derivatives (FpF and F2pF) were designed to possess twisted molecular structure comprising of singly bonded phenyl and fluorene chromophores with out-of-plane sticking dimethyl moieties for reduced intermolecular coupling, and thus for enhanced fluorescence and ASE properties in the solid state. The flexible molecular backbone also facilitated increased electron–vibronic coupling implying large Stokes shift (0.5 eV) and thereby reduced reabsorption of emission, which resulted in demonstration of fluorescence quantum yields up to 90% and radiative decay rates up to 1.3×10^9 s^{-1} in a dilute polystyrene matrix.

Both fluorene derivatives showed superior fluorescence properties (high quantum yields and high radiative decay rates) not only in a dilute polymer matrix but also in single crystals grown by physical vapor transport in nitrogen atmosphere which was determined by weak intermolecular interactions. The high radiative rates accompanied by excellent waveguiding properties, favorable orientation of transition dipole moments as well as non-overlapping excited-state absorption and gain regions enabled achieving extremely low ASE thresholds (1.8 kW/cm^2 for FpF and 0.7 kW/cm^2 for F2pF) in these fluorene-based single crystals. The achieved low threshold values encourage employment of rationally designed molecules in organic crystals for solid state lasing applications.

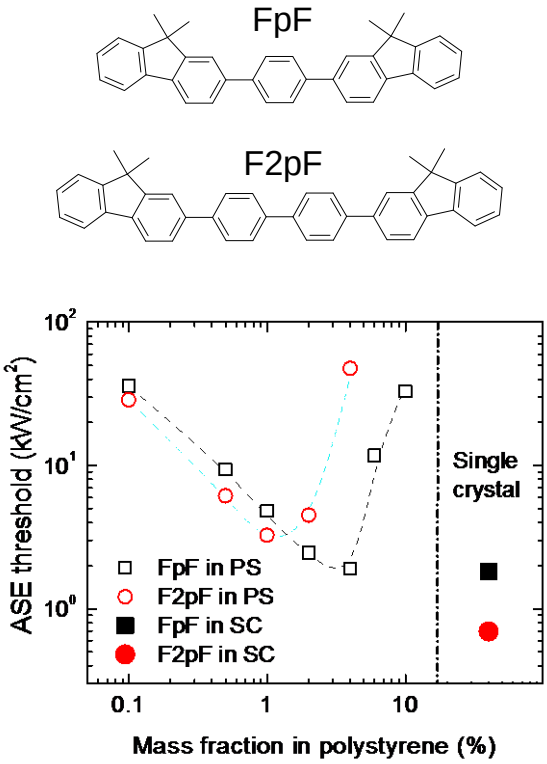

Figure 1. Molecular structure of fluorene derivatives (above), ASE threshold as a function of concentration in polystyrene matrix (below). ASE threshold values in single crystals are included for comparison.

Keywords: organic single crystals, fluorene derivatives, ampified spontaneous emission.

Literature:

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