有機半導体レーザ発振における電流励起と光励起の相関

Correlation between Electrical- and Optical- Driven Mode in Oscillation of Organic Semiconductor Lasers

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Compared to inorganic semiconductors (ISCs) such as GaN, organic semiconductors (OSCs) have many fascinating features such as flexibility, a feasible process, low cost-high performance as well as human-friendly texture[3]. In addition, considering that there are a variety of molecules in OSCs, lasers showing multi-color emission can be anticipated ranging from nearly deep-ultraviolet to far-infrared, and therefore realization of OSC lasers (OSCLs) has been an important research theme in optoelectronics. Nevertheless, many researchers have been continuing to target its realization. Optically driven solid-state OSCLs (op-OSCLs) have later been exemplified, and laser emission with various colors has been demonstrated to date. However, successful operation of electrically driven OSCLs (el-OSCLs) had still not yet been achieved due to the low carrier mobilities and the low electron-injection efficiency in OSCs. Recently, we have challenged for the realization of el-OSCLs and reported very intriguing indication of a successful el-OSCL with FET structure using sc-BP3T as a laser medium, where very sharp laser emission reaching the resolution limit of a detector emerges with a nonlinear increase in its intensity above the clear threshold of injection current density. For the purpose of realizing highly efficient light-emitting devices such as OSC lasers, the fundamental understanding on the difference between EL and PL are necessary. Here, we report accurate comparative studies on the difference between PL and EL of 5,5''-Bis(4-biphenylyl)-2,2':5',2''-terthiophene (BP3T). The result shows the spectrum shapes are different between EL- and PL- mode in the case of single-crystal thin films of BP3T and indicates there are the quenching of fluorescent emissions in high current region in EL-mode. In order to realize highly efficient light-emitting OFETs towards OSC lasers in the future, this annihilation should carefully be taken into account.