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Separation of Carrier-Transport and Light-Emission Functions in a Light-Emitting Organic Transistor with Bilayer Configuration

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In recent years, there is great interest in developing an electrically driven organic laser as it would provide a new class of convenient and easy-to-manufacture laser. Organic single crystal based ambipolar light-emitting field effect transistors (LE-FETs) is treated as the candidate to realize laser, because in the ambipolar organic LEFET the position of the recombination zone can be moved within the transistor channel by the applied gate and drain voltages to be far away any from absorbing metal electrodes which can just satisfy the requirement of high excitation densities for laser. Besides improving the technique of fabricating device, the active layer should contain both superb luminescent property and high charge-carrier mobility, which are always competing with each other in one material.

Our basic concept for solving aforementioned problem is divide these two factors (high carrier mobility and high PL efficiency) into two layers, and the combination of these two layers acts as the active layer of LEFET. As shown in Fig.1a, bottom layer with high carrier mobility can be assigned as carrier transporter, and top layer with high PL efficiency was assigned as light emitter. After injection, the carriers will have a recombination in the bottom layer and formed exciton will transfer into the top layer with light emission.

In this work, we have fabricated bilayer structure device, in which tetracene was used as bottom crystal (high carrier mobility) and 4-(dicyanomethylene)-2-methyl-6-(p-dimethylaminostyryl)-4H-pyran (DCM) doped tetracene (improved PL efficiency) was laminated on tetracene as light emitter. Fig. 1d has showed light emission from top crystal (red color), from which our aforementioned hypothesis was preliminary proved. Details and further work will be reported in the presentation.

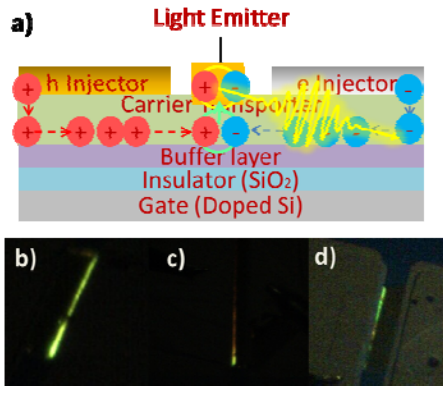

Figure 1. (a) is schematic drawing of bilayer device structure, (b), (c) and (d) are current driven light emssion in pure tetracene, doped tetracene and bilayer crystals, respectively.