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Enhancement of Luminescence Intensity in TMPY/Perylene Co-Single Crystal

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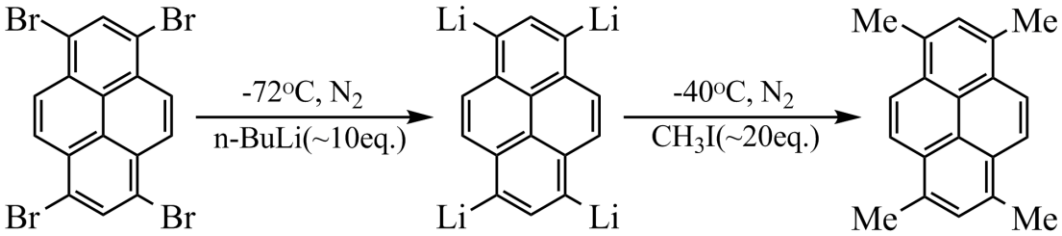
【Introduction】

Recently, light-emitting organic field-effect transistors (LEOFETs) are of interest both for practical application, such as displays industry, and for understanding the fundamental characteristics of carrier injection, transport, and exciton recombination processes in organic semiconductor. To make high performance OLEFET, it is essential to coping with two factors: (1) Ambipolar property with high carrier mobility. (2) High luminescence quantum yield. However, it is quite difficult to combine the two factors because the high mobility often needs strong molecular packing, but strong packing structures lead to increasing non-radiative decay paths for excitons, which cause the devices exhibit low quantum yield. One promising way to overcome this contradiction is introducing the host-guest system which wide gaped host and narrow gaped guest play a role of carrier transport and luminescence center, respectively.

In this paper, a new molecule 1, 3, 6, 8-tetramethylpyrene (TMPy), which has the similar shape to the renowned luminescence material perylene, has been successfully synthesized. We use perylene as the narrower HOMO-LUMO gaped guest materials to dope into the wider gaped host TMPY single crystals. Now some single crystals with different percentage had been grown, their luminescence properties had been characterized. From the luminescence spectra, we can find the luminescence performance is significant enhanced.

【Experiment】

Synthesis scheme of TMPY:



The mixed co-crystals were made by physical vapor transportation. Two temperature zones were used for crystal growth. We successfully get the crystal structure of pure TMPY and co-crystal (Perylene 12.8%).

For investigating the luminescence performance, we measure the absorption spectra and emission spectra of pure TMPY and co-single crystals. The photoluminescence quantum yields were also checked.

【Results and Discussion】

The cell parameters are not dramatically changed between pure TMPY and co-crystal. Since TMPY has the similar shape as the perylene, this reduces the mismatch in the crystal lattice. Figure 1 shows crystal structure of $TMPY_{0.87}perylene_{0.13}$ co-single crystal. TMPY molecules are partially substituted by perylene molecules. The absorption spectra showed that the energy is mainly absorbed by TMPY molecules in co-crystal.

We measured the emission spectra of doped co-crystal with different perylene ratios. There is no emission from the TMPY molecules but only emission from the perylene molecules. This result convinces that there is an effective energy transfer from the TMPY to perylene. From the photoluminescence quantum yields of different ratios co-crystal, we can find the luminescence efficiency is significantly enhanced (~ 80 %) compared with pure TMPY (~ 3 %) as shown in Figure 2.

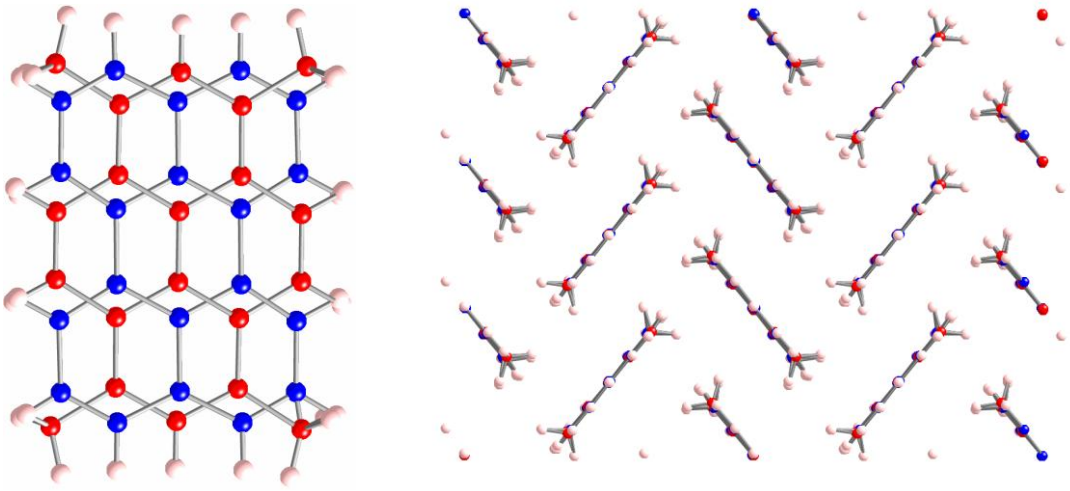


Figure 1. Crystal structure of $TMPY_{0.87}perylene_{0.13}$ co-crystal. Red: TMPY, Blue, perylene

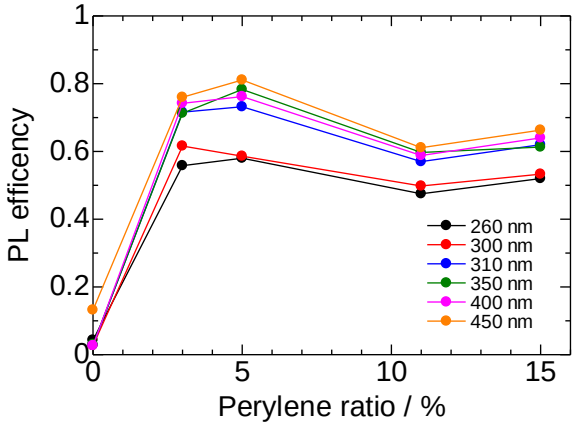


Figure 2. PL quantum efficiency of TMPY/perylene co-single crystals.