High Efficiency TADF-based Transparent OLEDs

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In this research, two new molecules DMAC-mmCN and DMAC-mpCN configured as donor (D)-pi-bridge-acceptor (A) were prepared to examine the property of thermally activated delayed fluorescence (TADF) and to make organic light emitting diodes (OLEDs). We selected dimethylacridine (DMAC) as D and phenylene as pi-bridge linking to CN-substituted benzene with two CN groups at different positions as acceptors. With cyclic voltammetry (CV), we observed a lower reduction potential of DMAC-mpCN as compared to that of DMAC-mmCN. The results indicate that DMAC-mpCN has a stronger electron-withdrawing acceptor, therefore, a stronger intramolecular transfer leading to a red-shifted emission comparing to DMAC-mmCN. Then, we measured the emission spectra of DMAC-mmCN and DMAC-mpCN blended films (5% in 26DZPPY) to determine the energy gap between the singlet (S1) and triplet (T1) excited states as well as the photoluminescence quantum yields (PLQYs). DMAC-mpCN was found to have an energy gap between S1 and T1 of 0.17 eV, indicating the potential of giving TADF. However, the transient fluorescence decay times indicated that there is no delayed component in micro-second range as observed in typical TADF cases. Nevertheless, we decided to make devices using DMAC-mpCN (15% in mCPCN) as the emitting layer because of its high PLQY of 93%. Interestingly, the device give a maximum EQE up to 26%, which is far beyond the theoretical efficiency of a fluorescent emitter without TADF contribution. We believe that a “hidden TADF” mechanism is working in DMAC-mpCN. In addition, we have fabricated transparent OLEDs employing DMAC-mpCN as the emitter. Our transparent devices may have great potential for the applications in the innovative wearable displays such as Google glasses.

Awards Won:
Third Award of $1,000