Cesium Azide - An Efficient Electron Injection Material for Green and Red Quantum Dot Light-Emitting Diodes

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A novel efficient and air-stable electron injection layer (EIL) of cesium azide (CsN_3) was compared with conventional ones (LiF) in type-II quantum dot light-emitting diodes (QLEDs) with both organic electron and hole transport layers. Via directly decomposing to pristine cesium (Cs), the low-temperature evaporated CsN_3 provided a better interfacial energy level alignment without damaging the underneath organic layer. Consequently, in comparison to similar devices with LiF, the current efficiencies of 0.276 and 6.33 cd/A have been achieved in the red-emitting and green-emitting QLEDs based on CsN_3, which were about 141% (at 1 mA) and 620% (at 0.1 mA) improvement with the maximum luminance exceeding 1020 and 5250 cd/m^2, respectively.

Figure 1 (a) exhibits the energy band diagram of QLEDs with different alkali metal compounds as EILs. In type-II architecture QLEDs, it is acceptable that the enhancement of electron injection by utilizing low WF EIL is an important key to improve performance of QLEDs. The WFs of LiF and CsN_3 are 2.9 and 2.14 eV as results of decomposing reactions under high evaporation temperature, respectively.

Fig.1. (b), (c) shows the current density-voltage (J-V) and luminance-voltage (L-V) characteristics of green and red QLEDs with different EILs. The current and luminance of QLEDs increased significantly by utilizing CsN_3 EIL in comparison with the LiF-devices. In case of red QLEDs for example, the maximum luminance in CsN_3-devices was 1025 cd/m^2 and the driving voltage at the current of 1mA was 8.2 V, whereas those values were 169.6 cd/m^2 and 14.9 V for the LiF-devices, respectively. The same results were observed at the CsN_3 based green QLEDs where the maximum luminance reached over 5000 cd/m^2 and the ~ 43% reduction of driving current (@ 0.1 mA) from 22.8 V to 13 V at the LiF-devices was observed.

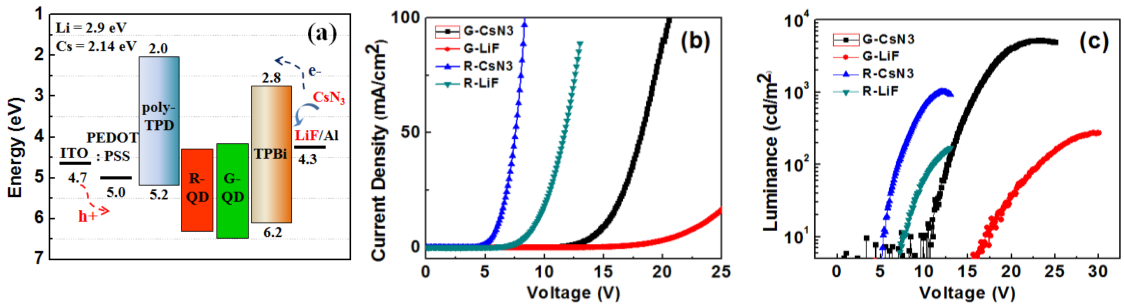

Fig. 1. (a) Energy band diagram of QLEDs, (b) J-V and (c) L-V characteristics

We have proposed an efficient electron injection layer based on CsN_3 to fabricate type-II green and red QLEDs. Robust air-stability, low-temperature evaporation, and certain decomposition make CsN_3 an ideal electron injection material in QD-related applications.

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