Supporting Information

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Constructing Effective Hole Transport Channels in Cross-Linked Hole Transport Layer by Stacking Discotic Molecules for High Performance Deep Blue QLEDs

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Constructing Effective Hole Transport Channels in Cross-linked Hole Transport Layer
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As shown in Figure S2a, the maximum absorption peak of CBP-V is at 336 nm. The optical band gap ($E_g$) of the CBP-V film is determined to be 3.3 eV by the band edge of the UV-vis spectrum. For CBP-V, $E_{\text{cutoff}}$ and $E_{\text{onset}}$ were observed at 17.12 and 1.72 eV respectively. The energy of UV excitation light is 21.2 eV, and the HOMO energy level of CBP-V were calculated according to $\text{HOMO} = 21.2 - E_{\text{cutoff}} + E_{\text{onset}}$, which was -5.8 eV for CBP-V. Lowest unoccupied molecular orbital (LUMO) energy levels of CBP-V is calculated to be -2.5 eV.
Figure S3. FT-IR spectra of (a) CBP-V and (b) composite HTL films before and after cross-linking.
Figure. S4. Different HTL images observed under the polarizing microscope: (a) T5DP-2,7; (b) CBP-V; (c) CBP-V : T5DP-2,7 (10wt%); (d) CBP-V : T5DP-2,7 (20wt%); (e) CBP-V : T5DP-2,7 (30wt%); (f) CBP-V : T5DP-2,7 (40wt%); (g) CBP-V : T5DP-2,7 (50wt%).
Figure S5. UV-vis absorption spectra of CBP-V(a), CBP-V:T5DP-2,7 (10wt%) (b), CBP-V:T5DP-2,7 (20wt%) (c), CBP-V:T5DP-2,7 (30wt%) (d), and CBP-V:T5DP-2,7 (40wt%) (e) before and after toluene rinsing.
Figure. S6. TEM images of CBP-V:T5DP-2,7 (10wt%) (a); CBP-V:T5DP-2,7 (20wt%) (b); CBP-V:T5DP-2,7 (30wt%); (c) and CBP-V:T5DP-2,7 (40wt%) (d).

Figure. S7. AFM images of CBP-V:T5DP-2,7 (10wt%) (a); CBP-V:T5DP-2,7 (20wt%)(b); CBP-V:T5DP-2,7 (30wt%) (c); and CBP-V:T5DP-2,7 (40wt%) (d).
Figure S8. AFM image of QDs based on different HTL: (a) CBP-V; (b) CBP-V:T5DP-2,7(10wt%); (c) CBP-V:T5DP-2,7(20wt%); (d) CBP-V:T5DP-2,7(30wt%); (e) CBP-V:T5DP-2,7(40wt%).

Figure S9. J-V characteristics of (a) ITO/PEDOT:PSS/HTL/MoO3/Al and (b) ITO/ZnO:PVP/Al.
Figure S10. (a) hole-only device. (b) electron-only device.

Figure S11. EL spectrum of QLEDs with different HTLs.
Figure S12. Histogram of peak EQEs measured from 72 devices (P < 0.05).

Figure S13. Synthesis routes of T5DP-2,7.
Fig S14. $^1$H NMR spectra of 3,6,10,11-tetrakis(pentyloxy)triphenylene-2,7-diyl bis(2,2-dimethylpropanoate).
Fig S15. Mass spectrum of 3,6,10,11-tetrakis(pentyloxy)triphenylene-2,7-diyl bis(2,2-dimethylpropanoate).
Table S1. Hole mobility of the different HTM

| HTM      | Hole mobility (cm$^2$V$^{-1}$s$^{-1}$) | Ref   |
|----------|----------------------------------------|-------|
| TFB      | 3.0×10$^{-3}$                          | [1]   |
| PVK      | 2.5×10$^{-6}$                          | [2]   |
| TCTA     | 1.0×10$^{-5}$                          | [3]   |
| Poly:TPD | 1.0×10$^{-4}$                          | [4]   |
| CBP      | 1.0×10$^{-3}$                          | [5]   |
| NPB      | 8.8×10$^{-4}$                          | [6]   |
| T5DP-2,7 | 2.6×10$^{-2}$                          | This work |

Table S2. QDs Fitting results for TRPL decays progress of QDs films

| Structure                        | A$_1$ | $\tau_1$(ns) | A$_2$ | $\tau_2$(ns) | $\tau$ave (ns) | $k_{CT}$ (10$^6$·s$^{-1}$) | $\eta_{CT}$ (%) |
|----------------------------------|-------|--------------|-------|--------------|----------------|--------------------------|-----------------|
| QD                               | 0.76  | 5.83         | 0.24  | 29.27        | 20.20          |                          |                 |
| V-CBP/QD                         | 0.77  | 5.67         | 0.23  | 29.14        | 19.88          | 0.79                     | 1.58            |
| V-CBP:T5DP-2,7 (10wt%)/QD        | 0.77  | 5.65         | 0.23  | 28.22        | 19.16          | 2.69                     | 5.15            |
| V-CBP:T5DP-2,7 (20wt%)/QD        | 0.78  | 5.40         | 0.22  | 27.15        | 18.15          | 5.59                     | 10.14           |
| V-CBP:T5DP-2,7 (30wt%)/QD        | 0.78  | 5.25         | 0.22  | 26.25        | 17.53          | 7.54                     | 13.21           |
| V-CBP:T5DP-2,7 (40wt%)/QD        | 0.79  | 5.10         | 0.21  | 25.44        | 16.69          | 10.41                    | 17.37           |
Table S3. Device performance comparison of blue QLEDs with HTL modification

| HTL            | V_{cd}(V) | λ_{max} (nm) | L_{max}(cd/m²) | EQE (%) | CIE    | Ref                              |
|----------------|-----------|--------------|----------------|---------|--------|----------------------------------|
| poly-TPD/DNA   | 3.3       | 462          | 16655          | 5.65    | (0.14,0.05) | Adv. Optical Mater. 2018, 1800578 |
| PVK/TFB        | 4.1       | 454          | 4140           | 5.99    | -      | ACS Nano 2018, 12, 1564–1570    |
| TPD/PVK=1:1    | 3.1       | 457          | 10824          | 8.62    | (0.15,0.04) | ACS Appl. Mater. Interfaces 2018, 10, 3865–3873 |
| TFB/Li-PVK     | 4.0       | 452          | 5829           | 5.37    | (0.15,0.03) | Superlattices and Microstructures 2020, 140, 10646 |
| TFB/ PVK       | 2.46      | 468          | 13944          | 13.7    | -      | Organic Electronics 2021, 94, 106169 |
| DV-FLCZ        | 2.8       | 475          | -9800          | 8.5     | (0.11,0.13) | Materials Chemistry Frontiers 2020, 4, (11), 3368-3377. |
| PFCz           | 3.2       | 460          | 48000          | 12.61   | -      | Organic Electronics 2021, 92, 106138 |
| TFB            | 5.8       | 445          | 4500           | 15.6    | -      | Nanoscale, 2017, 9, 13583–13591  |
| C-TFB          | 2.2       | 476          | -8000          | 8.8     | (0.11,0.12) | ACS Appl. Mater. Interfaces 2020, 12, 58369–58377 |
| This work      | 3.42      | 461          | 44080          | 18.59   | (0.14,0.04) | This work                        |

Table S4. Fitting parameters of the Nyquist plots for QLEDs based on different HTL

| HTL            | R_s (kΩ) | R_{tr} (kΩ) | CPE_1(S·Sec^n) | n_1 | R_{rec}(kΩ) | CPE_2(S·Sec^n) | n_2 |
|----------------|----------|-------------|----------------|-----|-------------|----------------|-----|
| CBP-V          | 0.26     | 15.22       | 5.49E-6        | 1.07| 61.89       | 6.36E-6        | 1.03|
| CBP-V:T5DP-2,7 | 0.25     | 2.66        | 4.95E-6        | 1.12| 29.35       | 4.66E-6        | 1.07|
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