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ARTICLE

Poly(*m*-phenylene): Conjugated Polymer Host with High Triplet Energy for Efficient Blue Electrophosphorescence

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ABSTRACT: A poly(*m*-phenylene) derivative tethering carbazole unit (PmPCz) is reported to have a triplet energy level (E_T) as high as 2.64 eV, sufficient to host blue electrophosphorescence. To our best knowledge, this is the first conjugated polymer with E_T higher than that of state-of-the-art blue phosphorescent dopant, iridium(III) bis(4,6-(difluorophenyl)pyridinato-*N*,C^2)picolinate (FIrpic). PmPCz exhibits good thermal stability and excellent miscibility with the blue phosphorescent dopant, FIrpic. Owing to the high E_T and good miscibility, blends of PmPCz with FIrpic show no triplet energy back-transfer and exhibit emission exclusively from FIrpic, even at FIrpic concentration as low as 1 wt %. Single-layer blue phosphorescent polymer light-emitting diode based on the blend exhibits a luminance efficiency of 4.69 cd/A.

Introduction

Phosphorescent polymer light-emitting diodes (PPLEDs) based on a phosphorescent dopant dispersed in a polymer host have received great attention thanks to solution processability and internal quantum efficiency potentially as high as 100%.[1−13] For both display and lighting applications, all three primary colors (red, green, and blue) are necessary. At present, the performance of blue PPLEDs lags far behind that of green and red PPLEDs, largely due to lack of a suitable polymer host.[6−10] Blue PPLEDs typically use nonconjugated polymers as the host, such as poly(vinylcarbazole) (PVK).[6−9] However, PVK transports only holes and requires the use of additional electron transporting materials. Their high resistivity leads to rather high operating voltages of the resulting devices. Recently, an alternative approach for blue PPLEDs is to use solution-processable small molecules as the host.[14,15] However, this approach suffers from tedious multistep organic synthesis of the materials and complicated device fabrication (extra vacuum-deposited electron-transporting layer is necessary). Conjugated polymers have been demonstrated to be excellent host for red and green PPLEDs with low driving voltage and high electroluminescence (EL) efficiency.[3−5] However, they are scarcely used in blue PPLEDs due to their low triplet energy level (E_T). A host should have an E_T higher than that of the phosphorescent dopant. Otherwise, triplet energy back-transfer from the dopant to the host will occur and lead to low EL efficiency.[16] The state-of-the-art blue phosphorescent dopant, iridium(III) [bis(4,6-difluorophenyl)-pyridinato-*N*,C^2]-picolinate (FIrpic), has an E_T of 2.62 eV. Unfortunately, no conjugated polymer is known to exhibit an E_T higher than 2.6 eV. The only conjugated polymer reported as the host for FIrpic is poly(3,6-fluorene) with an E_T of 2.58 eV, which is slightly lower than that of FIrpic.[13] The resulting PPLEDs show a maximum luminance efficiency of only 0.4 cd/A. Therefore, it is challenging but critically important to develop conjugated polymer hosts with high E_T.

Brunner et al. reported that E_T of conjugated polymers were determined by the longest poly(*p*-phenylene) chains that can be identified in the molecular structure.[17,18] In poly(3,6-fluorene), the longest poly(*p*-phenylene) chain is biphenyl structure (marked as blue in Figure 1). We observe that the moieties adjacent to the biphenyl structure also affect the E_T. For instance, 1,3-diphenylbenzene has a lower E_T (2.82 eV) than that of biphenyl (2.85 eV).[19] In poly(3,6-fluorene), owing to the nature of fluorene, the phenyl rings (marked as red) adjacent to the biphenyl structure (marked as blue) are coplanar with the biphenyl structure. Such a coplanarity increases conjugation and lowers the E_T of the biphenyl structure and of the conjugated polymer backbone. This effect may be circumvented in poly(*m*-phenylene), in which the phenyl rings (marked as red) adjacent to the biphenyl structure (marked as blue) are twisted with the biphenyl structure (see Figure 1). Therefore, poly(*m*-phenylene) is expected to have a high E_T that can be sufficient to host FIrpic.

Here, we report a poly(meta-phenylene) derivative (PmPCz) with an E_T of 2.64 eV as a conjugated polymer host for high-efficiency blue PPLEDs. The chemical structure of PmPCz shown in Figure 1 has a poly(*m*-phenylene) backbone and carbazole unit tethered as a side group to facilitate hole injection and to improve compatibility with phosphorescent dopants.[20] To our best knowledge, this is the first time for poly(*m*-phenylene) derivative to be used in PPLEDs. Moreover, this is the first conjugated polymer with E_T higher than that of FIrpic. The higher E_T of PmPCz than that of FIrpic prevents triplet energy back-transfer from FIrpic to PmPCz and leads to high EL efficiency. The resulting PPLEDs emits blue light with a luminance efficiency that is more than 10 times higher than that of the device based on poly(3,6-fluorene).[13] Moreover, the high E_T of PmPCz and high compatibility between PmPCz and FIrpic allow the use of the expensive iridium(III) dopant at a very low concentration (1 wt %), which is very desirable for low-cost PPLEDs.

Experimental Section

General. 9-Hexyl-9*H*-carbazole (Cz),[20] 1,3-dibromo-5-butoxybenzene (**4**),[21] and poly(5-butyloxyphenylen-1,3-yl)[21] were synthesized following the procedures in the literature. All the reactions were carried out under an argon atmosphere.

9-(6-Bromohexyl)-9H-carbazole (***1***). To a solution of carbazole (8.35 g, 50 mmol) in dry THF (40 mL) was added NaH

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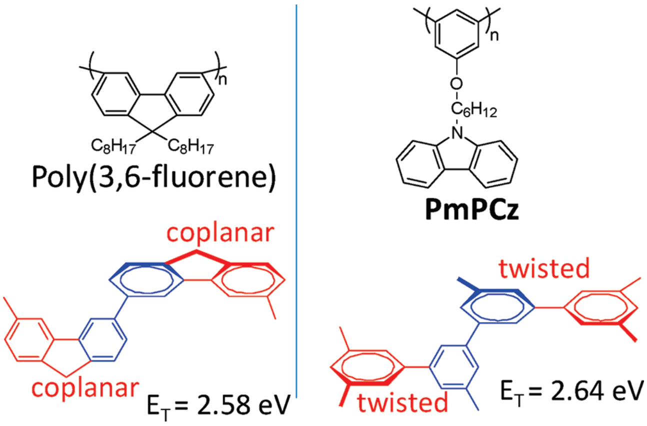


Figure 1. Chemical structure, schematic illustration, and triplet energy of poly(3,6-fluorene) and PmPCz. The E_T of the polymer backbones are determined by the biphenyl structure marked as blue. Moreover, the moieties adjacent to the biphenyl structure also influence the E_T. In poly(3,6-fluorene), the adjacent two phenyl units (marked as red) are coplanar with the corresponding phenyl ring in the biphenyl structure (marked as blue) due to the nature of fluorene. Such coplanarity decreases the E_T. In contrast, the coplanarity effect is avoided in the case of poly(*m*-phenylene) backbone. Therefore, PmPCz is expected to exhibit higher E_T than that of poly(3,6-fluorene).

(2.52 g, 63 mmol) in several portions. The resulting solution was stirred for 10 min at room temperature, followed by added dropwise to a refluxing solution of 1,6-dibromohexane (45.00 mL, 292 mmol) in THF (100 mL). Then the mixture was refluxed for 24 h. After being cooled to room temperature, the mixture was added several drops of water to destroy the excessive NaH, followed by remove of THF with rotatory evaporation and remove of excessive 1,6-dibromohexane with vacuum distillation. The residual was dissolved in CH_2Cl_2, washed with water three times, dried over anhydrous Na_2SO_4, filtered, and concentrated. Further purification by flash column chromatography with CH_2Cl_2/hexane = 1/4 as eluent gave the title compound as a white solid. Yield: 13.81 g (82.9%). ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm): 8.10 (d, 2H), 7.48 (t, 2H), 7.40 (d, 2H), 7.22 (t, 2H), 4.32 (t, 2H), 3.36 (t, 2H), 1.90 (m, 2H), 1.81 (m, 2H), 1.47 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm): 140.41, 125.63, 122.86, 120.39, 118.79, 108.60, 42.87, 33.72, 32.58, 28.84, 27.94, 26.49. HR-MS (*m*/*z* (%)): 330.08 (100) $[M + H]^+$. Anal. Calcd for $C_{18}H_{20}BrN$: C, 65.46; H, 6.10; N, 4.24. Found: C, 65.48; H, 6.14; N, 4.11.

9-(6-(3,5-Dibromophenoxy)hexyl)-9H-carbazole (**2**). A mixture of 3,5-dibromophenol (2.32 g, 9.2 mmol), 9-(6-bromohexyl)-9*H*-carbazole (**1**) (3.63 g, 11.0 mmol), K_2CO_3 (3.94 g, 28.6 mmol), and DMF (30 mL) was stirred at 110 °C overnight. After being cooled to room temperature, the mixture was poured into brine and extracted with CH_2Cl_2. The organic layer was washed with brine four times, dried over anhydrous Na_2SO_4, filtered, and concentrated. The residual was purified by flash column chromatography with CH_2Cl_2/hexane = 1/4 as eluent to afford the title compound as a white crystal. Yield: 4.10 g (88.9%). ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm): 8.11 (d, 2H), 7.47 (td, 2H), 7.40 (d, 2H), 7.24 (m, 3H), 6.95 (d, 2H), 4.33 (t, 2H), 3.84 (t, 2H), 1.92 (m, 2H), 1.72 (m, 2H), 1.45 (m, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm): 160.25, 140.43, 126.23, 125.63, 123.10, 122.87, 120.42, 118.81, 116.89, 108.62, 68.33, 42.90, 28.92, 28.85, 26.98, 25.83. HR-MS (*m*/*z* (%)): 502.01 (100) $[M + H]^+$. Anal. Calcd for $C_{24}H_{23}Br_2NO$: C, 57.51; H, 4.62; N, 2.79. Found: C, 57.77; H, 4.53; N, 2.76.

9-(6-(3-Bromo-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-phenoxy)hexyl)-9H-carbazole (**3**). To a solution of 9-(6-(3,5-dibromophenoxy)hexyl)-9*H*-carbazole (**2**) (2.04 g, 4.0 mmol) in dry THF (60 mL) at −78 °C was added *n*-BuLi (1.60 mL 2.5 M solution in hexane, 4.0 mmol). The resulting solution was stirred at −78 °C for 1 h, followed by addition of 2-isopropyloxy-4,4,5,5-tetramethyl-1,3,2-dioxaboronate (1.10 mL, 5.5 mmol) and stirring overnight. After work-up, the mixture was poured into water and extracted with CH_2Cl_2. The organic layer was washed with water for three times and dried over anhydrous Na_2SO_4. After being filtered and concentrated, the residual was purified by column chromatography with CH_2Cl_2/hexane = 1/1 as eluent to give the title compound as a white solid. Yield: 0.68 g (31%). ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm): 8.10 (d, 2H), 7.47 (m, 5H), 7.23 (m, 3H), 7.10 (dd, 1H), 4.43 (t, 2H), 3.91 (t, 2H), 1.92 (m, 2H), 1.73 (m, 2H), 1.46 (m, 4H), 1.34 (s, 12H). ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm): 159.41, 140.43, 129.63, 125.63, 122.85, 122.9, 120.37, 118.76, 108.64, 84.19, 67.97, 42.94, 29.07, 28.92, 27.02, 25.89, 24.86. HR-MS (*m*/*z* (%)): 550.18 (100) $[M + H]^+$. Anal. Calcd for $C_{30}H_{35}BBrNO_3$: C, 65.71; H, 6.43; N, 2.55. Found: C, 65.96; H, 6.49; N, 2.52.

Poly(5-(6-(9H-carbazole)hexyloxy)-1,3-phenylene) (*PmPCz*). A mixture of 9-(6-(3-bromo-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenoxy)hexyl)-9*H*-carbazole (**3**) (0.45 g, 0.90 mmol), $Pd(PPh_3)_4$ (0.010 g, 0.01 mmol), K_2CO_3 (2.00 mL 2.0 M aqueous solution, 4.00 mmol), toluene (6.0 mL), and Aliquat 336 (1 drop) was stirred at 90 °C for 48 h. After being cooled down, the mixture was poured into CH_2Cl_2 and washed with water three times, followed by drying over anhydrous Na_2SO_4. After being filtered and concentrated, the solution was precipitated in methanol. The white powder was collected, reprecipitated in CH_2Cl_2/CH_3OH two times, and dried in vacuum overnight. Yield: 0.16 g (51.2%). ^{1}H NMR (400 MHz, $CDCl_3$) δ (ppm): 8.04 (br, 2H), 7.45−7.33 (br, 5H), 7.19−7.11 (br, 4H), 4.31 (br, 2H), 3.93 (br, 2H), 1.84 (br, 4H), 1.30 (br, 4H). ^{13}C NMR (100 MHz, $CDCl_3$) δ (ppm): 159.78, 143.14, 142.88, 140.33, 125.58, 122.76, 120.30, 118.72, 112.36, 108.61, 67.96, 42.80, 29.15, 18.90, 26.98, 25.85. Anal. Calcd for $C_{24}H_{23}NO$: C, 84.42; H, 6.79; N, 4.10. Found: C, 84.37; H, 6.95; N, 3.88.

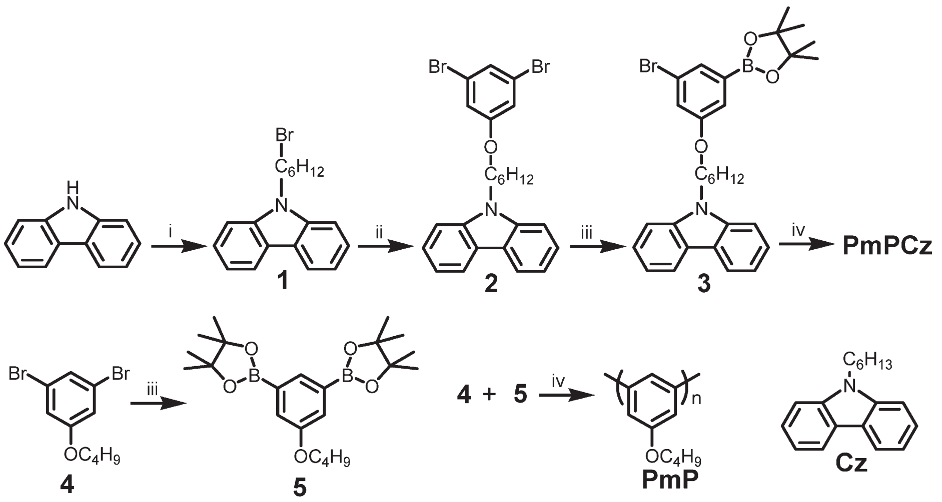
Characterization. ^{1}H and ^{13}C NMR spectra were recorded on a Bruker arx-400 spectrometer. Elemental analysis was carried out with a Perkin-Elmer 2400 elemental analyzer. Molecular weight of the polymers was measured by the gel permeation chromatography (GPC) method using polystyrene as the standard and tetrahydrofuran (THF) as the eluent. Cyclic voltammetry (CV) was conducted in a solution of Bu_4NBF_4 (0.1 M) in acetonitrile with Pt wire, Pt plate, and saturated calomel electrode (SCE) as the working electrode, counter electrode, and reference electrode, respectively. The polymer film was dip-coated on the working electrode from its solution in methylene chloride. Absorption spectra were obtained from a Shimadzu UV-1700 UV/vis spectrophotometer. Fluorescence spectra at room temperature and phosphorescence spectra at 77 K were measured with a PTI QuantaMaster 30 spectrofluorometer. Current−voltage and brightness−voltage curves of electroluminescent devices were recorded by a computer-controlled Keithley 2400/2002 source unit calibrated with a Photoresearch PR-655 spectrophotometer.

Device Fabrication. Indium tin oxide (ITO) glass substrates were ultrasonically cleaned for 30 min each sequentially with detergent, deionized water, acetone, and isopropanol. Then they were dried in a heating chamber at 70 °C. The PEDOT:PSS (Clevios VP Al 4083 from H. C. Starck Inc.) layer was spin-coated on the ITO at 3000 rpm for 60 s and then baked at 120 °C for 15 min to give an approximate thickness of 40 nm. The emissive layer (~90 nm) was then spin-coated from the solution of PmPCz (20 mg/mL) and FIrpic (from American Dye Source) in chlorobenzene. Finally, a thin layer of CsF (1.0 nm) followed by a layer of aluminum (100 nm) was deposited in a vacuum thermal evaporator through a shadow mask at a pressure of 10^{-6} Torr.

Results and Discussion

As shown in Scheme 1, our synthesis began with attaching carbazole to *m*-dibromobenzene with an alkyl spacer to obtain the intermediate **2**. Subsequent treatment with *n*-butyllithium and

Scheme 1. Synthetic Routes for PmPCz, PmP, and Cz[a]



[a] Reagents and conditions: (i) NaH, THF, 1,6-dibromohexane, reflux; (ii) 3,5-dibromo-1-phenol, DMF, K_2CO_3, 110 °C; (iii) (a) *n*-BuLi, THF, −78 °C, (b) 2-isopropyloxy-4,4,5,5-tetramethyl-1,3,2-dioxaboronate; (iv) $Pd(PPh_3)_4$, K_2CO_3 (aqueous, 2 M), Aliquat 336, toluene, 90 °C.

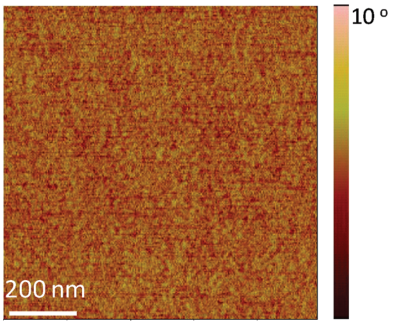


Figure 2. AFM phase image of the film spin-coated from the blend of PmPCz and FIrpic (10 wt %).

2-isopropyloxy-4,4,5,5-tetramethyl-1,3,2-dioxaboronate afforded the monomer **3**. The polymer host PmPCz was synthesized by Suzuki polycondensation using $Pd(PPh_3)_4$ catalyst. For comparison, we also synthesized poly(5-butyloxy-1,3-phenylene) (PmP) and *N*-hexylcarbazole (Cz), which can be regarded as the model compounds for poly(*m*-phenylene) backbone and carbazole unit, respectively.

PmPCz is readily soluble in common organic solvents, such as toluene, chloroform, and tetrahydrofuran. The weight-average molecular weight (M_w) is 9900 with a polydispersity index (PDI) of 1.26, as determined by gel permeation chromatography using a poly(styrene) standard. Differential scanning calorimetry (DSC) analysis of PmPCz shows neither crystallization nor melting behavior. The glass transition temperature (T_g) is 80 °C, suggesting a stable glassy morphology at normal PPLEDs operation conditions. The compatibility of PmPCz and the dopant FIrpic is investigated by atom force microscopy (AFM). As shown in Figure 2, the phase image of the film spincoated from the blend of PmPCz and FIrpic (10 wt %) implies smooth and uniform surface without pinholes, particles, and phase separation, indicating good compatibility of the host and the dopant.

Cyclic voltammetry was employed to estimate the LUMO and HOMO energy levels of the polymer host. As shown in Figure 3, the cyclic voltammogram of PmPCz shows two oxidation waves with onset potential at 1.16 and 1.50 eV, which are attributed to the carbazole unit and the poly(*m*-phenylene) backbone, respectively. No reduction behavior is observed despite many attempts. According to the empirical formula $E_{\mathrm{HOMO}} = -e(E_{\mathrm{ox}} + 4.40)$ [eV], the HOMO energy level of PmPCz is estimated to be −5.56 eV.

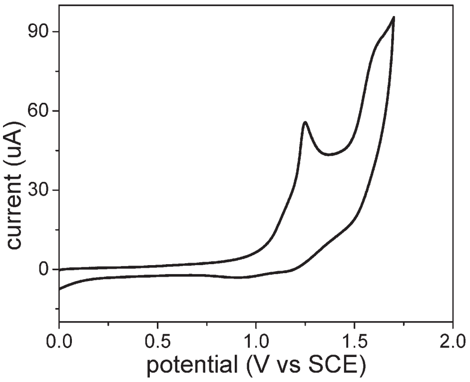


Figure 3. Cyclic voltammogram of PmPCz.

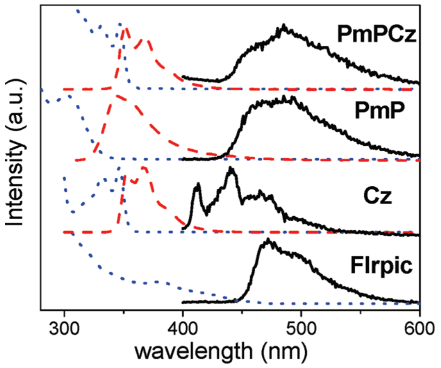


Figure 4. Absorption (blue dot), fluorescence (red dash), and phosphorescence (solid line) spectra of PmPCz, PmP, Cz, and FIrpic in solution.

On the basis of the absorption onset of the polymer in film, the optical bandgap of PmPCz is 3.44 eV. Thus, the LUMO energy level is calculated to be −2.12 eV.

Figure 4 shows the absorption spectra, fluorescence spectra at room temperature, and phosphorescence spectra at 77 K of PmPCz, PmP, Cz, and FIrpic. Poly(*m*-phenylene) has a larger singlet energy than that of carbazole, yet its E_T is smaller. Therefore, the fluorescence of PmPCz is dominated by the carbazole moiety, while its phosphorescence is characteristic of the poly(*m*-phenylene) backbone. The phosphorescence spectrum of PmPCz has two peaks. Deconvolution gives the higher energy peak at 470 nm, which is used to calculate the E_T of PmPCz to be 2.64 eV. This value is higher than those of conjugated polymers reported so far with high E_T, including poly(3,6-carbazole) and its derivatives (E_T = 2.53−2.60 eV),[18] poly(3,6-fluorene) (E_T = 2.58 eV),[13] and poly(3,6-silafluorene) (E_T = 2.55 eV),[22−24] due to the twisted conjugated polymer backbone in PmPCz. Most importantly, E_T of PmPCz is higher than that of FIrpic (E_T = 2.62 eV), the state-of-the-art blue phosphorescent dopant. This will prevent the triplet back energy transfer from FIrpic to PmPCz and make high EL efficiency possible. For other deep blue phosphorescent dopants with high E_T, such as iridium(III) bis(4′,6′-difluorophenylpyridinato)tetrakis(1-pyrazolyl)borate (FIr6, E_T = 2.7 eV), the E_T of PmPCz is not high enough to prevent triplet energy back-transfer.

Figure 5a shows the photoluminescence (PL) spectra of the blends of PmPCz and FIrpic at different weight ratios in solid films. The PL spectra of the blends are dominated by FIrpic's emission peaked at 472 nm even at a FIrpic concentration as low as 1 wt %, indicative of an efficient energy transfer from PmPCz to FIrpic. When the content of FIrpic is > 2 wt %, the emission from PmPCz is almost completely quenched. This phenomenon obviously indicates no triplet energy back-transfer from FIrpic to PmPCz and is consistent with the higher E_T of PmPCz than that of FIrpic. The energy transfer from PmPCz to FIrpic is supported by the overlap of the absorption spectrum of FIrpic and fluorescence spectrum of PmPCz (see Figure 4). Moreover, the efficient energy transfer from PmPCz to FIrpic also results from their good compatibility, which makes FIrpic well dispersed in PmPCz.

To test the capability of PmPCz as a polymer host, preliminary single-layer PPLEDs were fabricated with the configuration of ITO/PEDOT:PSS (40 nm)/PmPCz + FIrpic (90 nm)/CsF (1 nm)/Al (100 nm). The EL spectra of the devices are displayed in Figure 5b. In the concentration range of 1−10 wt % of FIrpic in the blends, all PLEDs exhibit sky-blue emission from FIrpic. No detectable emission from PmPCz is observed, even at FIrpic content as low as 1 wt %. The emission from the polymer host is more suppressed in EL than in PL due to the charge trapping effect of FIrpic.[25−27] The EL performance of the PPLEDs is listed in Table 1. The devices show increased turn-on voltage and decreased luminance efficiency with increasing FIrpic content from 1 to 10 wt % (see Figure 6a). The increased turn-on voltage results from the charge trapping of FIrpic, whereas the decreased EL efficiency is possibly caused by concentration quenching of

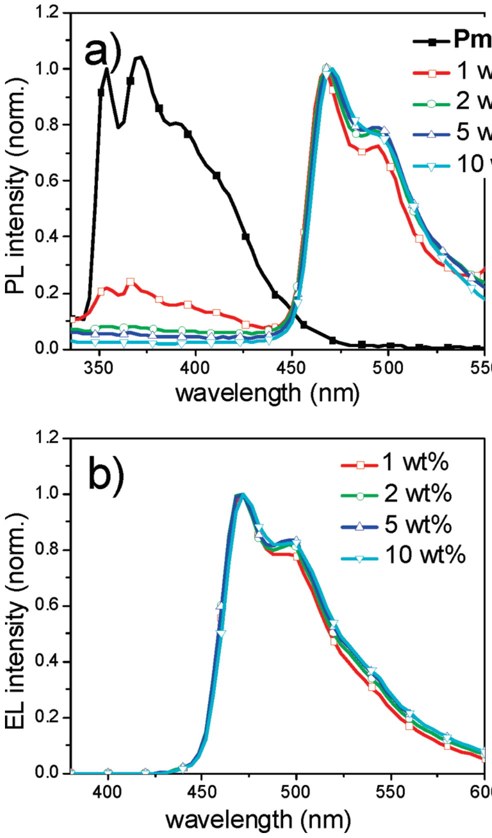


Figure 5. (a) PL spectra of spin-cast films of PmPCz and the blend of PmPCz and FIrpic (weight ratios specified). (b) EL spectra of the PPLEDs based on the blends of PmPCz and FIrpic (weight ratios specified).

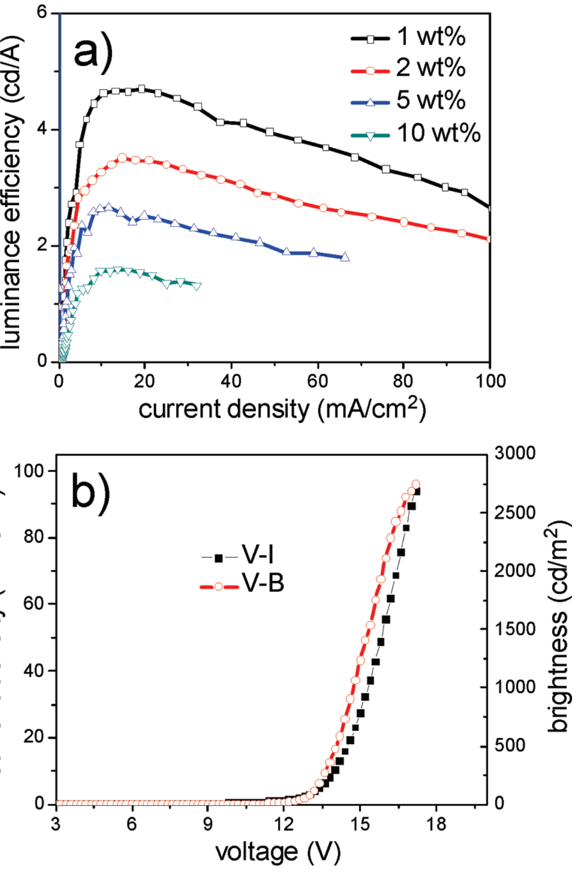


Figure 6. (a) Luminance efficiency−current density curves of PPLEDs with the single-layer configuration of ITO/PEDOT:PSS/PmPCz + FIrpic (blend with specified FIrpic content)/CsF/Al. (b) Voltage−current density−brightness curves of the device containing 1 wt % FIrpic in the blend.

Table 1. EL Performance of the Devices Based on the Blend of PmPCz and FIrpic with Different Ratios

content of FIrpic (wt %)	turn-on voltage[a] (V)	luminance efficiency (cd/A)	power efficiency (lm/W)	maximum brightness (cd/m^2)	CIE coordinates (*x*, *y*)
1	10.0	4.69	1.04	2742	(0.16, 0.34)
2	12.0	3.53	0.68	1991	(0.17, 0.35)
5	13.8	2.74	0.45	1530	(0.18, 0.35)
10	15.0	1.60	0.26	–[b]	(0.18, 0.37)

[a] Voltage at the brightness of about 1 cd/m^2. [b] The device did not reach maximum brightness at the bias limit of our voltage source.

FIrpic, reduced charge carrier balance, or both. The best EL performance is achieved at a FIrpic content of 1 wt %. In comparison, blue PPLEDs reported so far generally use 5−10 wt % of FIrpic for optimal EL performance.[25] The low optimal FIrpic content in this work is very attractive because low content of expensive phosphorescent complex means low cost of PPLEDs. The low optimal content here is probably related to the high E_T of PmPCz, which prevents triplet energy back-transfer and makes triplet excitons confined in FIrpic to generate light emission.

Figure 6b shows the voltage−current density−brightness curves of the device with 1 wt % FIrpic. The turn-on voltage is 10.0 V, and the brightness reaches 2742 cd/m^2 at 17.5 V. At a current density of 19.4 mA/cm^2, the device exhibits the maximum luminance efficiency of 4.69 cd/A and power efficiency of 1.04 lm/W. Although this performance is moderate compared to the values of blue PPLEDs in the literature,[6−9] the luminance efficiency is 10 times higher than the 0.4 cd/A reported for a single-layer device based on a conjugated polymer host, poly(3,6-fluorene).[13] A control device with the typical nonconjugated polymer, PVK, as the host shows a turn-on voltage of 12.6 V and maximum luminance efficiency of 1.7 cd/A. It is well-known that PVK only transport holes. The device of PmPCz exhibits lower turn-on voltage and higher EL efficiency than those of PVK, probably because the conjugated poly(*m*-phenylene) backbone in PmPCz facilitates electron injection/transporting and improves charge carrier balance.

PPLEDs generally exhibit higher luminance efficiency with decreasing current density because of long diffusion distance of triplet excitons and triplet−triplet annihilation.[9] However, the devices based on PmPCz have abnormally low luminance efficiency at low current densities. This may be explained by unbalanced charge carriers: The high-lying LUMO energy level of PmPCz induces a large barrier for electron injection from cathode to the emissive layer. Device optimization with improved charge carrier balance[24] is expected to lead to improved EL performance.

Conclusion

In conclusion, a new conjugated polymer with a poly(*m*-phenylene) backbone and tethered carbazole side groups has been developed. PmPCz exhibits good thermal stability and excellent miscibility with FIrpic. The E_T of PmPCz at 2.64 eV is higher than that of FIrpic, making PmPCz a suitable polymer host for blue PPLEDs. The high E_T prevents triplet energy back-transfer, confines triplet excitons in FIrpic to emit light, and allows the use of low content of FIrpic for high EL efficiency. Single-layer PPLEDs using the blend containing 1 wt % of FIrpic emits blue light exclusively from FIrpic with a maximum luminance efficiency of 4.69 cd/A. Our results provide a novel avenue for the design of polymer host materials for phosphorescent dopants. Study is ongoing to use PmPCz in blue and white polymer light-emitting electrochemical cell (PLEC) with low driving voltage and balanced charge carriers.

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