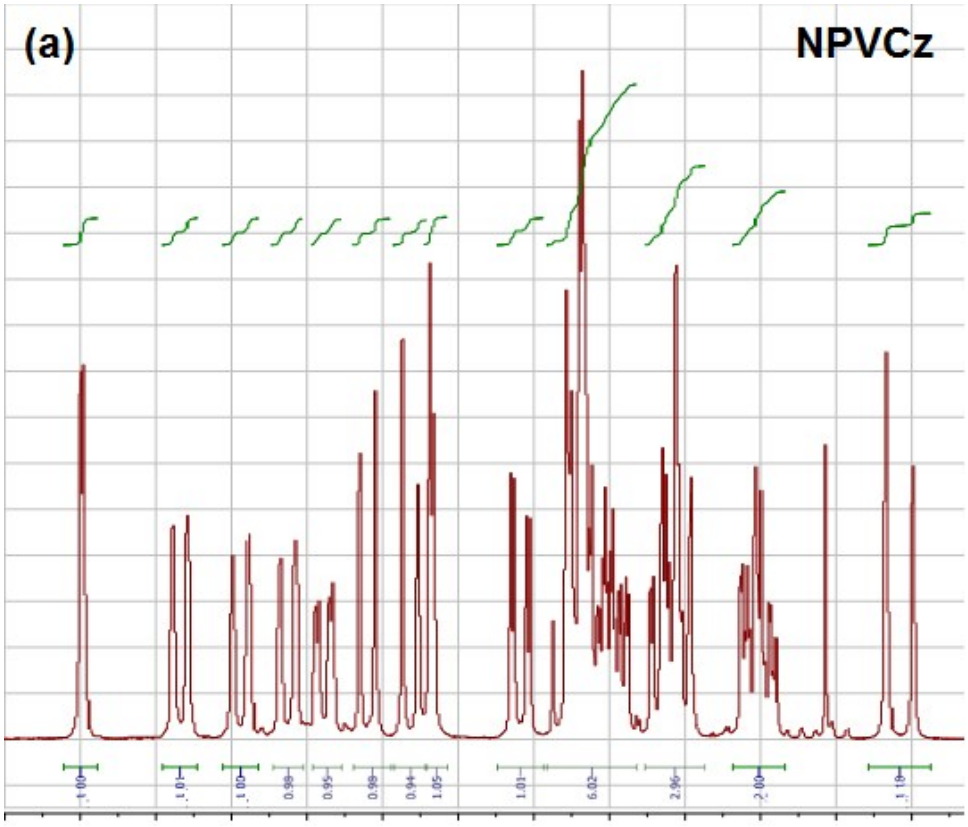
Supplementary Information

Solution-processable naphthalene and phenyl substituted carbazole core based hole transporting materials for efficient organic light-emitting diodes

Sudhir Kumar[a,b], Chih-Chia An[a], Snehasis Sahoo,[a] R. Griniene[c], D. Volyniuk[c], Juozas V. Grazulevicius[c], Saulius Grigalevicius[c,*], Jwo-Huei Jou[a,*]

[a]Department of Materials Science and Engineering, National Tsing-Hua University, No.101, Kung-Fu Rd. Hsin-Chu 30013 Taiwan, R.O.C.
[b]Present address: Institute for Chemical and Bioengineering, ETH Zürich, Vladimir Prelog Web 1, 8093 Zürich, Switzerland.
[c]Department of Polymer Chemistry and Technology, Kaunas University of Technology, Radvilenu plentas 19, LT50254, Kaunas, Lithuania.

Contents



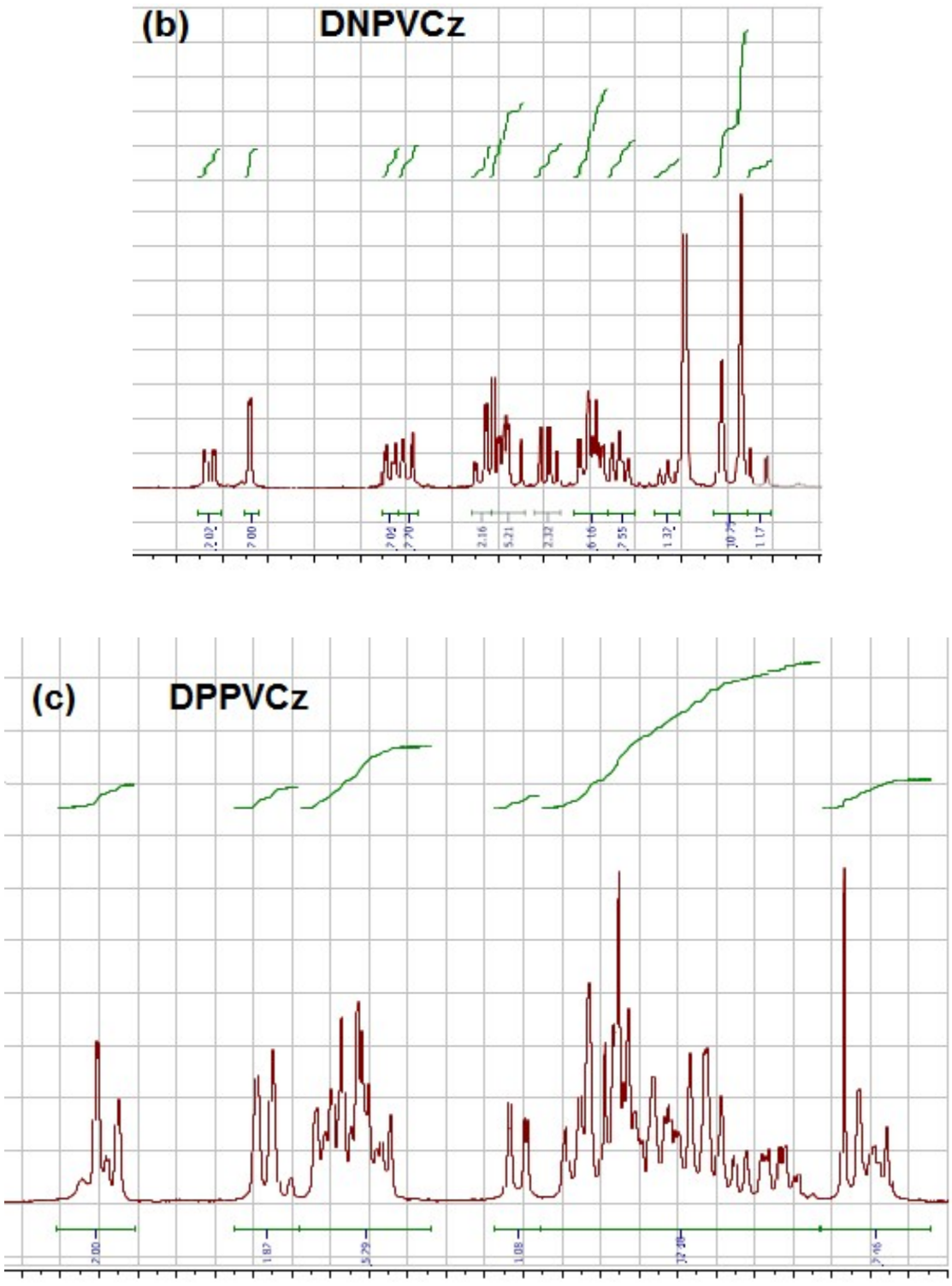
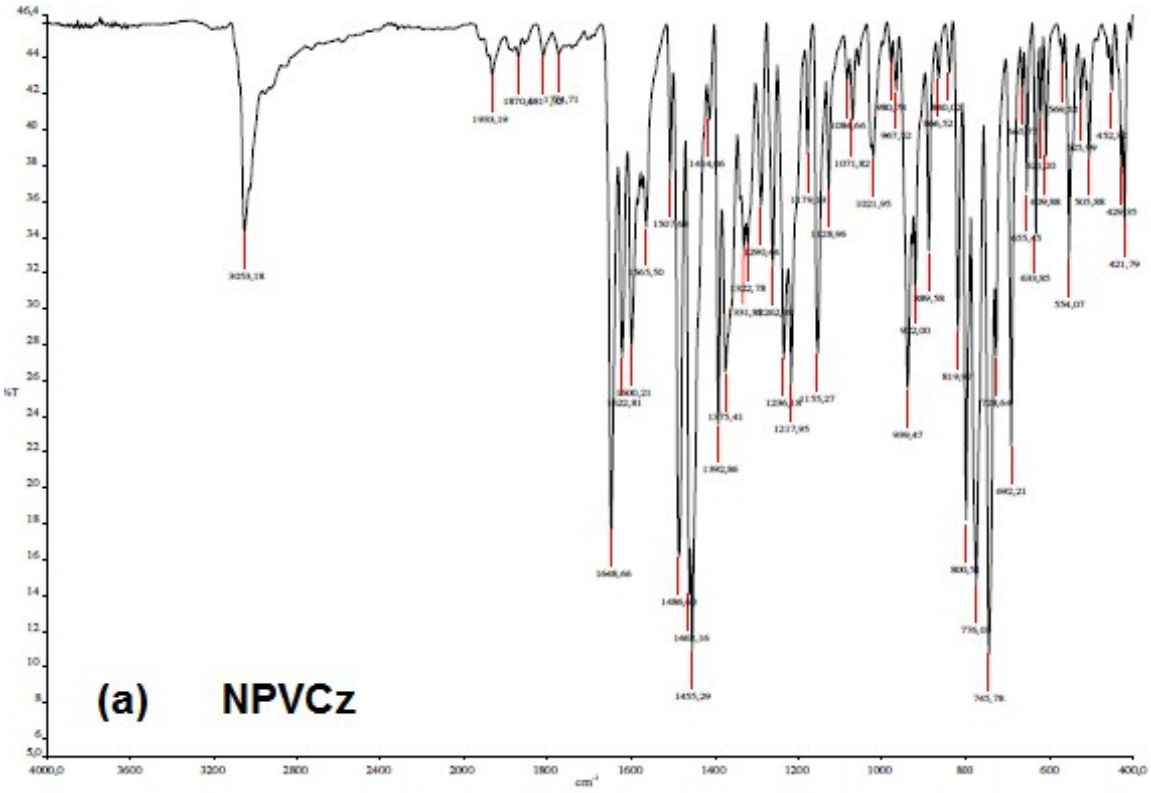
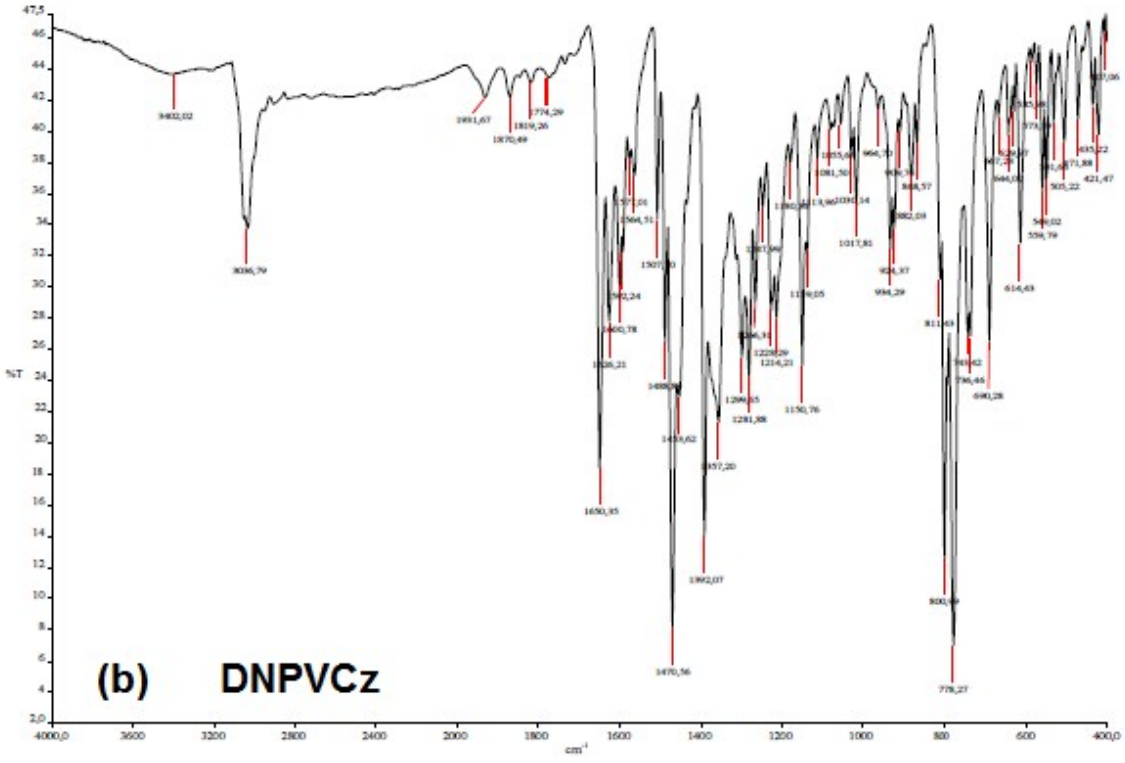


Figure S1. H^1 NMR spectra of HTMs, (a) NPVCz, (b) DNPVCz, and (c) DPPVCz.


(a) NPVCz
%T
cm-1


(b) DNPVCz
%T
cm-1

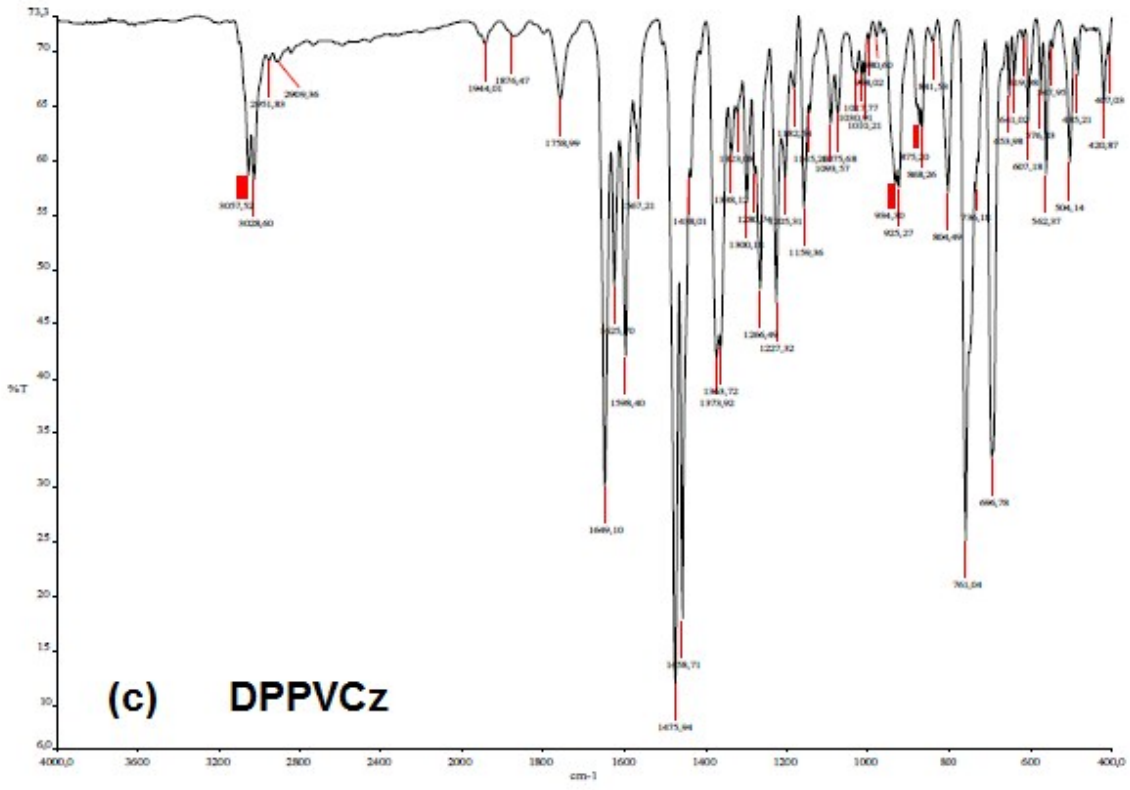


Figure S2. IR spectra of HTMs, (a) NPVCz, (b) DNPVCz, and (c) DPPVCz.

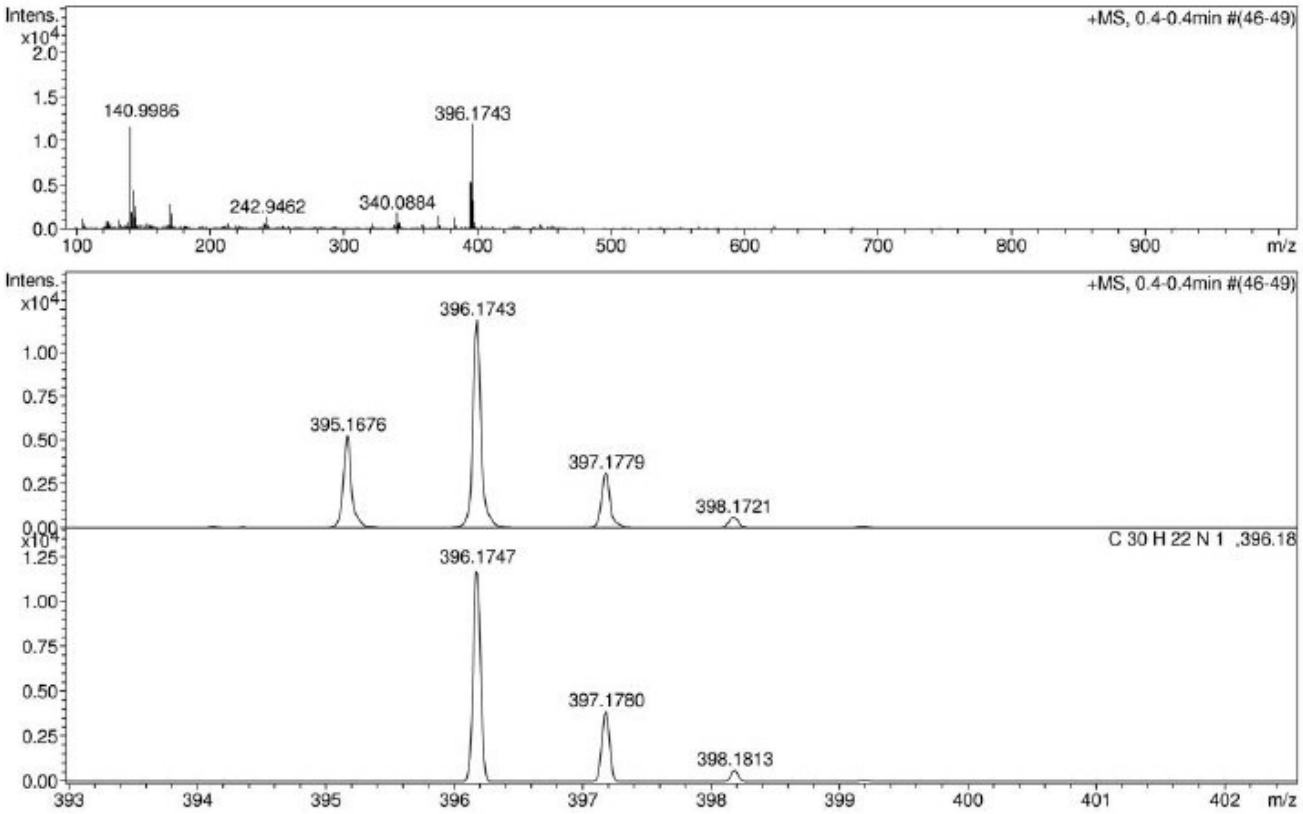
MS-Flowinjection

Analysis Info

Analysis Name	D:\Data\141112\mcrg13 APCI_000002.d	Acquisition Date	12.11.2014 10:44:45
Method	APCI_1min_50_bis_1000_posb_Standardneu.m	Operator	ip
Sample Name	mcrg13 APCI	Instrument / Ser#	micrOTOF 168
Comment	APCI: Flowinjection.		

Acquisition Parameter

Source Type	APCI	Ion Polarity	Positive	Set Nebulizer	3.0 Bar
Focus	Not active			Set Dry Heater	200 °C
Scan Begin	100 m/z	Set Capillary	4000 V	Set Dry Gas	5.0 l/min
Scan End	1000 m/z	Set End Plate Offset	-500 V	Set Divert Valve	Source



Generate Molecular Formula Parameter

Formula, min.	C30H22N						
Formula, max.							
Measured m/z	396.174	Tolerance	4	mDa	Charge	1	
Check Valence	no	Minimum	0		Maximum	0	
Nirogen Rule	no	Electron Configuration	both				
Filter H/C Ratio	no	Minimum	0		Maximum	3	
Estimate Carbon	yes						

Sum Formula	Sigma	m/z	Err [ppm]	Mean Err [ppm]	Err [mDa]	rdb	N Rule	e⁻
C 30 H 22 N 1	0.038	396.1747	1.01	2.15	0.40	20.50	ok	even

Figure S3. Mass-spectrum of NPVCz compound.

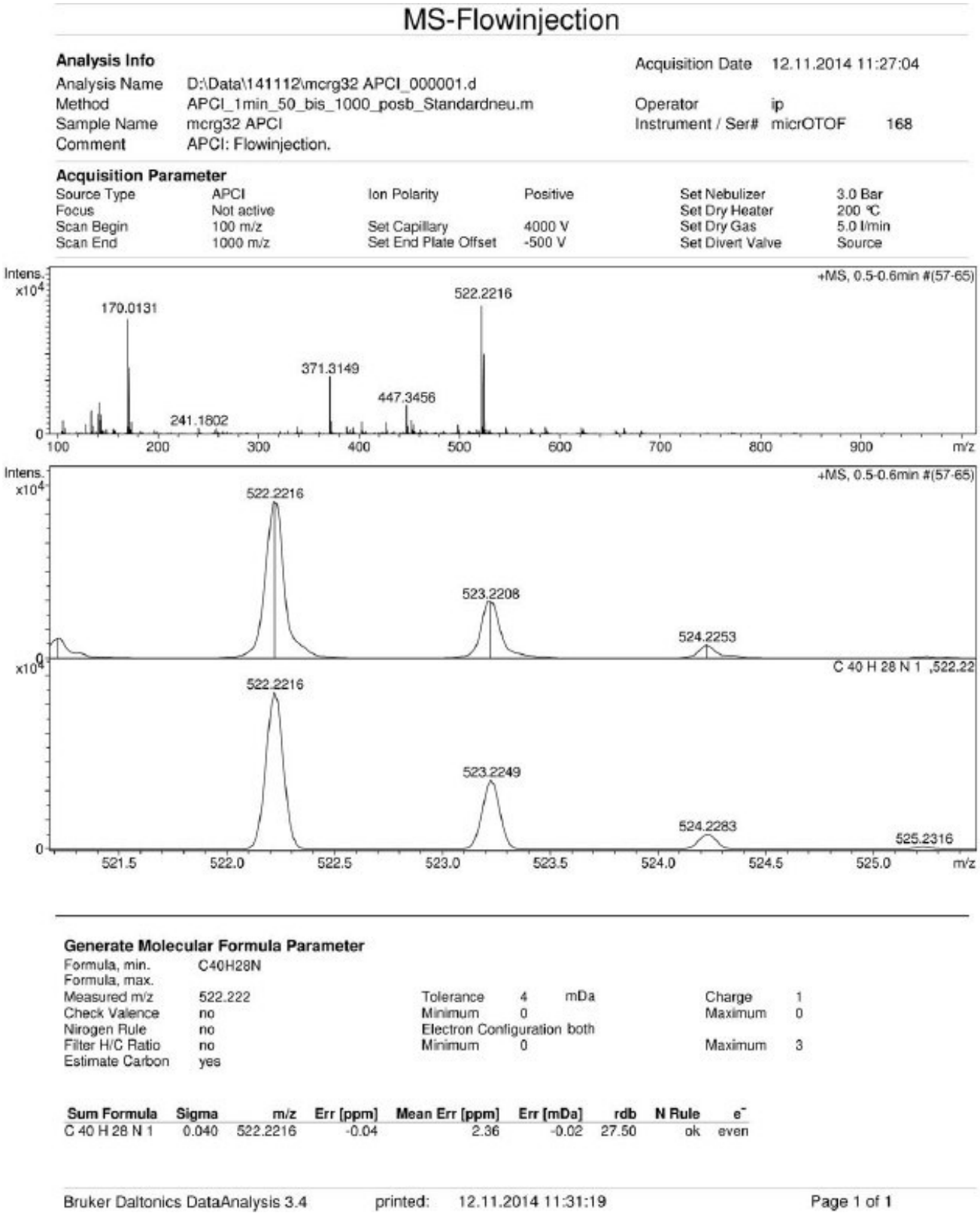


Figure S4. Mass-spectrum of DNPVCz compound.

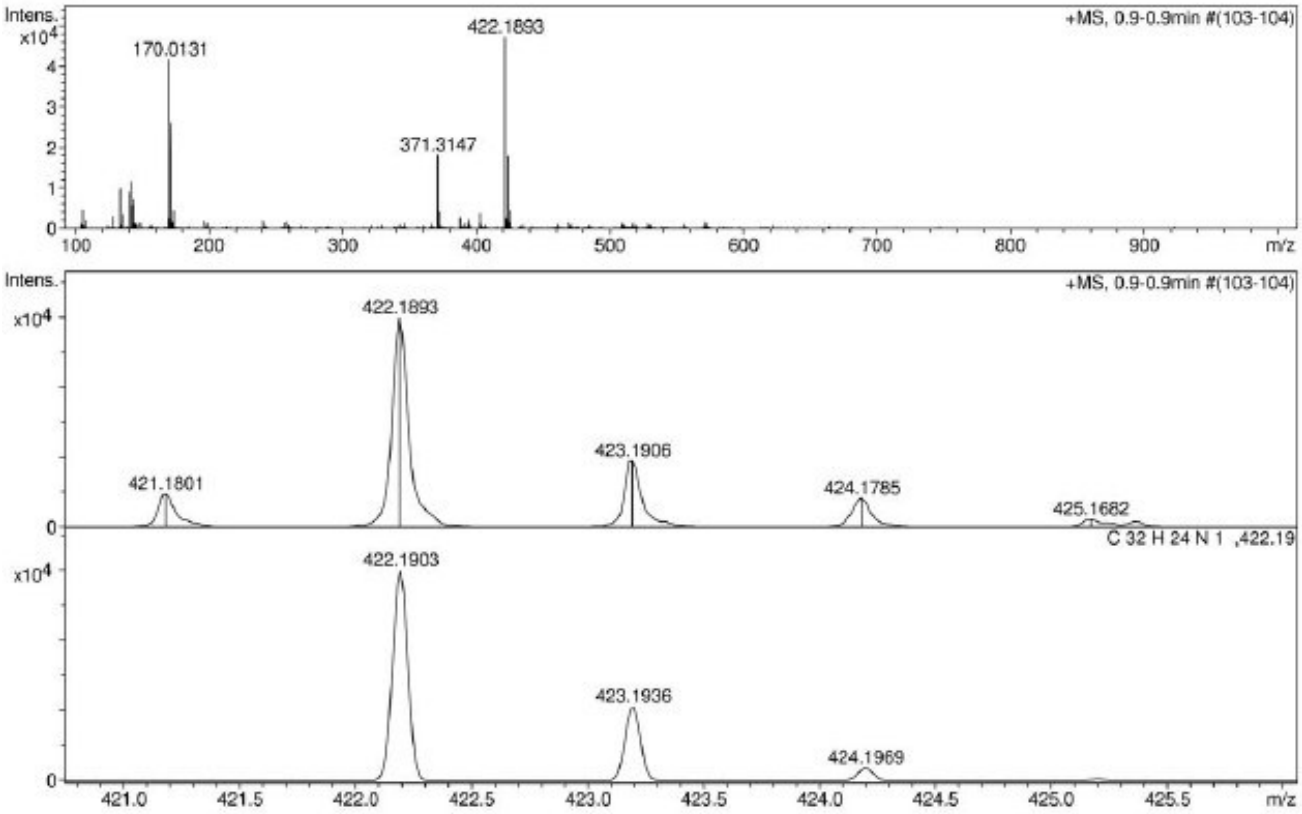
MS-Flowinjection

Analysis Info

Analysis Name	D:\Data\141112\mcrg31 APCI_000001.d	Acquisition Date	12.11.2014 10:51:51
Method	APCI_1min_50_bis_1000_posb_Standardneu.m	Operator	ip
Sample Name	mcrg31 APCI	Instrument / Ser#	micrOTOF 168
Comment	APCI: Flowinjection.		

Acquisition Parameter

Source Type	APCI	Ion Polarity	Positive	Set Nebulizer	3.0 Bar
Focus	Not active			Set Dry Heater	200 °C
Scan Begin	100 m/z	Set Capillary	4000 V	Set Dry Gas	5.0 l/min
Scan End	1000 m/z	Set End Plate Offset	-500 V	Set Divert Valve	Source



Generate Molecular Formula Parameter

Formula, min.	C32H24N						
Formula, max.							
Measured m/z	422.189	Tolerance	4	mDa	Charge	1	
Check Valence	no	Minimum	0		Maximum	0	
Nirogen Rule	no	Electron Configuration	both				
Filter H/C Ratio	no	Minimum	0		Maximum	3	
Estimate Carbon	yes						

Sum Formula	Sigma	m/z	Err [ppm]	Mean Err [ppm]	Err [mDa]	rdb	N Rule	e⁻
C 32 H 24 N 1	0.049	422.1903	2.35	6.46	0.99	21.50	ok	even

Figure S5. Mass-spectrum of DPPVCz compound.

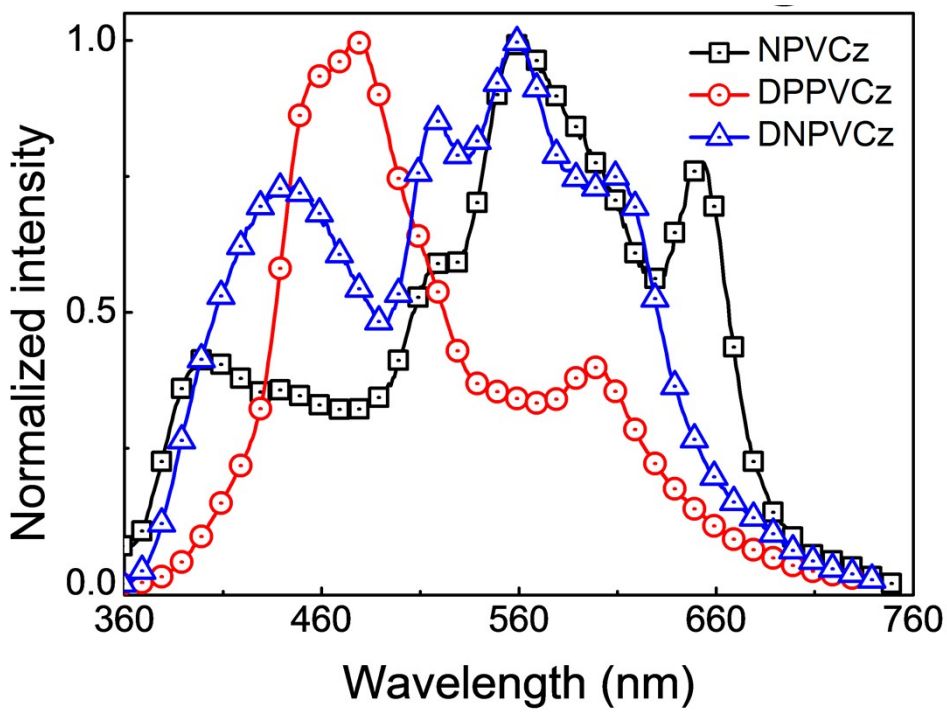


Figure S6. PL spectra of NPVCz, DPPVCz and DNPVCz, in THF solution at 77 K.

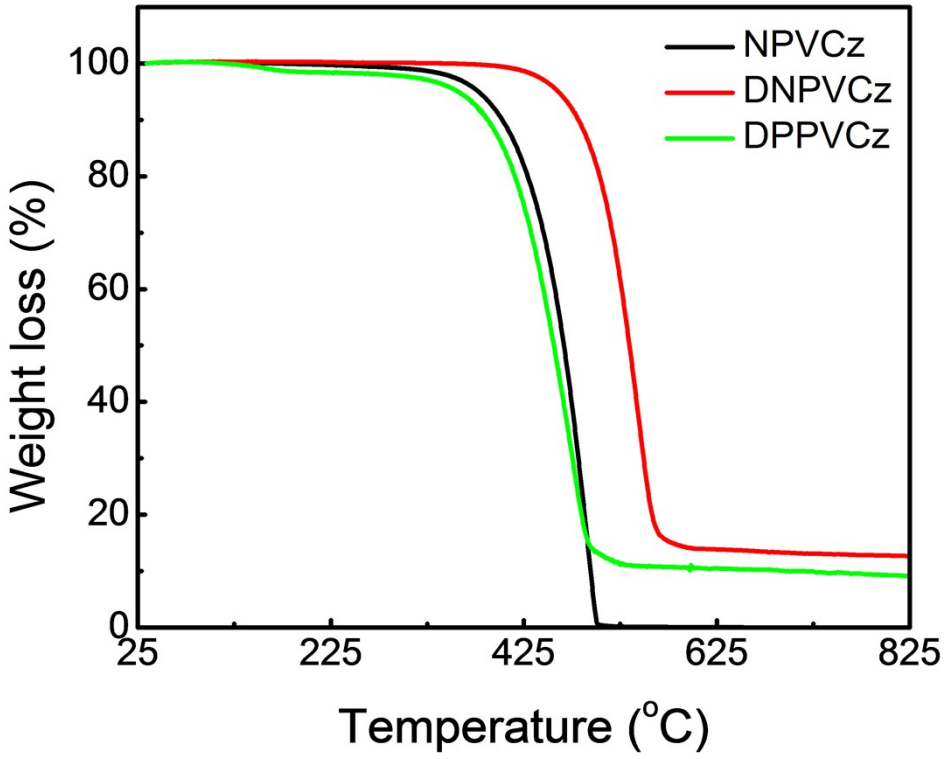
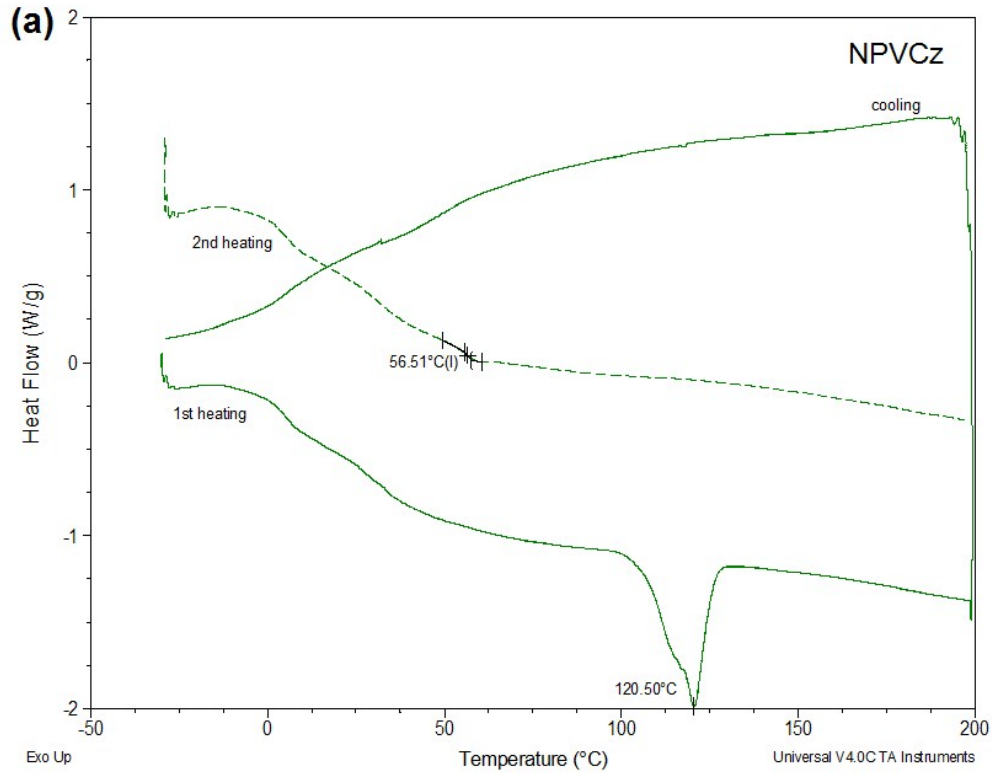
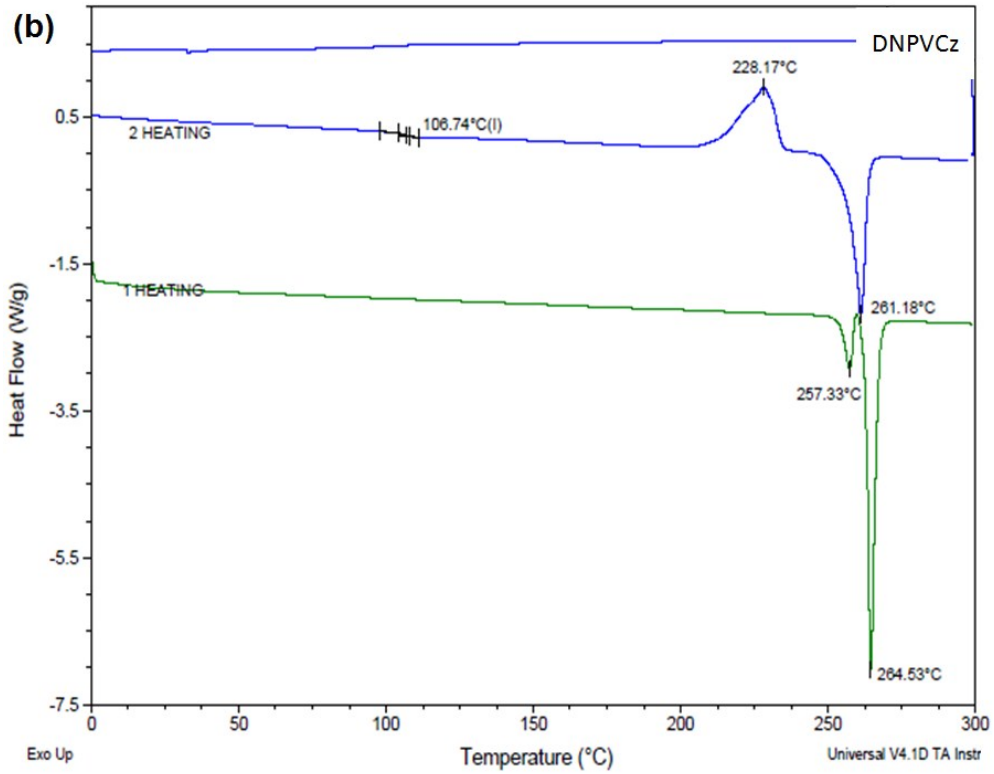


Figure S7. TGA plots of NPVCz, DNPVCz, and DPPVCz.


(a)
NPVCz
cooling
2nd heating
56.51°C(I)
1st heating
120.50°C
Heat Flow (W/g)
Temperature (°C)
Exo Up
Universal V4.0C TA Instruments


(b)
DNPVCz
228.17°C
106.74°C(I)
2 HEATING
1 HEATING
261.18°C
257.33°C
264.53°C
Heat Flow (W/g)
Temperature (°C)
Exo Up
Universal V4.1D TA Instr

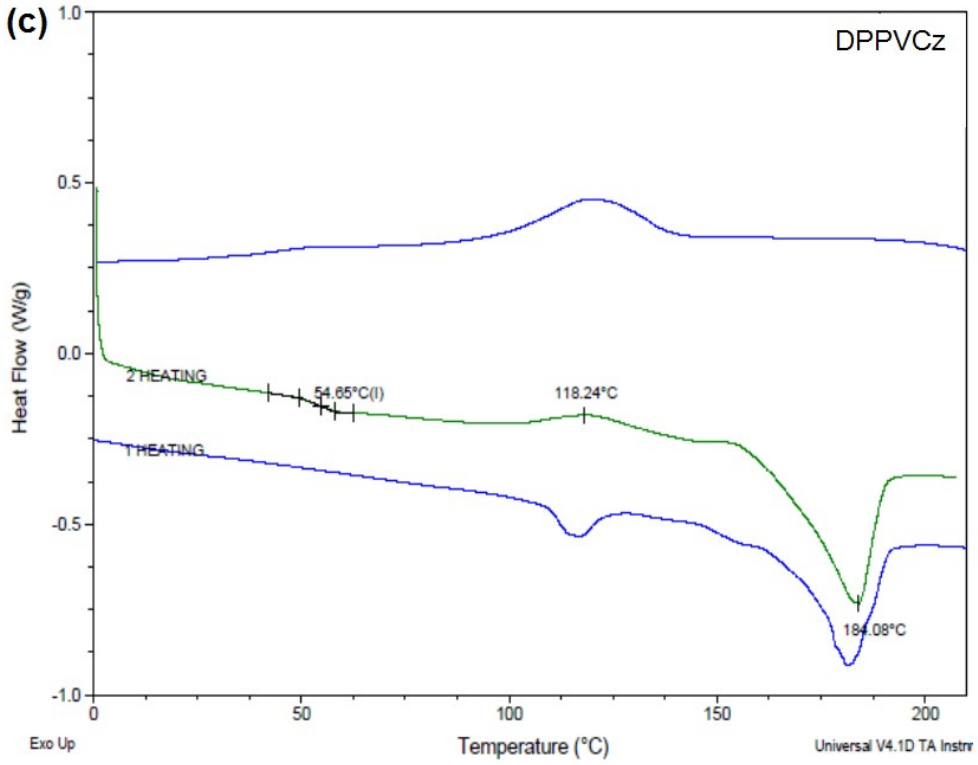
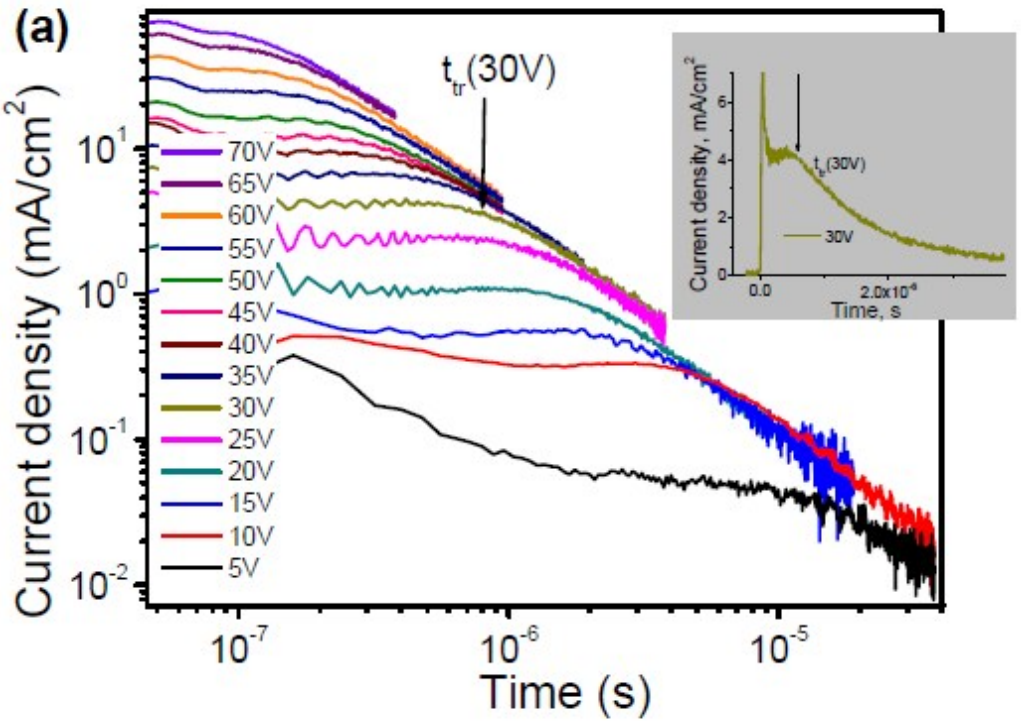


Figure S8. DSC curves of (a) NPVCz, (b) DNPVCz, and (c) DPPVCz.



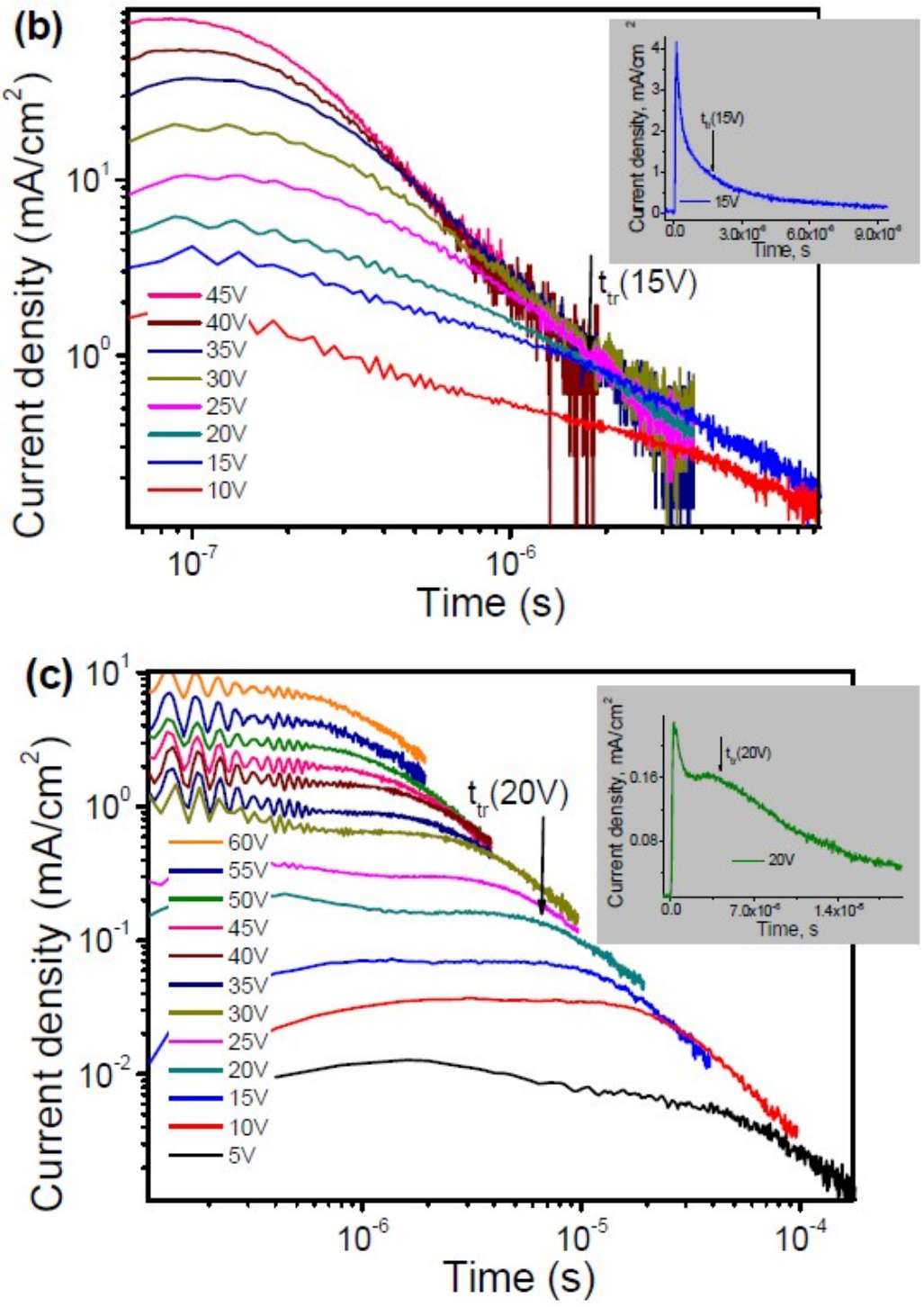


Figure S9. Double-logarithmic represantation of transient photocurrents curves of the newly synthesized HTMs, (a) NPVCz, (b) DNPVCz, and (c) DPPVCz, and inset show the TOF transient curves.

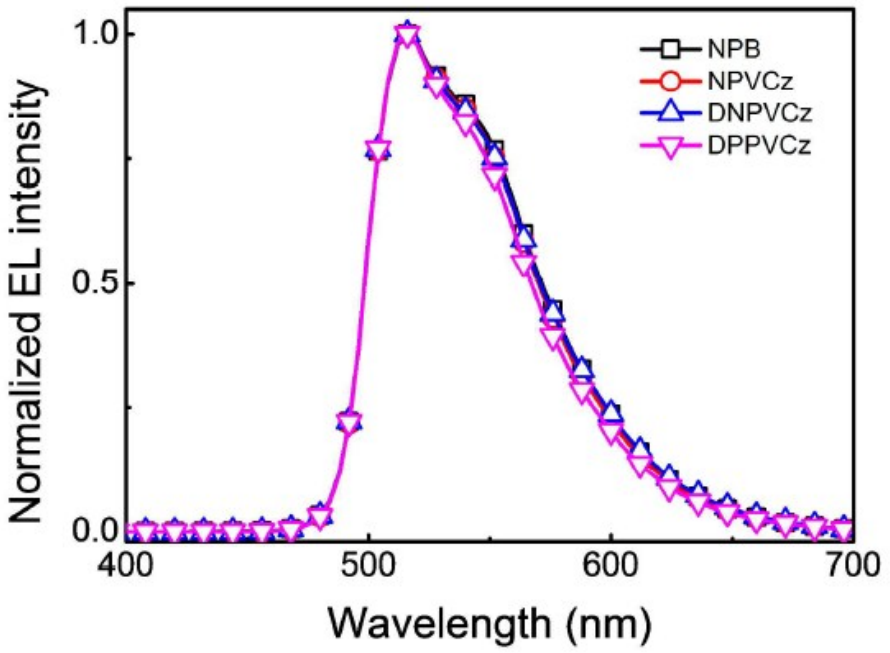
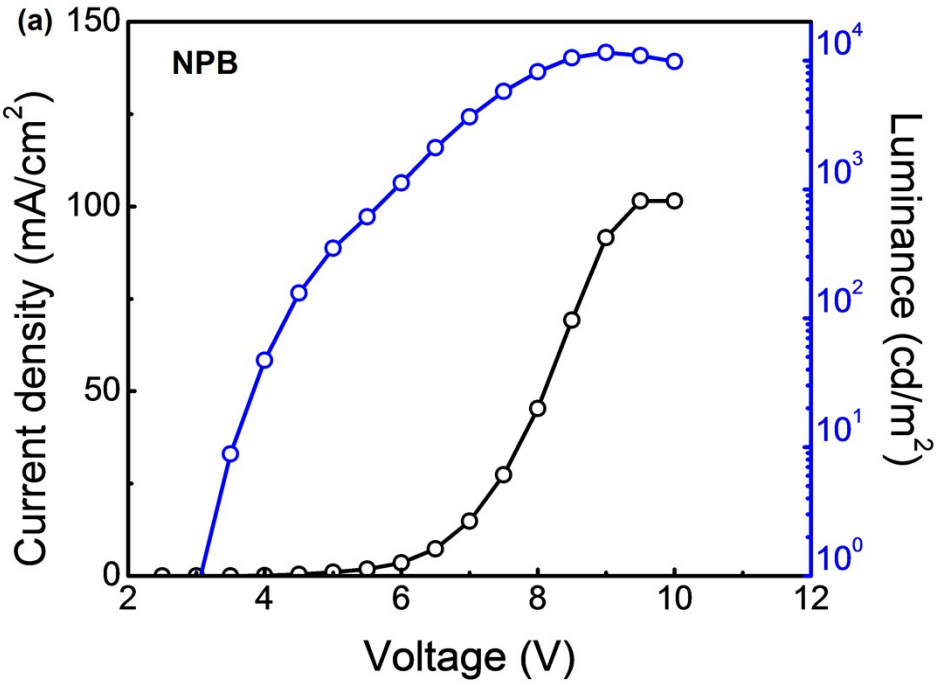


Figure S10. Effect of the HTMs, NPB, NPVCz, DNPVCz, and DPPVCz, on the EL spectra of fluorescent green OLED devices.



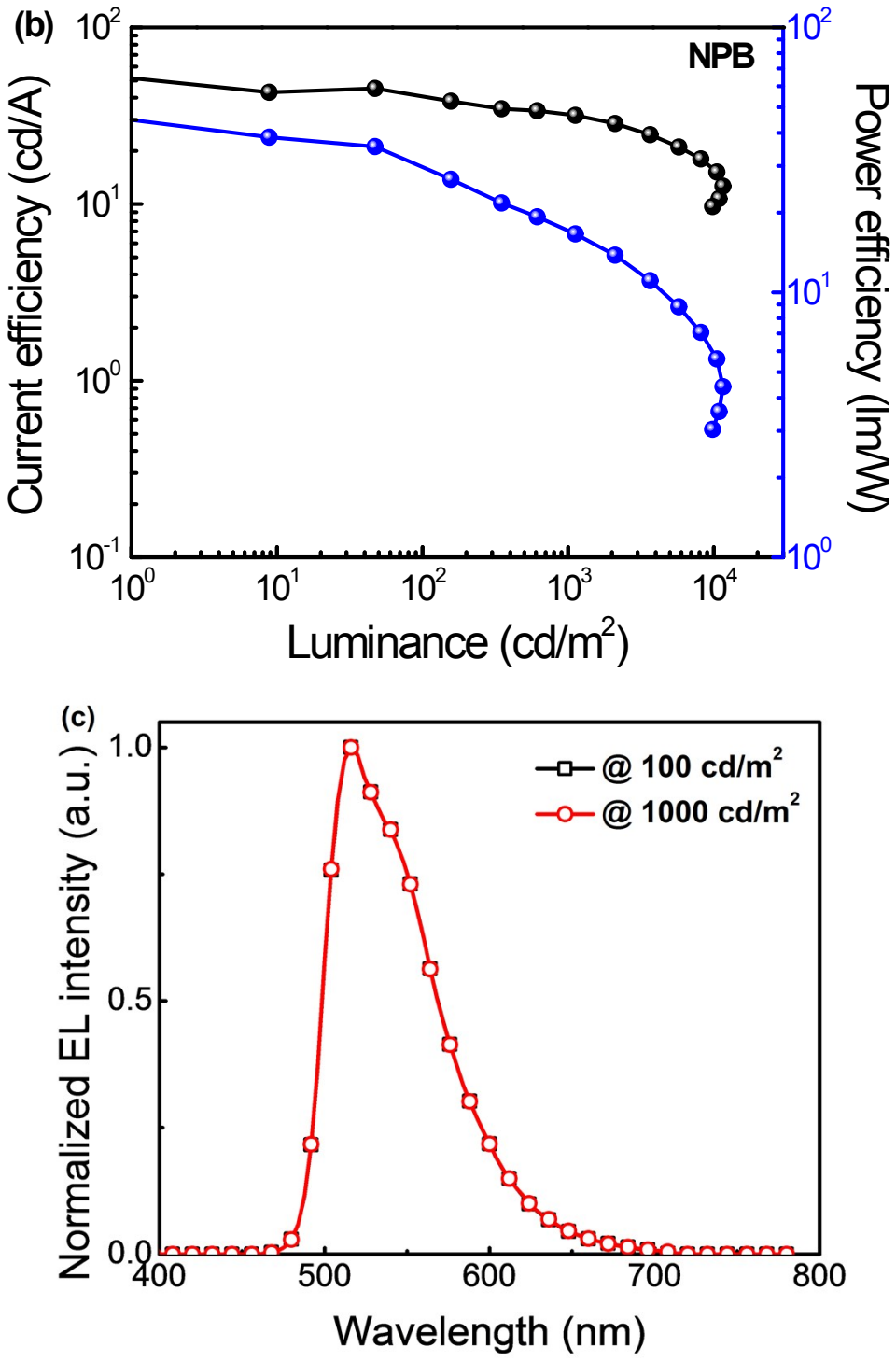


Figure S11. Effects of typical HTM, NPB, on (a) current density and luminance, (b) current efficiency- luminance-power efficiency, and (c) EL spectra of phosphorescent OLED devices.

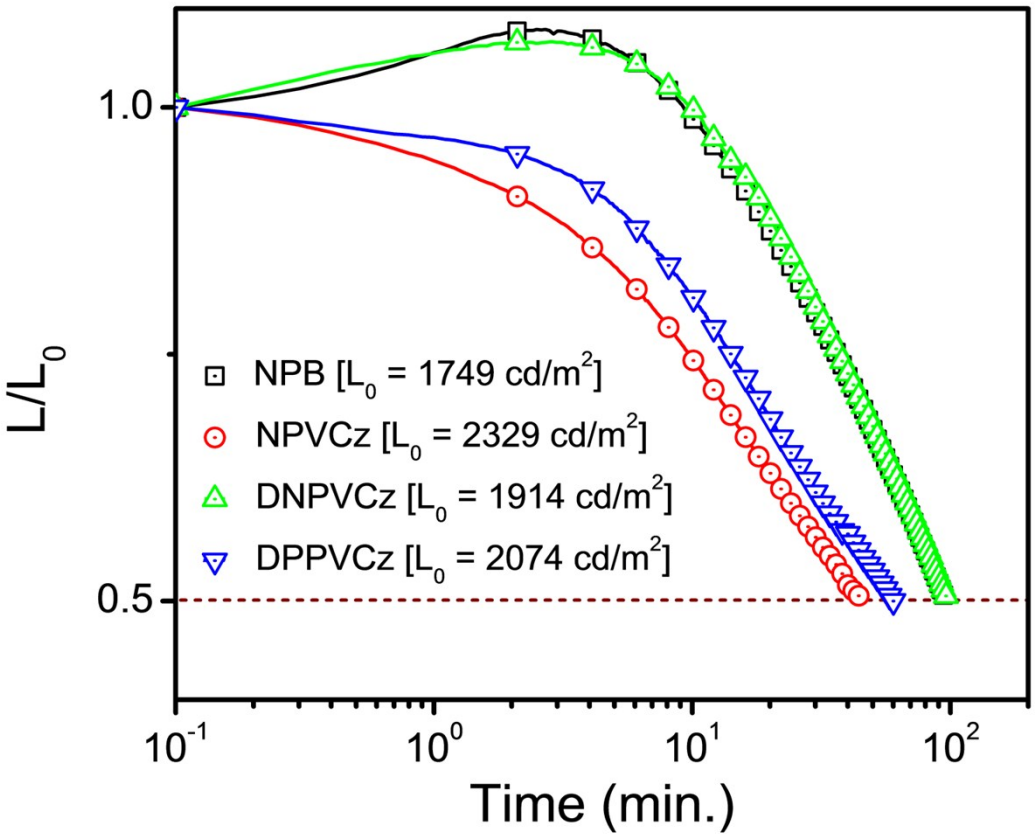


Figure S12. Normalized luminance as a function of operational lifetime of solution-processed HTLs, NPVCz, DNPVCz, DPPVCz, and conventional NPB, based phosphorescent OLEDs.