Fluorene-Based Conjugated Polymer Network and Side-Chain Polarity Dependent Photoluminescence and Deep their Blue Electroluminescence

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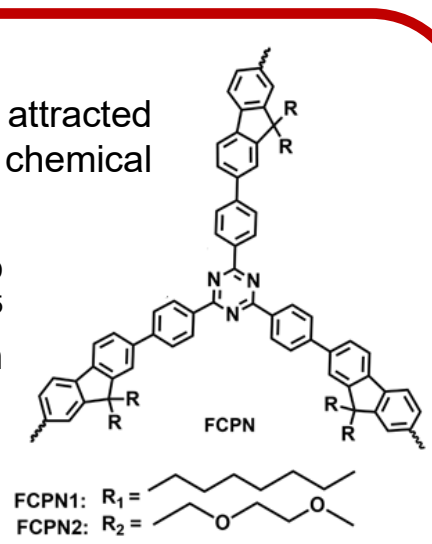
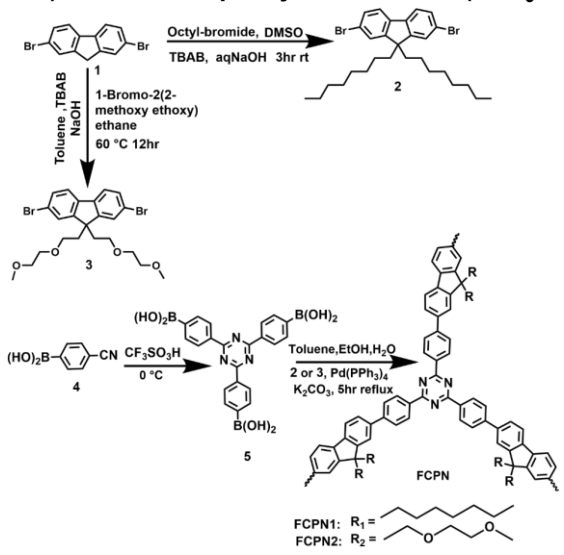
Introduction

- Conjugated polymer network (CPN) which belong to higher dimensional polymer has attracted significant research attention for electronic and optoelectronic applications owing to their high chemical stability, porous structure, reversible redox chemistry and excellent luminescence property.[1,2]
- Whereas, highly fluorescent materials are a significant component in scientific research due to their diverse potential applications in optoelectronic devices,[3] cellular imaging,[4] and sensors.[5] There is a growing need for environment-sensitive fluorescent molecules with high photostability, and quantum yield.
- **Here, we report two fluorene based conjugated polymer networks (FCPN) with two different side-chains and investigated the effect of side-chain polarity on the fluorescence and electroluminescence properties of the polymer.**



Synthesis

Fluorene and triazine containing conjugated polymer networks were synthesized by Palladium-catalyzed Suzuki polycondensation reaction between 2,7 Dibromo-9,9-dioctyl-9H-fluorene (2) or 2,7-Dibromo-9,9-bis(2-(2-methoxyethoxy)ethyl)-9H-fluorene (as B linker) with triazine-phenyl boronic acid (as A_3 knot)



Scheme 1: Synthesis scheme of FCPN1 and FCPN2

Characterization

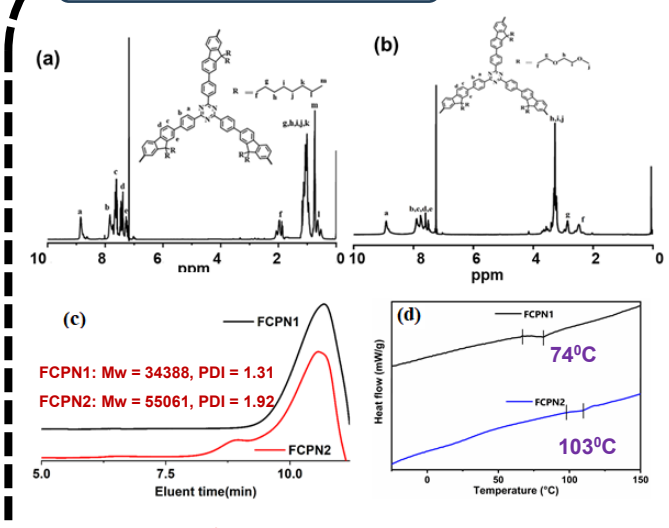


Figure 1: (a) & (b) ^{1}H NMR spectra of FCPN1 and FCPN2 (c) GPC traces (d) DSC plot of both polymer FCPN1 & FCPN2

Further characterization performed

- **FTIR study confirms the inclusion of triazine ring in the polymer.**
- **The powder X-ray diffraction (PXRD) analysis revealed amorphous structure.**

Optical Properties and self-assembly

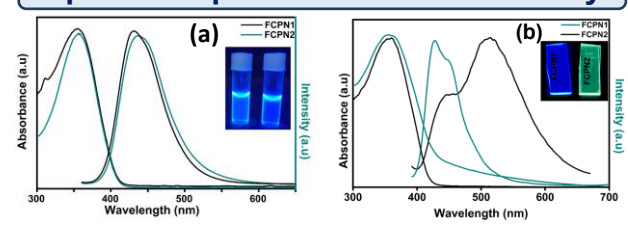


Figure 2: UV and PL spectra of FCPNs (a) THF solution and (b) in thin film state

Self-assembly

TEM image

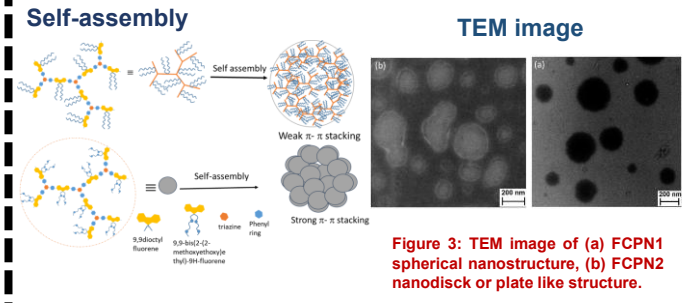


Figure 3: TEM image of (a) FCPN1 spherical nanostructure, (b) FCPN2 nanodisck or plate like structure.

- **The strong dipole-dipole interaction and better flexibility of the ethylene glycol side chain drive the FCPN2 to self- assembled in a parallel fashion with strong π-π interaction.**
- **Weak π-π stacking results spherical structure adopted by the polymer chains in FCPN1.**

Electroluminescence study

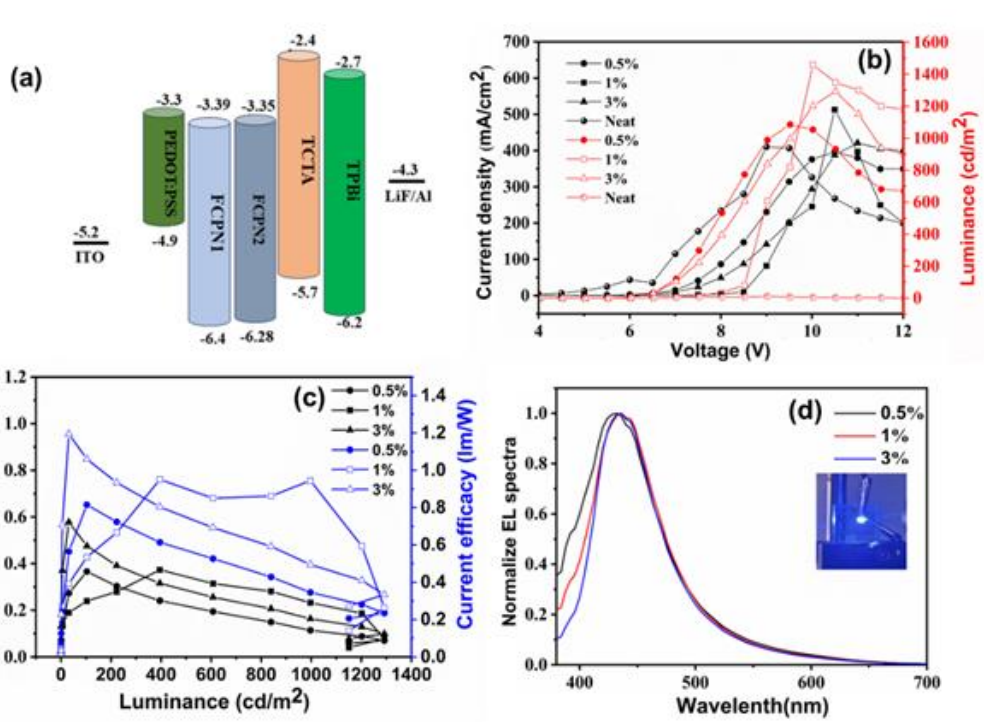


Figure 4: (a) Schematic diagram of OLED device from FCPN1/2 using TCTA as host material b) current density-voltage-luminance plot of doped FCPN2 OLED devices (c) PE-luminance-CE plot (d) electroluminescence spectra for OLED devices.

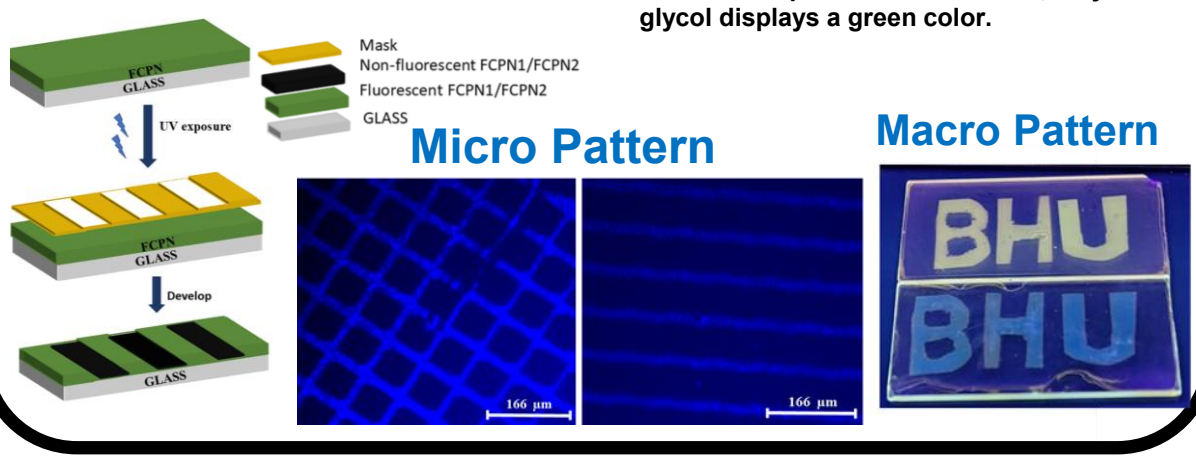
Table 1. Shows the summarized data of OLED devices made from FCPN1 and FCPN2 using TCTA as host matrix

	Dopant Emitt (FCPN2)	Driving Voltage (V)	Operation voltage (V) @ 100 cd/m^2	Power efficacy (lm/W)	Current efficacy (cd/A)	EQE (%)	(CIE), FWHM (nm)	Maximum luminance (cd/m^2)
Emitter FCPN1	100	…	…	..	…	….	….	0
	0.5 %	7.3	8.6	0.1	0.4	0.5	(0.18, 0.12), 90	507
	1 %	7.8	9.6	0.1	0.3	**0.3**	**(0.18, 0.12), 76**	415
	3 %	7.4	9.7	0.1	0.2	0.2	(0.18, 0.12), 70	240
Emitter FCPN2	0 %	8.8	9.0	..	…	….	….	11
	0.5 %	6.1	6.8	0.5	1.2	2.2	(0.17, 0.11),78	1,086
	1 %	6.6	7.5	0.5	1.2	**2.7**	**(0.17, 0.11), 65**	1,458
	3 %	6.1	7.0	0.5	1.1	1.6	(0.16, 0.1), 60	1,292

- **OLEDs based on FCPN2 with ethylene glycol chain show maximum quantum efficiency (EQE) of 2.7% much higher than 0.5% displayed by FCPN1 with alkyl side chain.**
- **FCPN2 exhibits a maximum brightness of 1458 cd/m^2 and a maximum current efficiency of 1.2 cd/A with deep blue emission.**

Fluorescent Pattern

- **The polymer network with an alkyl side chain shows a deep blue color whereas, ethylene glycol displays a green color.**



Summary

- **Here, we report two solution-processable highly fluorescent and wide band gap conjugated polymer networks (CPN) consisting of triazine and fluorene.**
- **These results highlight how side-chain polarity can be used to regulate the fluorescence characteristics and enhance the electroluminescence performance of deep blue OLED devices based on conjugated polymers.**

Reference

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