Supporting Information

Pentafluorophenyl Substituted Fulleropyrrolidine: A molecule enabling the most efficient flexible electrochromic device with fast switching

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Device Fabrication recipe

1. Firstly, ITO coated substrates were cleaned with ultra-sonication in acetone, ethanol and distilled water successively for 10 minutes prior to device fabrication. Then solutions of 0.3 wt% P3HT and 0.2 wt% pentafluorophenyl substituted fulleropyrrolidine in 1, 2- Dichlorobenzene were prepared and stirred using vortex.
2. Thereafter, 50 µL of pentafluorophenyl substituted fulleropyrrolidine solution was spin coated on ITO substrate at 600 rpm for 120 seconds. After few minutes, spin coat P3HT solution on above substrate at 600 rpm for 120 seconds and let the substrate dry to get P3HT film of ~1 µm.
3. A 5wt% PEO is dissolved in ACN and a mixture of 1M $LiClO_4$ in ACN has been prepared. To make a gel electrolyte, PEO gel was mixed with solution of $LiClO_4$ in 2:1 ratio.
4. Then take a second substrate patterned with tape and add $LiClO_4$ embedded in PEO matrix as an electrolyte in between substrates, stick them together such that their conducting surfaces face each other to fabricate device.
5. The same procedure is used for making flexible device on ITO coated PET substrates.

Synthesis procedure of pentafluorophenyl substituted fulleropyrrolidine.

The pentafluorophenyl substituted fulleropyrrolidine was synthesized by following reported procedure[1]. A mixture of C_{60} (200 mg, 0.28 mmol), 2,3,4,5,6-pentafluorobenzaldehyde (26 mg, 0.14 mmol), and N-methylglycine (36 mg, 0.41 mmol) in 25 mL of dry toluene was refluxed for 16 h. After evaporation of the solvent, the crude compound was purified over a silica column. The desired compound was eluted by hexane:dichloromethane (90:10 v/v). Yield = 35%. ^1H

NMR (300 MHz, $CDCl_3$) δ 5.47 (s, 1H), 5.03 (d, J = 9.5 Hz, 1H), 4.21 (dd, J = 9.5, 3.0 Hz, 1H), 2.86 (s, 3H).HRMS (m/z): $[M+H]^+$ calcd for $C_{69}H_6F_5N$, 944.049, found 944.045.

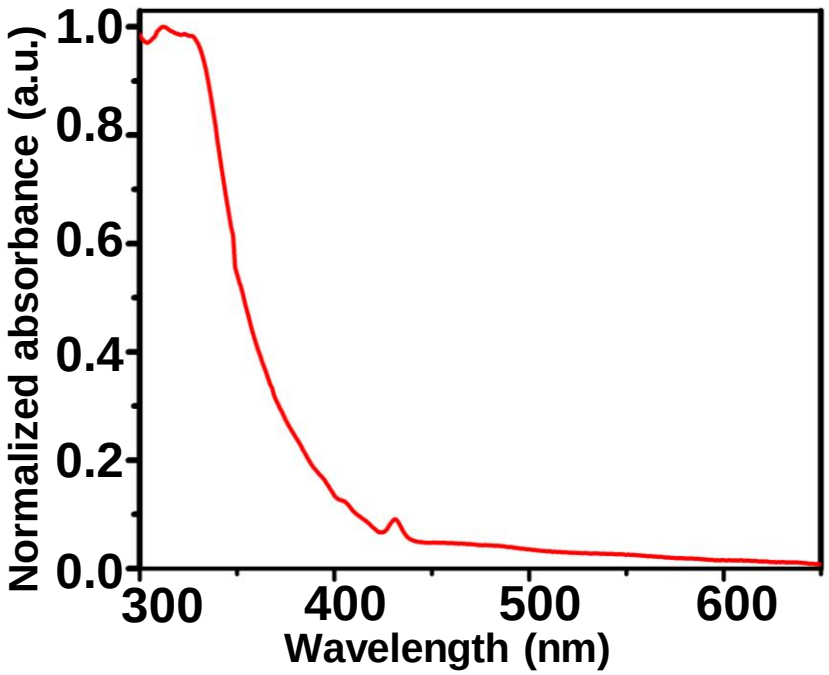

Figure S1: UV-Vis absorbance spectrum of pentafluorophenyl substituted fulleropyrrolidine.

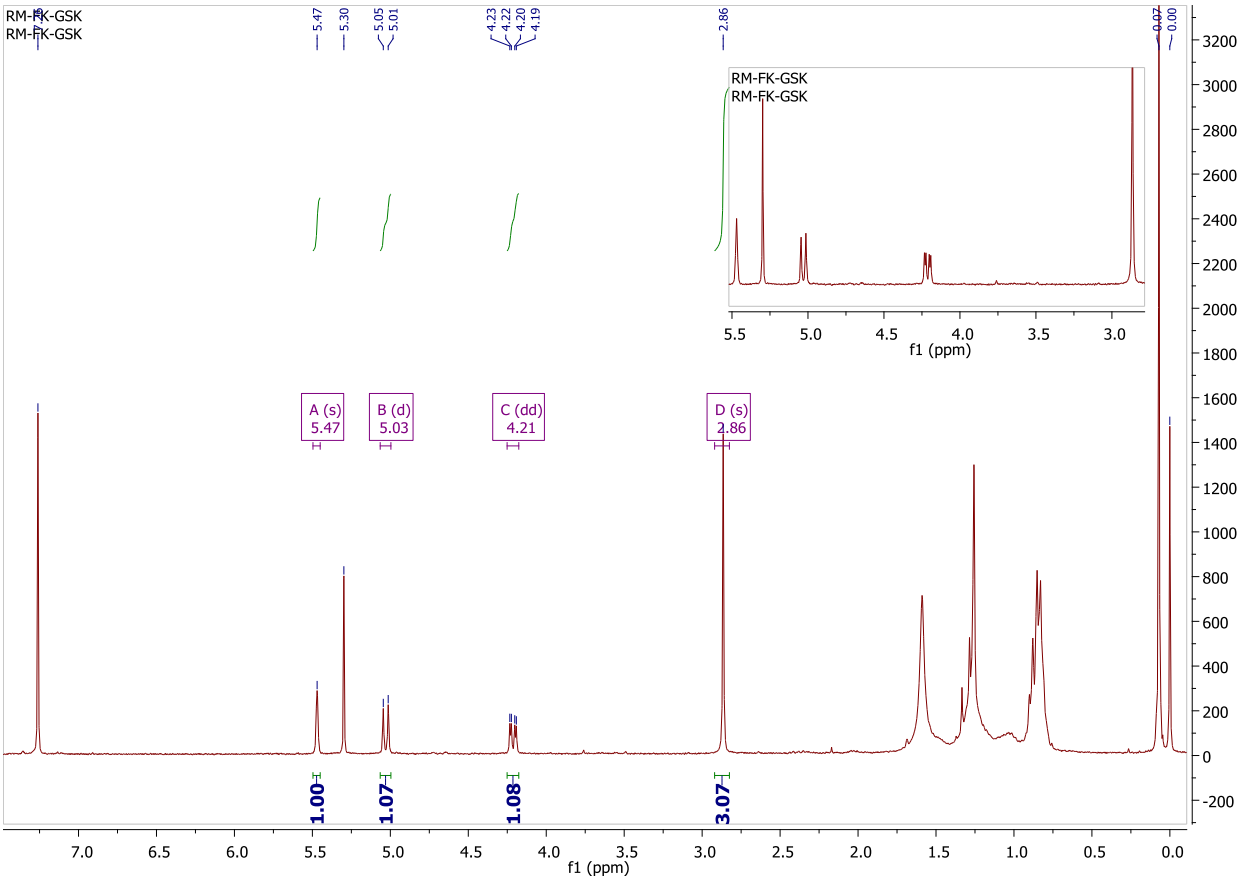

Figure S2: ^{1}H-NMR of compound pentafluorophenyl substituted fulleropyrrolidine.

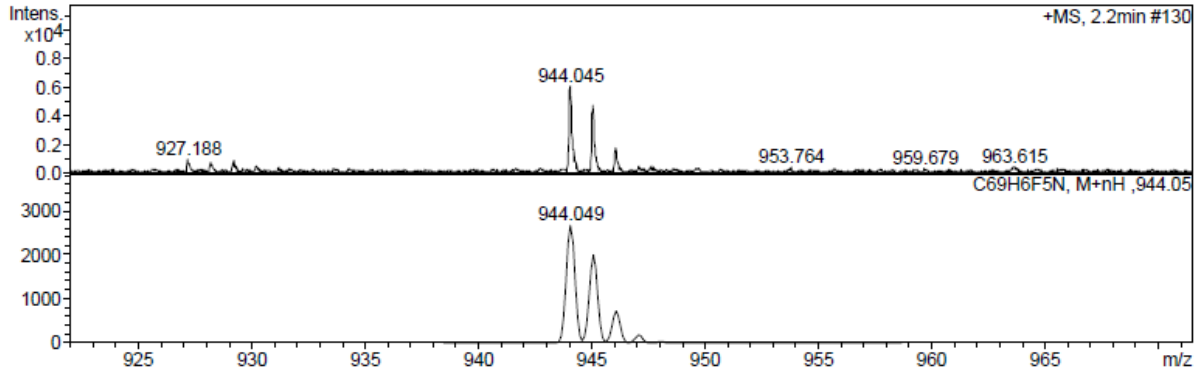

Figure S3: HRMS of compound pentafluorophenyl substituted fulleropyrrolidine.

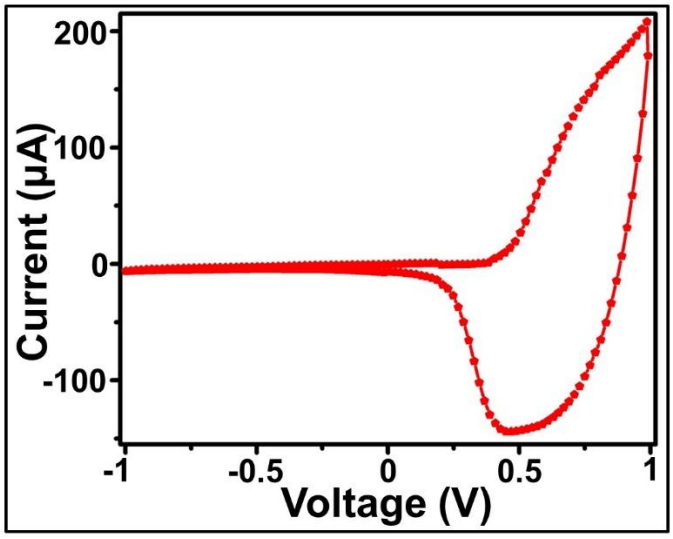

Figure S4: Cyclic Voltammogram of P3HT in PSF solvent.

To establish the fact that PSF helps in facilitating electron transfer in combined PSF-P3HT device. Cyclic Voltammogram of P3HT electrode in PSF solution has been carried out as shown in Figure S4. From 0 to -1V, it shows zero current since PSF holds electron in this situation, an effect similar to the one reported earlier with different molecule[2].

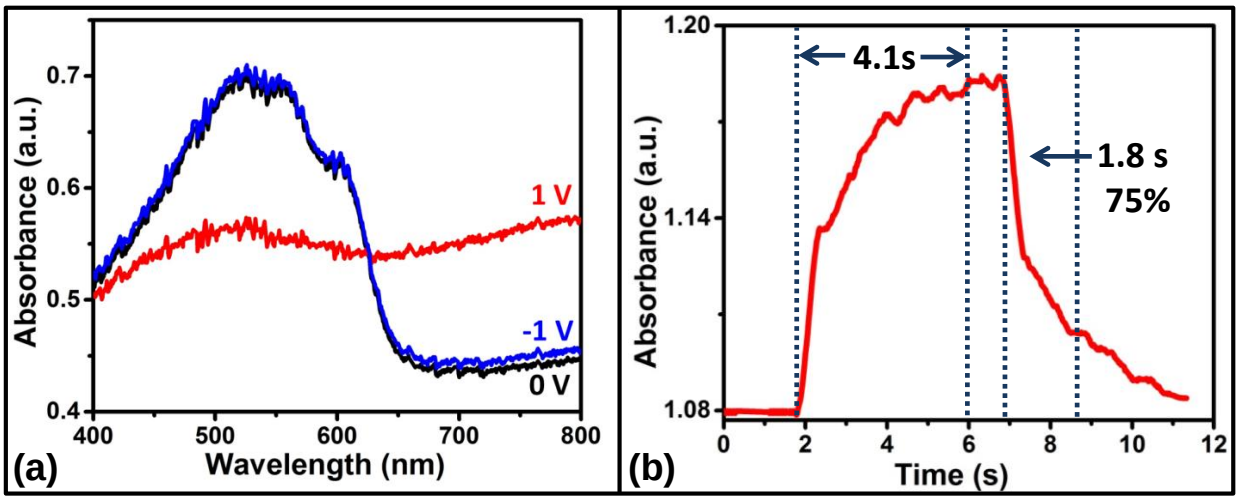

Figure S5: (a) In-situ bias dependent absorbance spectra of P3HT device and (b) one absorbance cycle to demonstrate switching time.

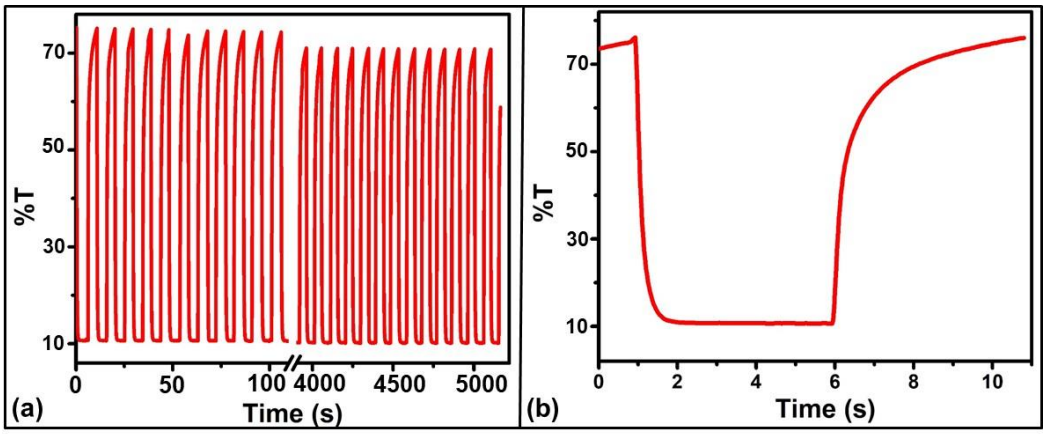

Figure S6: (a) %Transmission of colouration/bleaching cycles of device for 5100 s and (b) one % Transmission cycle displaying switching time of the device.

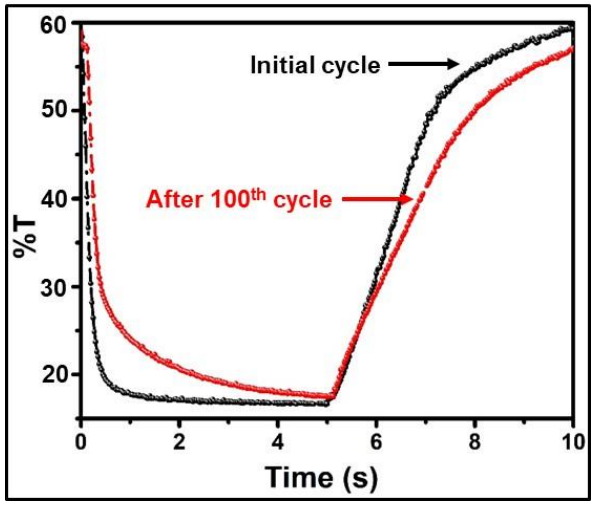

Figure S7: Switching response of flexible device in first cycle and after 100 bending cycles.

Table S1: Comparison of different electrochromic performance parameters of P3HT containing devices.

S.no.	Device composition	Switching time (s)	Coloration Efficiency (cm^2/C)	Stability (s)	References
1.	P3HT/ pentafluorophenyl substituted fulleropyrrolidine	0.3	443	5000	This work
2.	P3HT/WO_3	1.3/5.1	Not reported	Not reported	Kim et al[3]
3.	P3HT	1.4/1.2	Not reported	1800	Chou etal[4]
4.	P3HT	1.01/1.88	Not reported	2000	Jiemsakul etal[5]
5.	P3HT	2.5/2.5	230	Not reported	Li et al[6]
6.	P3HT/EV	2/4	222	500	Chaudhary et al[7]

Table S2: Comparison of switching speed of different flexible devices.

S.No.	Device composition	Switching time (s)	References
1.	SiO_2/PANI	15/12.3	Zhang et al [8]
2.	Monoheptyl viologen & diheltyl viologen	17/32	Oh et al [9]
3.	WO_3	5	Cossari et al [10]
4.	$WO_3.2H_2O$	13.4/12.5	Liang et al[11]
5.	poly(ε-caprolactone) (PCL) electrospun mats filled with silica (SiO2)	25.2/16.2	Liu et al [12]

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