Supporting Information

Novel synthetic approach for designing metal free, redox active quinoxaline-benzimidazole based organic polymers with high energy storage capacity.

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SectionS-1:

Experimental

M-cresol, selenium dioxide and dichloromethane (s. d. fine Bombay) were purified. Phenylacetyl chloride, biphenyl dicarboxylic acid (BPDA) and 3, 3' Diamino benzidine (Sigma Aldrich) were used as received. The inherent viscosities of QOP and QOP-BOP were measured with 3 % concentration in m-cresol at 30 °C using Ubbelohde suspended level viscometer. The chemical structure of intermediates, monomer and polymers were recorded on a Thermo NicoletiS-10 Mid Fourier transform infrared spectrometer. Proton NMR of monomer and polymer were obtained with a Bruker spectrophotometer. X-ray diffraction of polymers was recorded on Rigaku X-ray Diffraction System. Thermogravimetric analysis was performed on a Mettler Toledo Thermal Analysis system under nitrogen atmosphere with a scan rate of 10°C min^{-1}. Differential Scanning Calorimetry was performed on a Mettler Toledo DSC at a heating rate of 10°C min^{-1}. The scanning electron micrograph of the sample was taken with the help of JSM5910 Scanning Electron Microscope, JEOL, Japan. Cyclic Voltammogram measurements was carried out with a CHI 608E Electrochemical Analyzer (CH Instruments Inc., USA) with polymer coated on stainless steel plate was taken as anode, platinum wire as cathode and the reference electrode was a saturated calomel electrode. Experiments were performed in 1M Na_2SO_4 solutions as an electrolyte and measured at a potential scan rate of 2-100mV/s.

Section S-2:

^{1}H NMR of Polymer

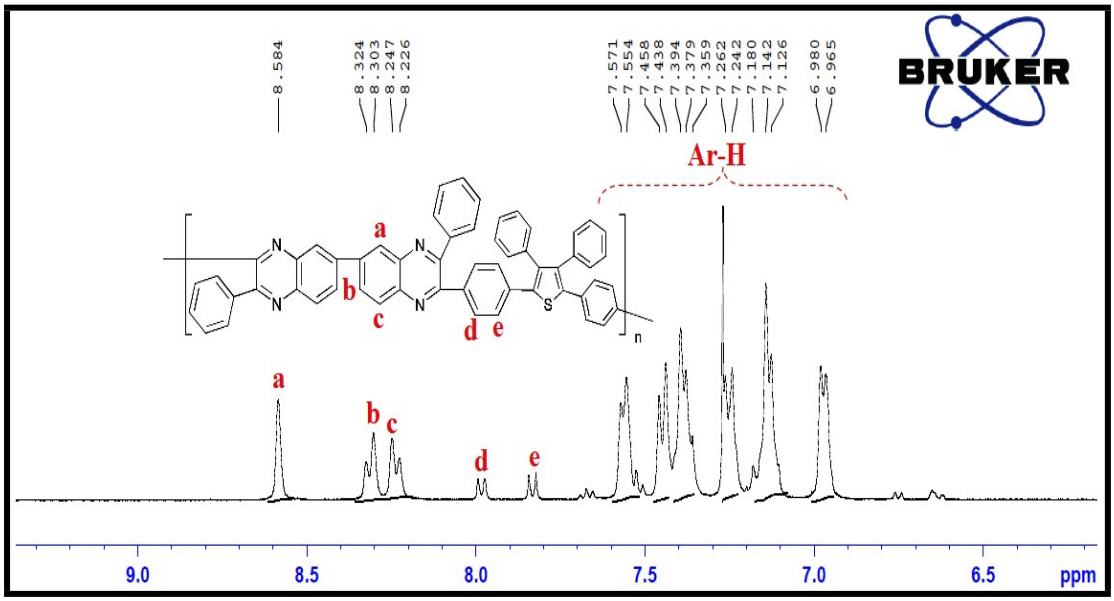


Figure S-1: ^{1}H NMR of QOP.

Section S-3: Energy Dispersive X-ray Spectroscopy (EDX)

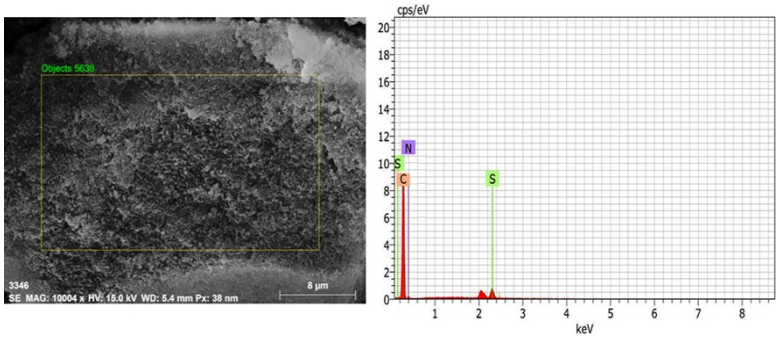


Figure S-2: Energy Dispersive X-ray Spectroscopy (EDX) of copolymer QOP-BOP.

Section S-4: Electrochemical Analysis

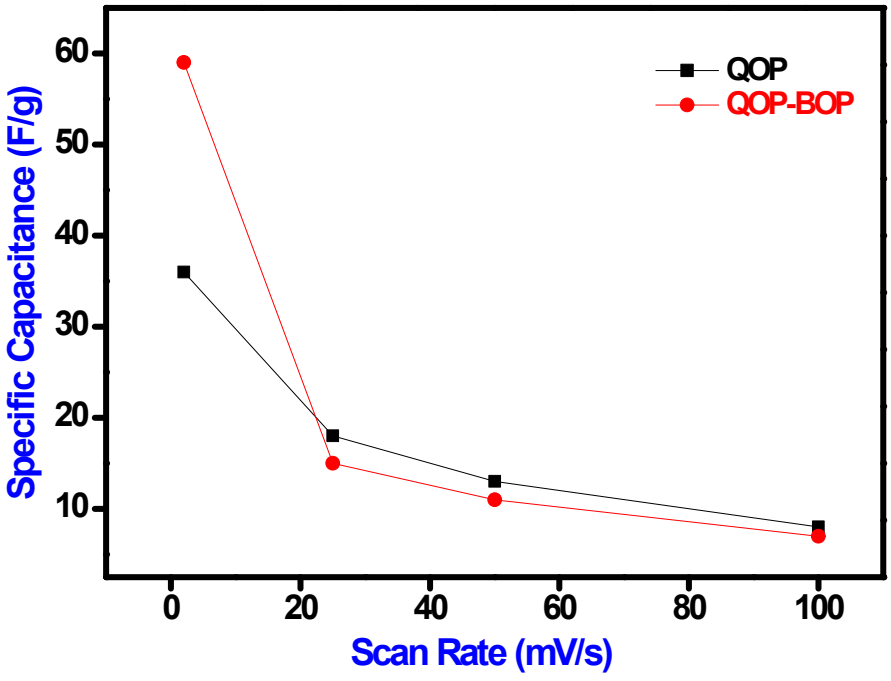


Figure S-3: Variation of scan rate Vs specific capacitance.

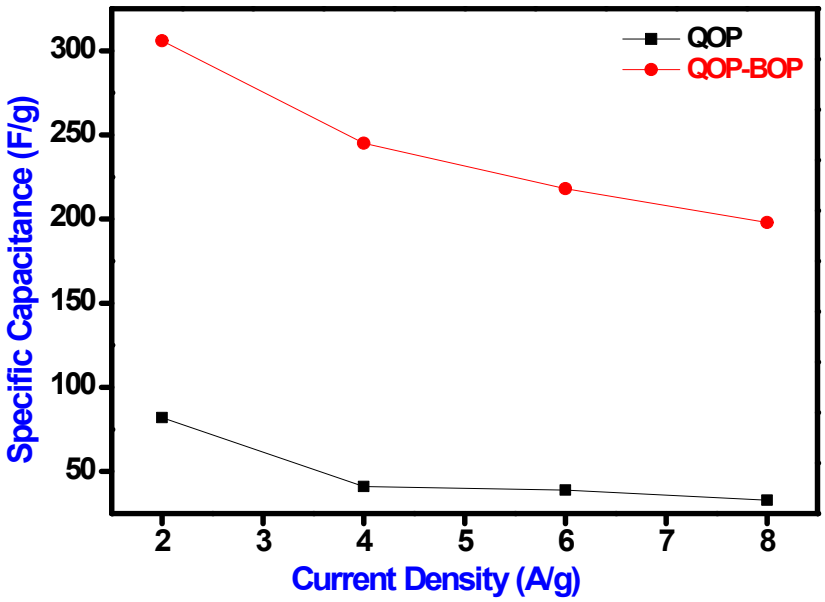


Figure S-5: Variation of current density Vs specific capacitance.

Calculations

The electrical parameters such as specific energy, specific power and columbic efficiency of QOP and QOP-BOP electrodes calculated using following formulae:

$$Specific\ energy = V \times I_d \times T_d / W \quad (1)$$

$$Specific\ power = V \times I_d / W \quad (2)$$

$$Columbic\ efficiency\ \eta\ (\%) = T_d / T_c\ x\ 100 \quad (3)$$

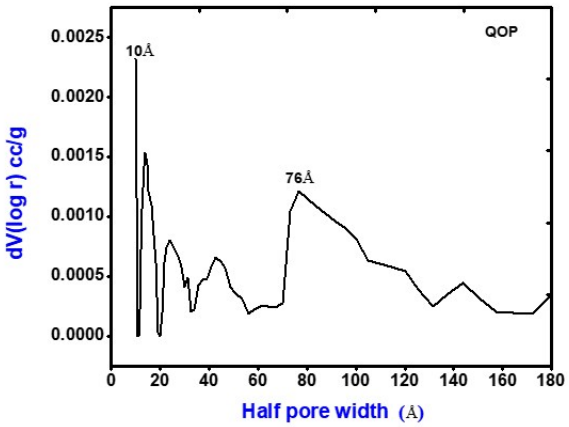
Where, V is the applied potential, W is the mass of electrode dipped in the electrolyte, I_d is discharging current, T_d is discharging time and T_c is charging time. It is found that QOP electrode has the specific energy of 70.90 Wh/kg, specific power of 31.66 KW/kg and columbic efficiency 75 %. Similarly QOP-BOP electrode has the specific energy of 92.40 Wh/kg, specific power of 11.00 KW/kg and columbic efficiency 65 % at 1mA current density in 1M Na_2SO_4 electrolyte solution.

Table S-1. Parameter values by fitting the impedance data of QOP and QOP-BOPfilmto equivalent circuit shown in main manuscript figure 4.

Parameters → / Components ↓	QOP	QOP-BOP

R	3.406	5.66
Cdl/mFg^{-1}	2.01x10^{-4}	2.04x10^{-4}
R_1/k.ohm	233.2	256.2
R_2/k.ohm	1228	1244
W/mS s^{-n}	0.00139	0.00152
CPE	2.99X10^{-4}	2.99X10^{-4}

Section S-5. NLDFT study of QOP and QOP-BOP



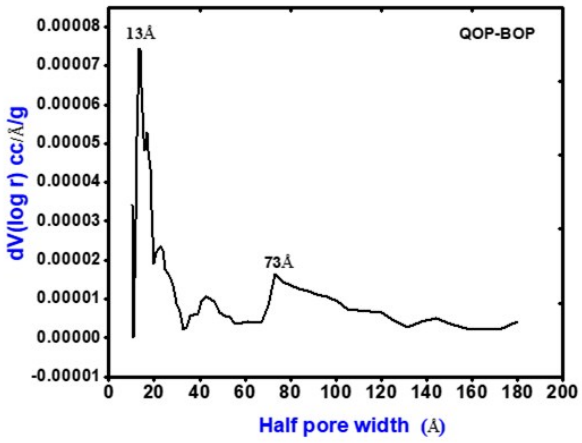
DFT method summary

Pore volume = 0.100 cc/g
Lower confidence limit = 10.104 Å
Fitting error = 0.734 %
Half pore width (Mode) = 10.104 Å

Moving point average : off

DFT method summary

Pore volume = 0.100 cc/g
Lower confidence limit = 10.104 Å
Fitting error = 0.734 %
Half pore width (Mode(dLog)) = 76.550 Å



DFT method summary
Pore volume = 0.002 cc/g
Lower confidence limit = 10.104 Å
Fitting error = 0.536 %
Half pore width (Mode) = 13.236 Å

Moving point average : off

DFT method summary
Pore volume = 0.002 cc/g
Lower confidence limit = 10.104 Å
Fitting error = 0.536 %
Half pore width (Mode(dLog)) = 73.182 Å

Moving point average : off

Figure S-6: Pore size distribution curve for QOP and QOP-BOP derived from N_2 adsorption isotherm at 77 K using the NLDFT method.

Section S-6. Comparative study of electrochemical charge storage activity of different electrode materials

Table S-2.

Electrode Material	Electrolyte	Specific capacitance (F/ g)	Current density (A g^{-1})	Reference
azo based covalent organic frameworks (COFs)	1 M Na_2SO_4	226		1
Porous triazine-based frameworks (PTF)	1-ethyl-3-methylimidazolium Tetrafluoroborate	147 (PTF@500°C) 151(PTF@700 °C)	0.1	2
Graphene	30 wt.% KOH	150	0.1	3
Radical COFs (i)[TEMPO]100 %-NiP-COF (ii) [TEMPO]50%-NiP-COF	0.1 M (C4H9)4NClO4 in CH3CN	(i)167 (ii) 124	0.1	4
Hierarchically porous B doped carbons	1 M H_2SO_4	160	10 mV/s	5

Nitrogen-doped porous carbon foam	6 M KOH	210	0.5	6
Hierarchically porous carbonAS-ZC-800	1 M H_2SO_4	251	0.25	7
MOF-derived nonporous carbons	1 M H_2SO_4	251	0.5	8
Interconnected micropores Carbon	1 M H_2SO_4	258	0.5	9
TpDAB	1M Na_2SO_4	432	0.5	10
PAM	1M NaOH	252	5 mV/s	11
β-ketoenamine-linked conjugated microprous polymer	1M H_2SO_4	252	1	12
Reduced graphene oxide hydrogels	1 M H_2SO_4 + 0.2 M HQ	252.6	1	13
N-rich hollow carbon sphere	5 M KOH	230	0.5	14
MnO2/CNT	1 M Na_2SO_4	201	1	15
QOP-BOP	**1M Na_2SO_4**	**305**	**2**	**Present Work**

Section S-7.

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