Electronic Supplementary Information

2D-Black Phosphorus/Polyaniline Hybrids for Efficient Supercapacitor and Hydrogen Evolution Reaction Applications

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Calculation of areal capacitance, energy density and power density

The practical capacitance of the supercapacitors in two-electrode configuration was calculated from the GCD curves at different current densities using $C = \frac{2I\int vdt}{A(V_i^2 - V_f^2)}$, where i and dv/dt are the current and the slop of discharge curve. The specific capacitance of device was calculated by $C_X=2C_{Cell}/X$, where X can be surface area. The areal energy density (E_{cell}) can be calculated using $E_{cell,A}=C_A V_2/(8\times3600)$ where C_A, V are the areal specific capacitance, and voltage window. The areal power density ($P_{cell,A}$) are calculated by $P_{cell}= E_{cell}\times3600/t_{discharge}$, where E_{cell} and $t_{discharge}$ are the entire device areal energy density and discharge time.

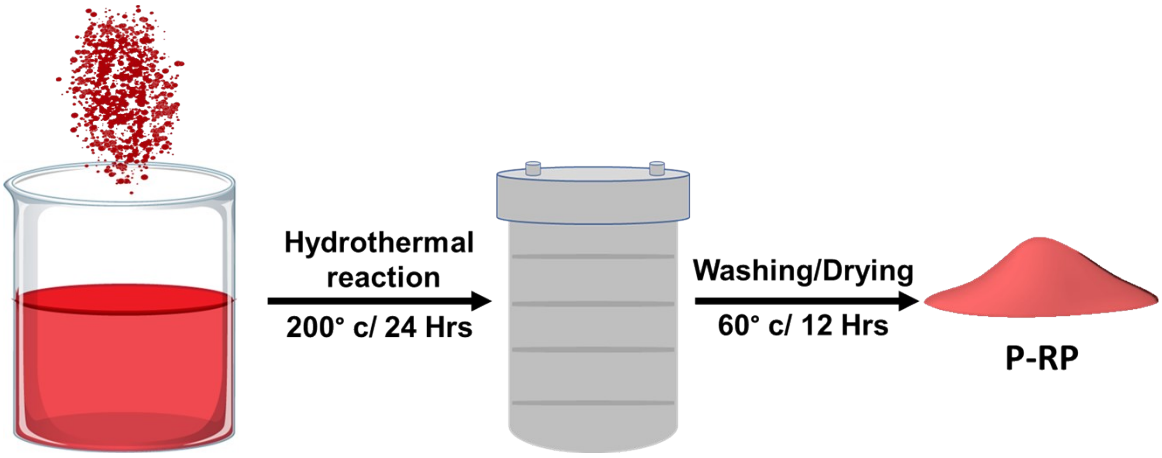

Fig.S1 Schematic illustration represents pre-treatment of red phosphorus

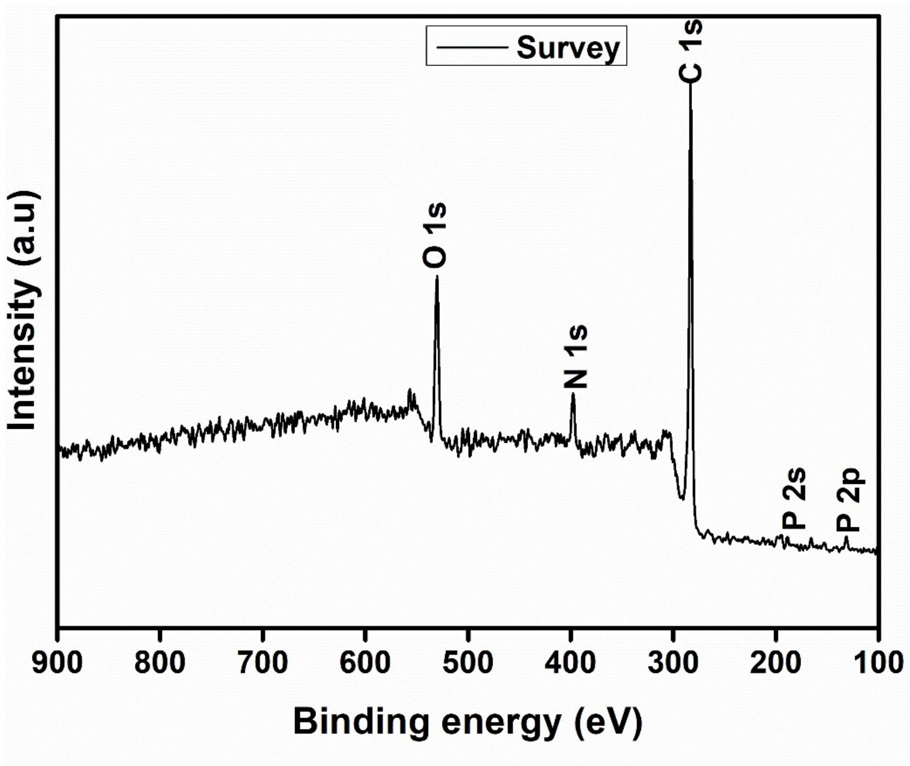

Fig.S2 XPS survey spectra of the PANI/BP.

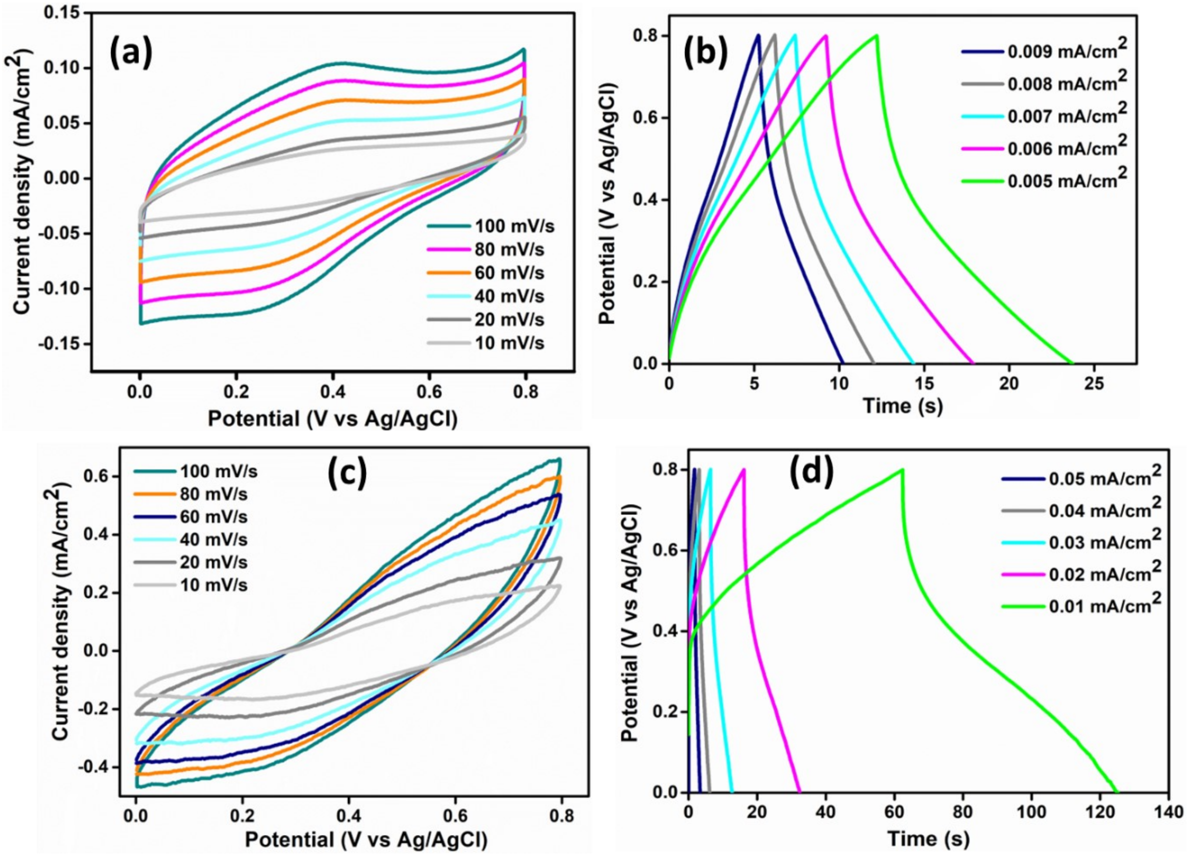

Fig.S3 CVs and GCD of prepared (a-b) BP, (c-d) PANI at different scan rate and current density.

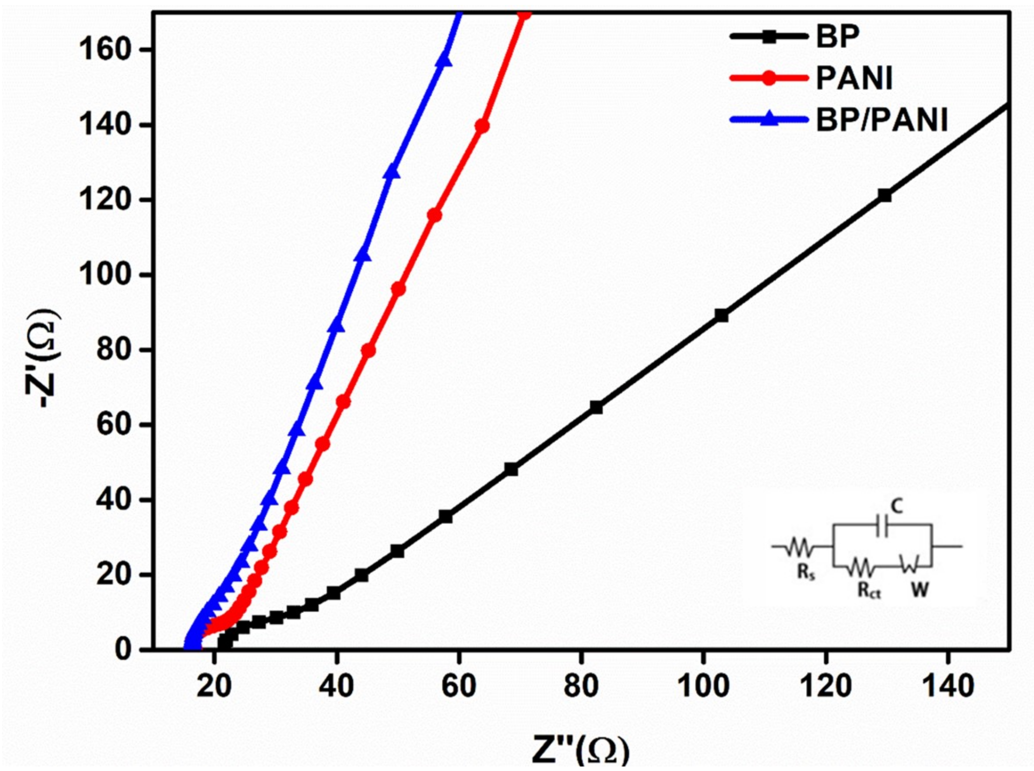

Fig.S4 Impedance spectra of prepared BP, PANI and BP/PANI

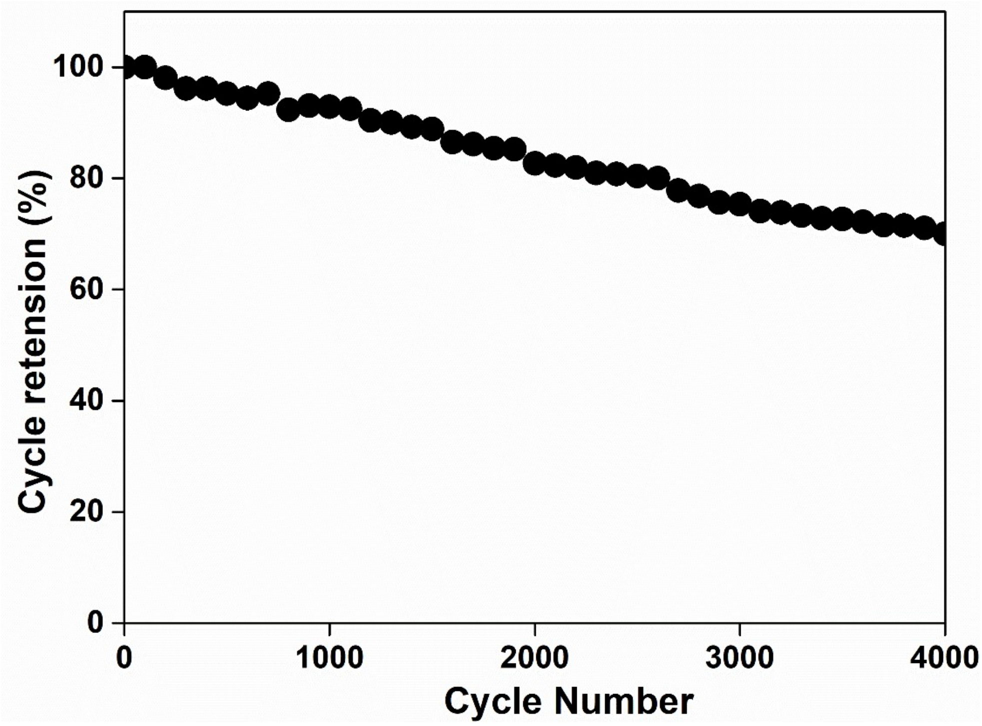

Fig.S5 Cycling stability analysis of PANI for continues 4000 charge discharge cycle

Material	Capacitance mF/cm^2	Energy density µWh/cm^2	Power density mW/cm^2	Stability %	Ref
BP/PPy	-	3.3	3.2	96%	1
G/PANI@Cloth	246 m	9.7	0.8	98% after 3800 cycles	2
G/PANI	176 mF/cm^2	17.1	0.25	74.8 after 500 cycles	3
G/PANI	87.8	12.2	0.226	-	4
RGO/PPy@CNT	443	7	8.2	94% after 10000 cycles	5
Carboxyl-G/PPy@CNT	196	10.9	8.1	98.1% after	6

				5000 cycles	
PANI@GF	357	7.9	167	96.4% after 5000 cycles	7
CNT@C	19.5	11.6	0.52	-	8
rGO/C	145	5.04 μWh cm^{-2}	0.5 mW cm^{-2}	91% after 10000 cycles	9
Graphene/MnO_2	42	1.46 μWh cm^{-2}	2.9 mW cm^{-2}		10
Cellular Graphene	2.47	0.34	5.3	97% after 10000 cycles	11
Graphene/CNT	-	0.32	23	-	12
Graphene/BP	13.7	2.32	0.3	85%	13
VGN	145	0.56	10.5	91%	14
MoSSe@vertically aligned graphene	252	11.2 μWhcm^{-1}	130 mWcm^{-1}	80%	15
BP/PANI Present work	**350 mFcm^{-2}**	**31.2**	**330**	**83.3% after 10000 cycles**	Present work

Table ST1 Comparison of the energy storage performance of BP and conducting polymer-based supercapacitors

Material	**Overpotential mV**	**Tafal Slope mV/dec**	**Reference**
Vertically aligned MoS_2	300	105-120	16
Silica polypyrrole	200	83	17
Edge BP	550	-	18
BP/$MoSe_2$	380	97	19
Co_3O_4/PPY	140	83	20

Co_3O_4/PPY/CNT	490	110	21
NF/PPy@SiO_2	192	77	22
Polyaniline/BP	**128**	**71**	**Present Work**

Table ST2 Comparative electrocatalytic performance of conducting polymer, BP and their composites

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