Supplementary Information

High-performance asymmetric supercapacitor based on vanadyl phosphate/carbon nanocomposite and polypyrrole-derived carbon nanowire

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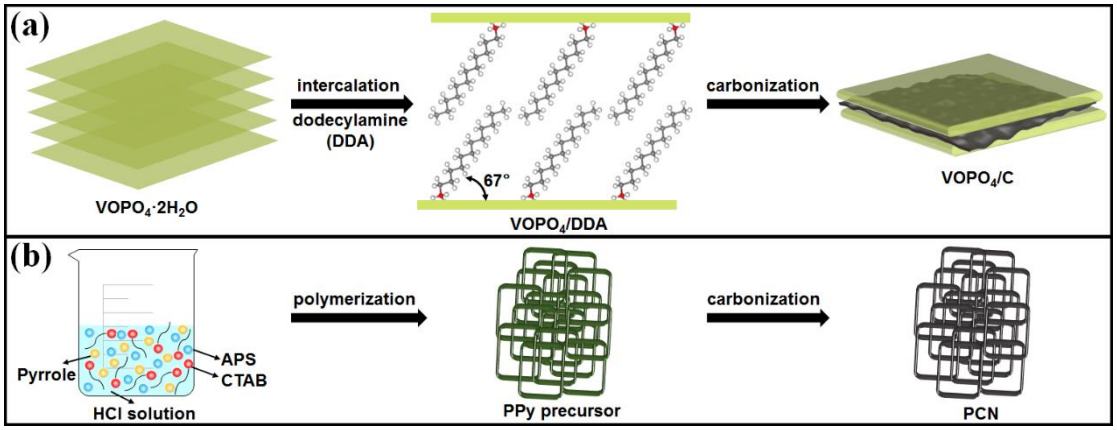
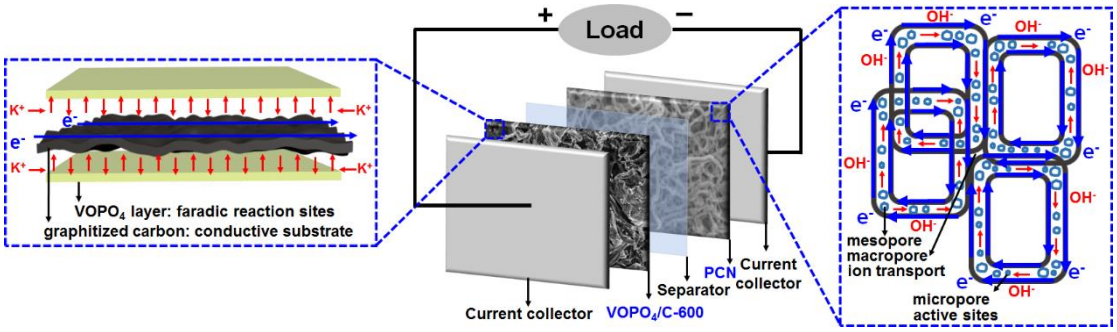


Scheme S1. Schematic illustration for the synthesis of (a) $VOPO_4$/C nanocomposites and (b) PPy-derived carbon nanowires (PCN).



Scheme S2. Schematic representation for the charge and discharge mechanism of $VOPO_4$/C-600//PCN asymmetric supercapacitor in aqueous KOH electrolyte.

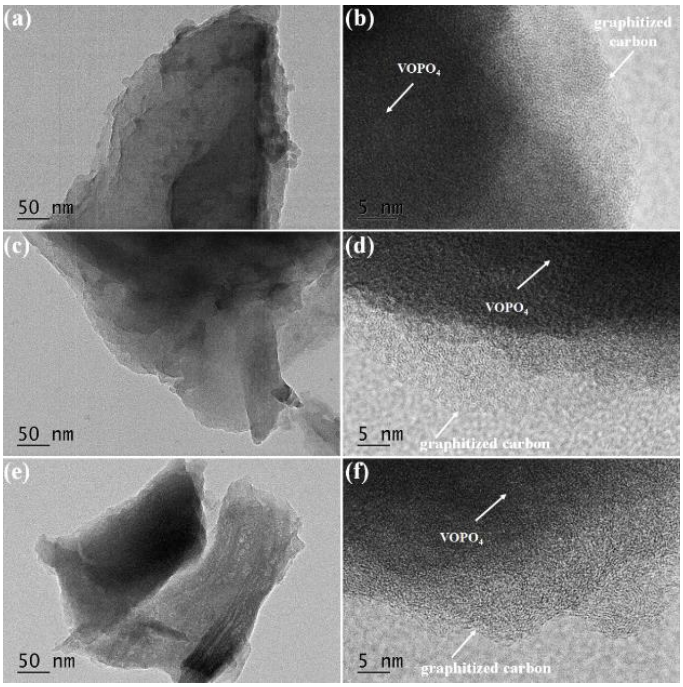


Fig. S1 TEM images at different magnifications of $VOPO_4$/C-400 (a, b) $VOPO_4$/C-600 (c, d) and $VOPO_4$/C-800 (e, f), respectively.

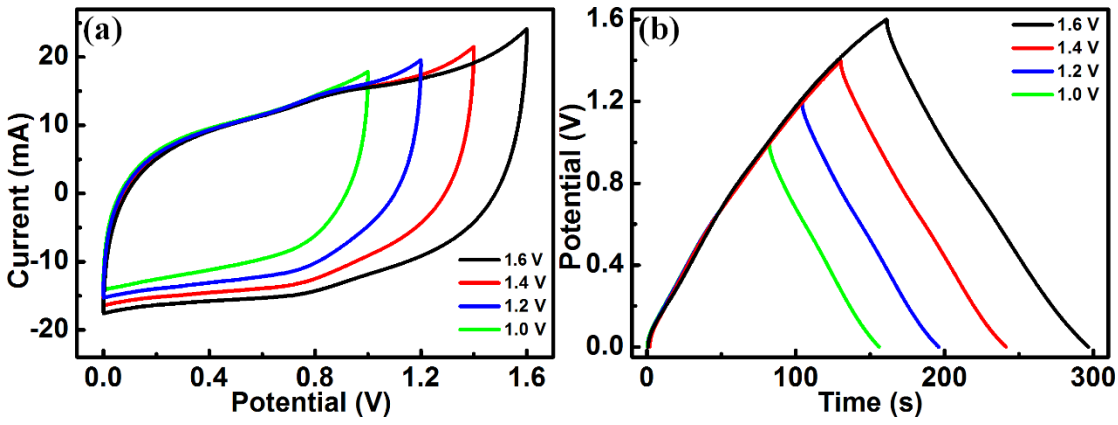


Fig. S2 (a) Cyclic voltammetry curves of $VOPO_4$/C-600//PCN asymmetric supercapacitor at increasing voltage window from 1.0 V to 1.6 V, all acquired at 100 $mV \cdot s^{-1}$ and (b) Corresponding galvanostatic charge-discharge curves at a current density of 1.0 $A \cdot g^{-1}$ from 1.0 V to 1.6 V.

Table S1 Results of XPS peak fitting for (a) $VOPO_4$/C-400, (b) $VOPO_4$/C-600 and (c) $VOPO_4$/C-800 in the C 1s region.

(a) Peak	Position (eV)	Relative peak area (%)	FWHM (eV)
O–C=O	288.5	4.1	1.7
C=O	287.0	6.8	1.4
C–O	286.0	13.3	1.3
C–C/C=C	284.8	75.8	1.3
(b) Peak	Position (eV)	Relative peak area (%)	FWHM (eV)
O–C=O	288.6	3.6	1.9
C=O	286.9	6.0	1.2
C–O	286.0	12.0	1.2
C–C/C=C	284.8	78.4	1.2
(c) Peak	Position (eV)	Relative peak area (%)	FWHM (eV)
O–C=O	288.6	3.7	1.8
C=O	286.8	6.1	1.1
C–O	286.0	12.4	1.1
C–C/C=C	284.8	77.8	1.2

Table S2 Results of XPS peak fitting for (a) $VOPO_4 \cdot 2H_2O$, (b) $VOPO_4$/C-400, (c) $VOPO_4$/C-600 and (d) $VOPO_4$/C-800 in the V 2p region.

(a) Peak	Position (eV)	Relative peak area (%)	FWHM (eV)
$V^{+5}(2p_{1/2})$	525.6	17.0	2.4
$V^{+4}(2p_{1/2})$	524.2	9.9	2.6
$V^{+5}(2p_{3/2})$	518.5	48.2	1.1
$V^{+4}(2p_{3/2})$	516.9	24.9	1.8
(b) Peak	Position (eV)	Relative peak area (%)	FWHM (eV)
$V^{+5}(2p_{1/2})$	525.0	10.0	1.5
$V^{+4}(2p_{1/2})$	524.0	16.8	2.0
$V^{+5}(2p_{3/2})$	517.3	33.0	1.8
$V^{+4}(2p_{3/2})$	516.7	40.2	1.8
(c) Peak	Position (eV)	Relative peak area (%)	FWHM (eV)
$V^{+5}(2p_{1/2})$	525.0	9.4	1.5
$V^{+4}(2p_{1/2})$	524.1	16.1	1.9
$V^{+5}(2p_{3/2})$	517.4	32.6	1.8
$V^{+4}(2p_{3/2})$	516.6	41.9	1.9
(d) Peak	Position (eV)	Relative peak area (%)	FWHM (eV)
$V^{+5}(2p_{1/2})$	525.0	9.5	1.4
$V^{+4}(2p_{1/2})$	524.0	19.2	2.0
$V^{+5}(2p_{3/2})$	517.3	31.6	1.8
$V^{+4}(2p_{3/2})$	516.7	39.7	1.7

Table S3 A comparison of specific capacitance, rate capability and cycle stability of the present work with those reported $VOPO_4$-based composite electrodes.

Material	Capacitance	Rate capability	Cycling performance	Ref
$VOPO_4$/C-600 composite	469 $F \cdot g^{-1}$ (1 $A \cdot g^{-1}$)	77% (1 to 10 $A \cdot g^{-1}$)	94% (2 $A \cdot g^{-1}$ for 5000 cycles)	This work
Amorphous $VOPO_4$/graphene (2:1)	483 $F \cdot g^{-1}$ (1 $A \cdot g^{-1}$)	74% (1 to 10 $A \cdot g^{-1}$)	80% (2 $A \cdot g^{-1}$ for 5000 cycles)	[1]
$VOPO_4$/graphene-based flexible ultrathin-film supercapacitor	8360.5 $\mu F \cdot cm^{-2}$ (0.2 $A \cdot cm^{-2}$)	/	96% (2000 cycles)	[2]
$VOPO_4$-graphene nanocomposite	50 $F \cdot g^{-1}$ (1 $A \cdot g^{-1}$)	47% (1 to 10 $A \cdot g^{-1}$)	85% (100 $mV \cdot s^{-1}$ for 5000 cycles)	[3]
$VOPO_4$/RGO	378 $F \cdot g^{-1}$ (5 $mV \cdot s^{-1}$)	68% (0.5 to 10 $A \cdot g^{-1}$)	64% (20 $mV \cdot s^{-1}$ for 1000 cycles)	[4]
$VOPO_4 \cdot H_2O$	202 $F \cdot g^{-1}$ (2 $mV \cdot s^{-1}$)	67.4% (0.2 to 2 $A \cdot g^{-1}$)	/	[5]

Table S4 A list of gravimetric and volumetric specific capacitances of the assembled asymmetric supercapacitor device ($VOPO_4$/C-600//PCN) at different current densities.

Current density ($A \cdot g^{-1}$)	Gravimetric specific capacitance ($F \cdot g^{-1}$)	Current density ($A \cdot cm^{-3}$)	Volumetric specific capacitance ($F \cdot cm^{-3}$)
1.0	84.7	0.5	44.2
2.0	75.3	1.1	40.1
4.0	68.0	2.1	35.4
8.0	58.1	4.2	30.2
10.0	52.5	5.2	27.6

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