Porous 3D Carbon Decorated Fe_3O_4 Nanocomposite Electrode for Highly Symmetrical Supercapacitor Performance

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SUPPORTING INFORMATION

Supplementary table

Table 1: Type of Fe_3O_4 composite and reported electrochemical performance

Composite materials	Specific surface area, (m^2 g^{-1})	Electrolyte	Capacitance, Fg^{-1} (Current density)	Capacitive retention, % (cycles)	Energy density ($Whkg^{-1}$)	Power density (Wkg^{-1})	(Year) [Ref.]
Fe_3O_4 /CNT	-	1 mol L^{-1} Na_2SO_3	165.0 (0.2 A g^{-1})	-	-	-	(2011) [1]
Ultrathin nanoporous Fe_3O_4/CNS	229	1 mol L^{-1} Na_2SO_3	163.4 (1 A g^{-1})	-	-	-	(2013) [2]
Fe_3O_4/Gr	-	1 mol L^{-1} Na_2SO_4	154 (1 A g^{-1}) 236 (TX-100 surfactant)	-	-	-	(2015) [3]
4wt% Fe_3O_4/Ac	949.03	1 mol L^{-1} Na_2SO_3	86 (10mV s^{-1})	-	-	-	(2013) [4]
Fe_3O_4/Ac	1197 (AC) 25 (Fe_3O_4)	6 mol L^{-1} KOH	37.9 (0.5 mA cm^{-2})	85.1% (1000)	-	-	(2009) [5]
Nanosized Fe_3O_4-Modified AC	-	0.5 mol L^{-1} Na_2SO_4	154.3 (5 mA cm^{-1})	79.6% (1000)	-	-	(2013) [6]
Fe_3O_4/Fe-CNTs	-	3 mol L^{-1} KOH	1065 (1A g^{-1})	82.1% (1000)	29.9 [a] 18.54 [b]	897 [a] 8139.51 [b]	(2016) [7]
Fe_3O_4@C	-	1 mol L^{-1} KOH	110.8 (0.5A g^{-1})	95.6% (2000)	34.6 [a] 9.1 [b]	375 [a] 3000 [b]	(2014) [8]
Fe_3O_4@carbon nanosheets	-	6 mol L^{-1} KOH	586 (0.5 A g^{-1})	70.8% (5000)	18.3	351	(2016) [9]
Fe3O4/Carbon	344	1 mol L^{-1} Na_2SO_4	136.2 (1 A g^{-1})	84.5% (1000)	27.2	705.5	(2016)[10]
Active carbon-Fe_3O_4 nanocomposite	-	6 mol L^{-1} KOH	120 (5 A g^{-1})	93.66% (1000)	15.97	-	(2014) [11]

Fe_3O_4 on oxidised activated carbon	2356.6	1 mol L^{-1} Na_2SO_3	202.6 (10 mVs^{-1})	94% (5000)	-	-	(2015) [12]
Porous 5% Fe/HC	**1712.3**	**1 M Na_2SO_4**	**245.3 (1 Ag^{-1}) - initial 233.5 -5000th cycle**	**95.1% (5000)**	27.6 [a] 22.4 [b]	2490.6 [a] 15186.7 [b]	**This work**

*Footnote: a = maximum energy density condition, b = maximum power density condition

Table 2: The textural properties of p-HC and porous 5%Fe/HC nanocomposite

Samples	BET surface area $m^2 g^{-1}$	Micropore volume $cm^3 g^{-1}$	Micropore area $m^2 g^{-1}$	External surface area $m^2 g^{-1}$	Average pore diameter/ Å
p-HC	1117.6922	0.150571	351.0773	766.6149	38.5
5%Fe/HC	1712.7953	0.263566	602.6501	1110.1452	37.2

Table 3: Electrochemical performance of p-HC symmetric cell at 1 mol L^{-1} Na_2SO_4

Current density (Ag^{-1})	Specific capacitance (Fg^{-1})	Energy density ($Whkg^{-1}$)	Power density (Wkg^{-1})	Coulombic Efficiency (%)
0.5	204.7	23.0	1309.6	95.8
1	172.6	19.4	2618.5	96.4
2	157.7	17.7	5554.6	94.3
3	145.6	16.4	8672.3	93.2
4	137.3	15.4	12359.0	90.0
5	129.8	14.6	16426.8	84.2

Table 4: Electrochemical performance of p-Fe/HC symmetric cell at 1 mol L^{-1} Na_2SO_4

Current density (Ag^{-1})	Specific capacitance (Fg^{-1})	Energy density ($Whkg^{-1}$)	Power density (Wkg^{-1})	Coulombic Efficiency (%)
0.5	259.3	29.2	1212.8	96.3
1	245.4	27.6	2490.6	97.3
2	224.7	25.3	5260.7	96.1
3	213.0	24.0	8216.0	93.8
4	204.4	23.0	11498.1	92.3
5	198.7	22.4	15186.7	88.3

Supplementary figures

Electrochemical impedance spectroscopy was performed for both symmetric cell before and after charge-discharge cycle. It was observed that the slope of p-HC and p-Fe/HC was not steeper as before and bending Walburg diffusion region. This might due to fast charge-discharge cycle causing partial damage of charge transfer channels, results in decay of specific capacitance. However, overall variation on the nyquist plot show that p-HC and p-Fe/HC nanocomposites electrodes had good stability and charge-discharge rate.

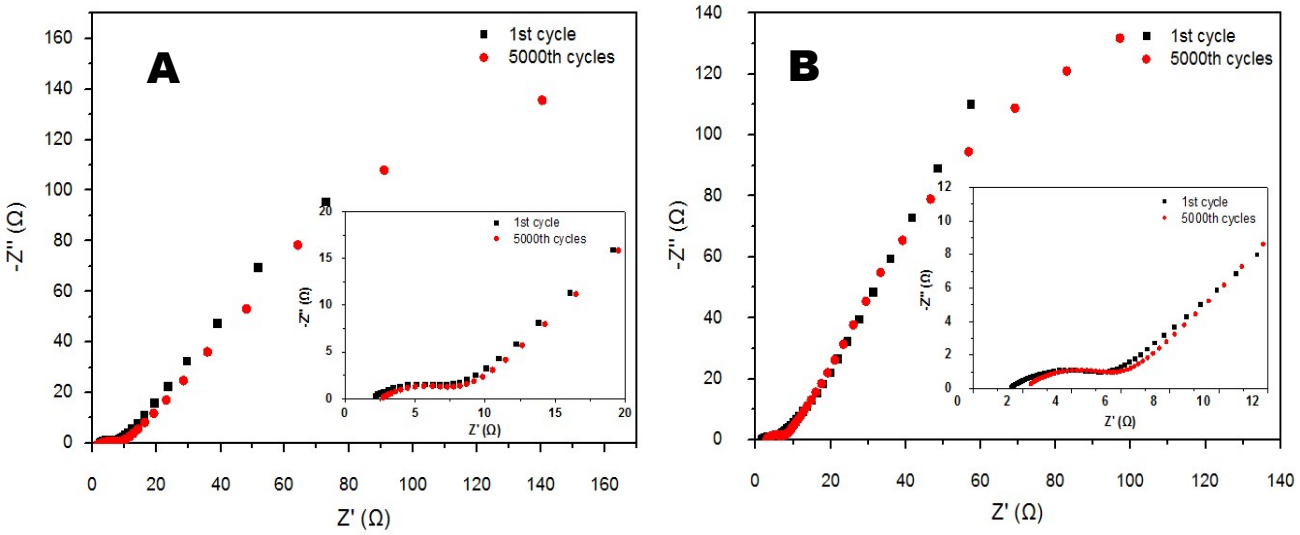

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Fig S1: Nyquist plot of 1st and 500th cycles (a) p-HC electrode and (b) p-Fe/HC nanocomposite electrode

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