Supplementary Information

A Novel Strategy for the Synthesis of Hard Carbon Spheres Encapsulated with Graphene Networks as a Low-Cost and Large-Scalable Anode Material for Fast Sodium Storage with an Ultralong Cycle Life

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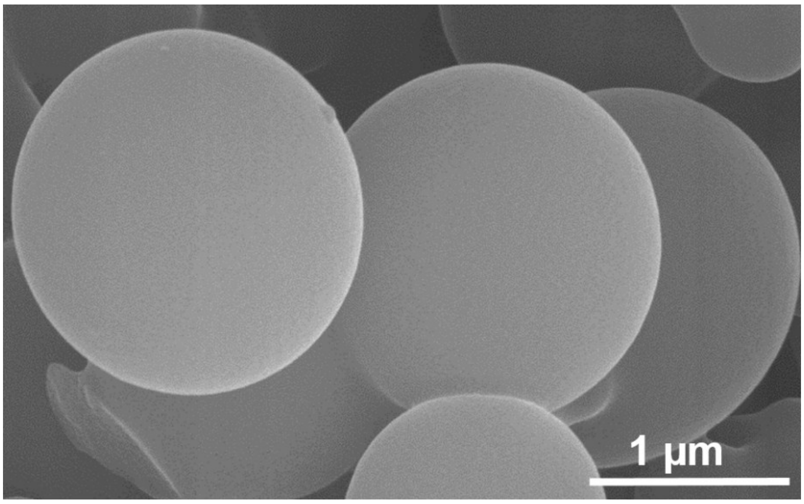

Fig. S1. SEM image of hard carbon spheres.

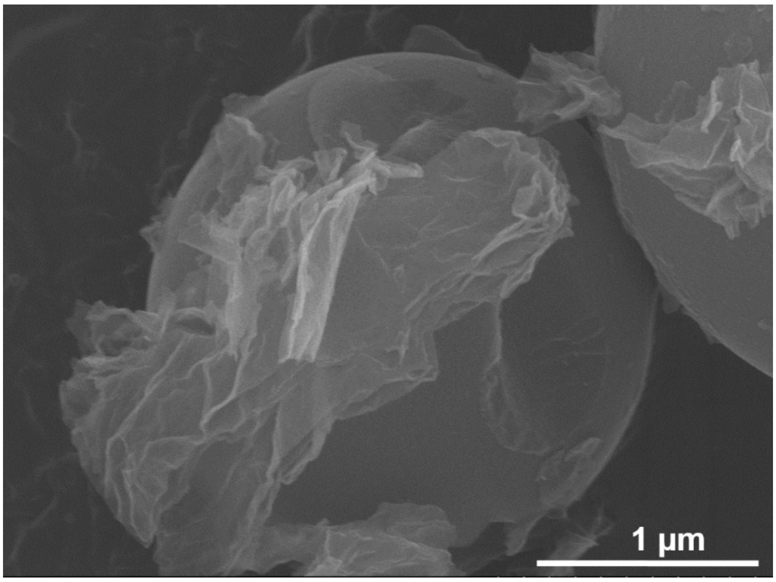

Fig. S2. SEM image of hard carbon spheres wrapped with flexible conductive networks of graphene nanosheets.

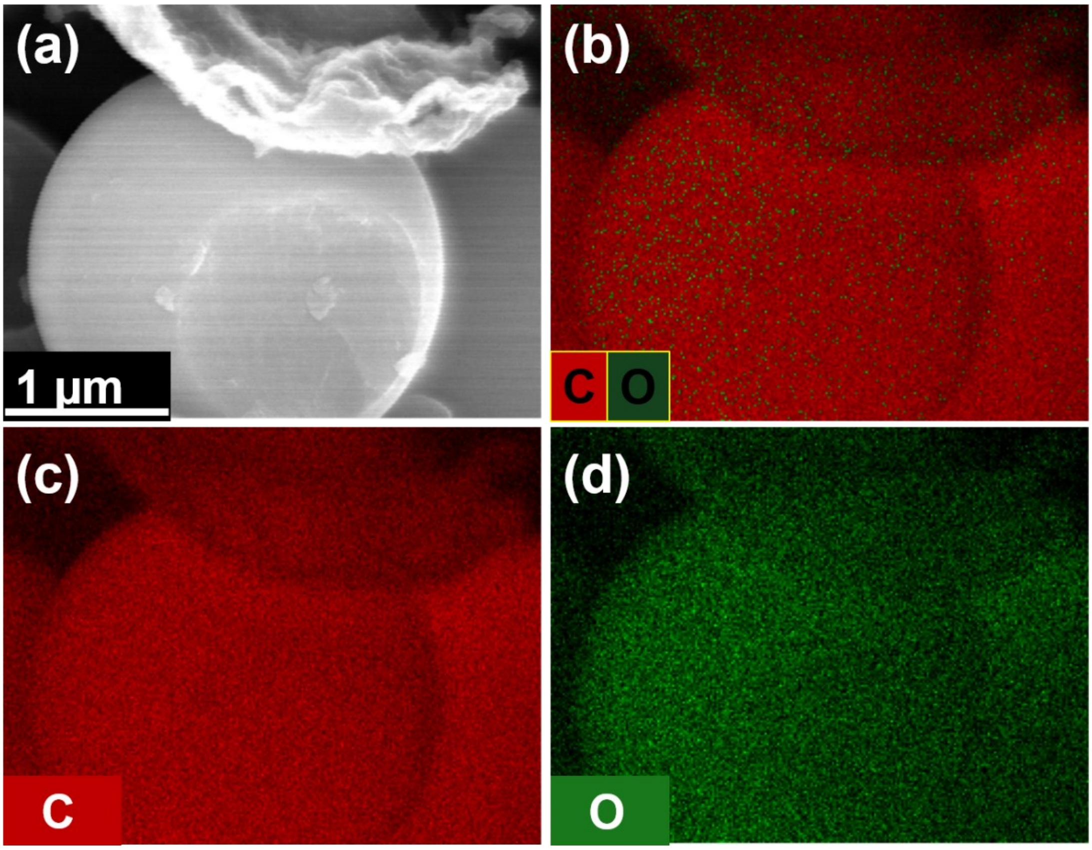

Fig. S3. SEM image (a) and (b-d) SEM-EDS elemental mapping of G-HCS.

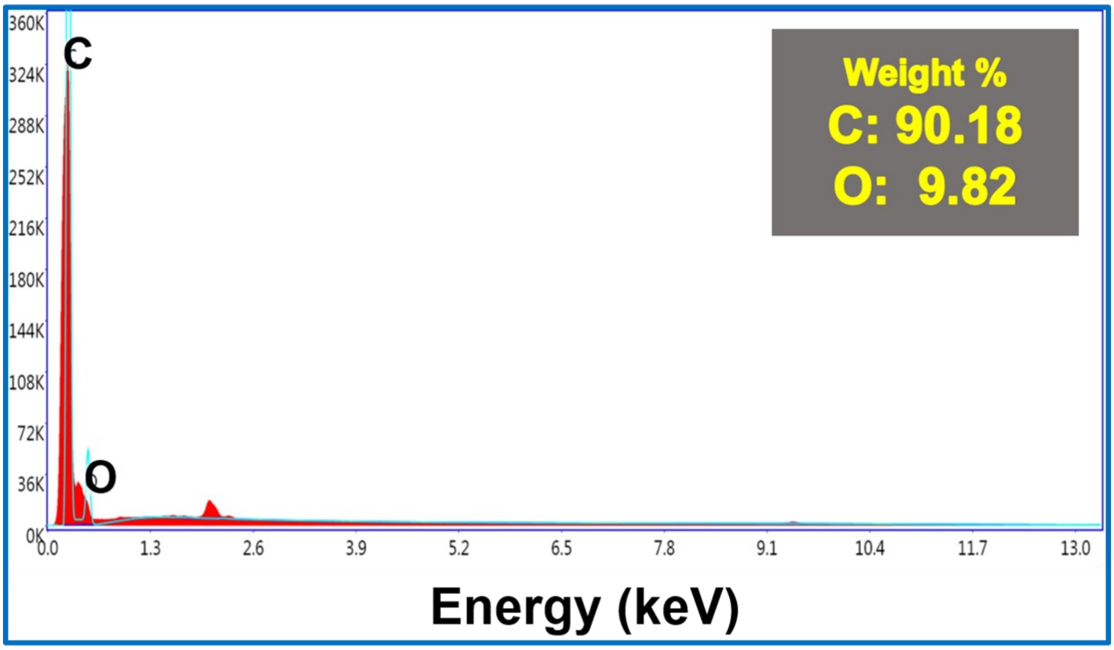

Fig. S4. EDS spectra for elemental composition of G-HCS.

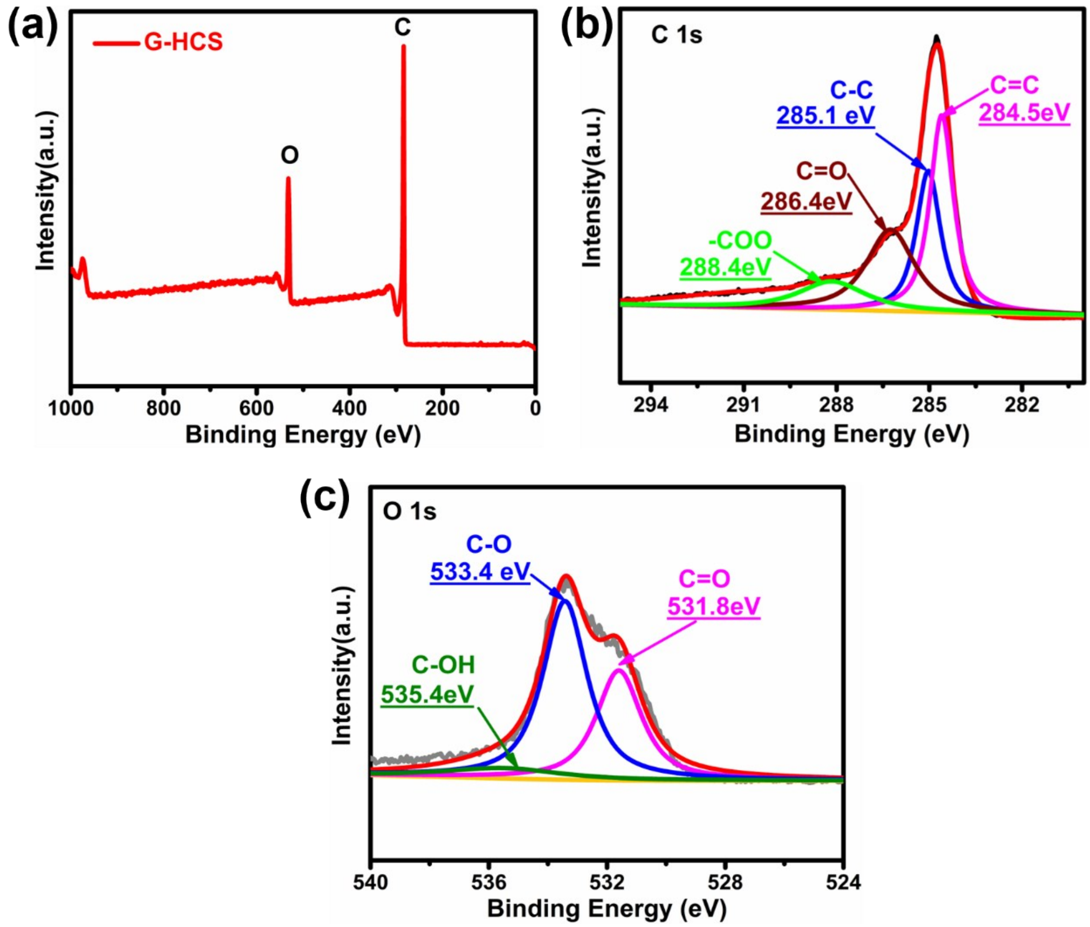

Fig. S5. XPS analysis of G-HCS sample (a) XPS survey, High-resolution XPS spectra of (b) C 1s and (c) O 1s.

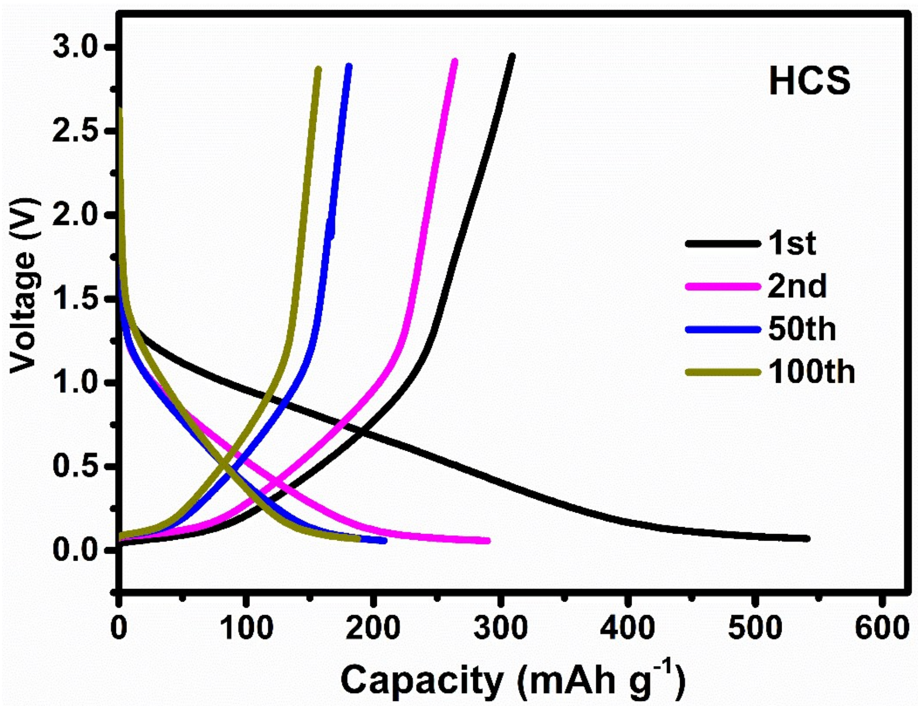

Fig. S6. Galvanostatic discharge/charge curves of HCS at current rate of 100 mA g^{-1}.

Table S1. Performance comparison of G-HCS with other reported state-of-the-art carbon anode materials for SIBs.

Carbon Anode	Initial reversible capacity ($mA\ h\ g^{-1}$)	Current rate for ultra-long cycling ($A\ g^{-1}$)	Cycle number	Capacity after cycles ($mA\ h\ g^{-1}$)	References
G-HCS	**421** **100 mA g^{-1}**	**10**	**4000**	**122**	**This work**
Hollow Carbon Nanospheres	223 50 mA g^{-1}	0.1	100	160	[1]
Hard Carbon Microspheres	322 28 mA g^{-1}	0.128	40	73	[2]
Hard carbon from orange peel	220 500 mA g^{-1}	1	1000	117	[3]
Rice husk-derived hard carbons	372 25 mA g^{-1}	0.025	100	346	[4]
Sulfurized polyacrylonitrile derived carbon	295 500 mA g^{-1}	10	10000	126.5	[5]
Micro-nano structure carbon	323 20 mA g-1	0.020	100	286	[6]
Carbon from Banana Peels	385 50 mA g^{-1}	0.5	600	210	[7]
S-doped N-rich carbon	419 50 mA g^{-1}	1	1000	211	[8]
Nitrogen-doped carbon sheets	315.2 56 mA g^{-1}	1.69	2000	ca. 70	[9]
Amorphous carbon/graphene composite	280 100 mA g^{-1}	0.5	2500	142	[10]
N/S codoped carbon microspheres	280 30 mA g^{-1}	0.5	3400	ca. 150	[11]

Table S2. Performance comparison of G-HCS with other reported state-of-the-art anode materials for SIBs except carbon materials.

Carbon Anode	Initial reversible capacity ($mA\ h\ g^{-1}$)	Current rate for ultra-long cycling ($A\ g^{-1}$)	Cycle number	Capacity after cycles ($mA\ h\ g^{-1}$)	References
G-HCS	**421 100 $mA\ g^{-1}$**	**10**	**4000**	**122**	**This work**
Graphene-TiO_2 hybrid	265 50 $mA\ g^{-1}$	0.5	4300	ca. 120	[12]
Amorphous SnO_2	495 50 $mA\ g^{-1}$	1	800	220	[13]
$Na_2Ti_3O_7$@NDoped Carbon Hollow Spheres	297 177 $mA\ g^{-1}$	8.8	1000	68	[14]
Graphene/Ni_2P Hybrid	516 100 $mA\ g^{-1}$	0.3	500	161	[15]
WS_2/CNT-rGO Aerogel	305 200 $mA\ g^{-1}$	0.2	100	252.9	[16]
Sb-C nanofibers	663 40 $mA\ g^{-1}$	0.2	400	446	[17]
SnSe/carbon nanocomposite	447.7 500 $mA\ g^{-1}$	0.5	200	324.6	[18]
Sb@C yolk-shell microspheres	637 50 $mA\ g^{-1}$	0.2	200	598	[19]
Layered nickel sulfide-reduced graphene oxide composites	512.7 100 $mA\ g^{-1}$	0.1	50	391.6	[20]

Notes and references

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