Electronic Supplementary Information (ESI) for Growth of 3D hierarchical porous NiO@Carbon nanoflakes on graphene sheets for high-performance Lithium-ion batteries

Xiongwei Wang[a,‡], Ludan Zhang[b,‡], Zehui Zhang[a], Aishui Yu[b], Peiyi Wu[a,*]

[a]State Key Laboratory of Molecular Engineering of Polymers, Collaborative Innovation Center of Polymers and Polymer Composite Materials, Department of Macromolecular Science and Laboratory for Advanced Materials, Fudan University, Shanghai 200433, China

[b]Department of Chemistry, Shang hai key laboratory of Molecular Catalysis and Innovation Materials, Collaborative Innovation Center of Chemistry for energy Materials, Institute of New Energy, Fudan university, Shanghai 200438, P. R. China.

E-mail：peiyiwu@fudan.edu.cn

‡These authors contributed equally to this work

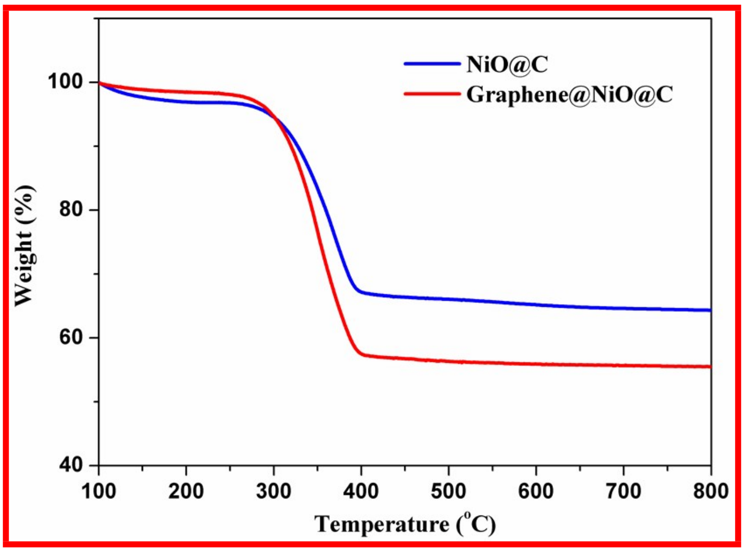

Fig. S1 TGA curves of graphene@NiO@C and NiO@C after solvothermal process

In order to find the suitable annealing temperature in air, theraml gravity analysis (TGA) of graphene@NiO@C and NiO@C after solvothermal process was measured in air, as shwn in Fig. S1. According to the TGA curves, we choose the temperature 320 ^{o}C as the subsequent annealing temperature at which the graphene@NiO@C generates 10 wt% weight loss. Annealing under 320 ^{o}C in air can not only improve the crystallinity of NiO and graphene, but also reduce the amorphous carbon loss and prevent the NiO from transforming to Ni.

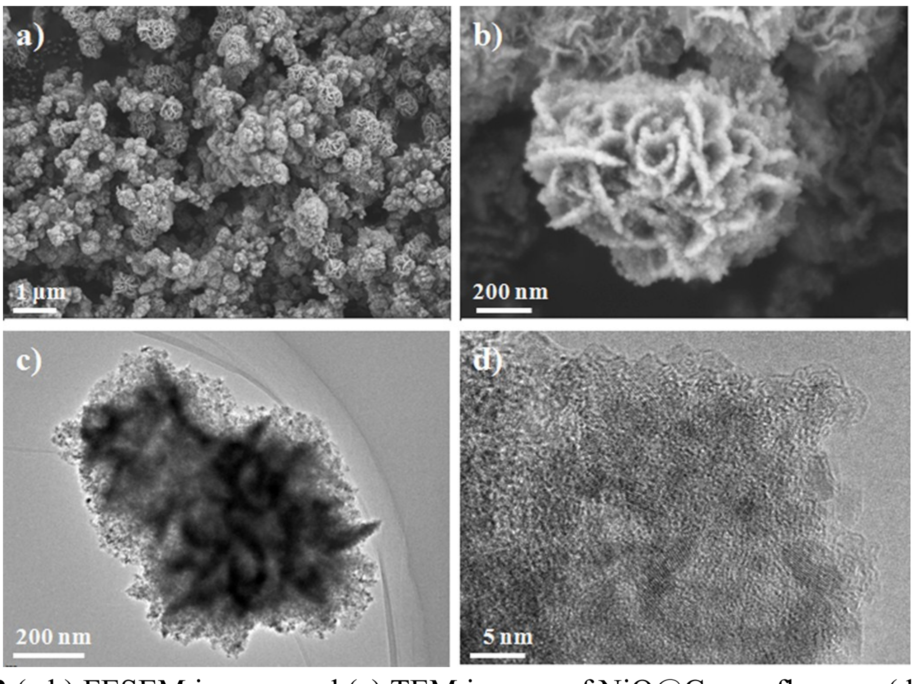

Fig. S2 (a,b) FESEM images and (c) TEM images of NiO@C nanoflowers. (d) high-resolution TEM of NiO@C nanoflowers

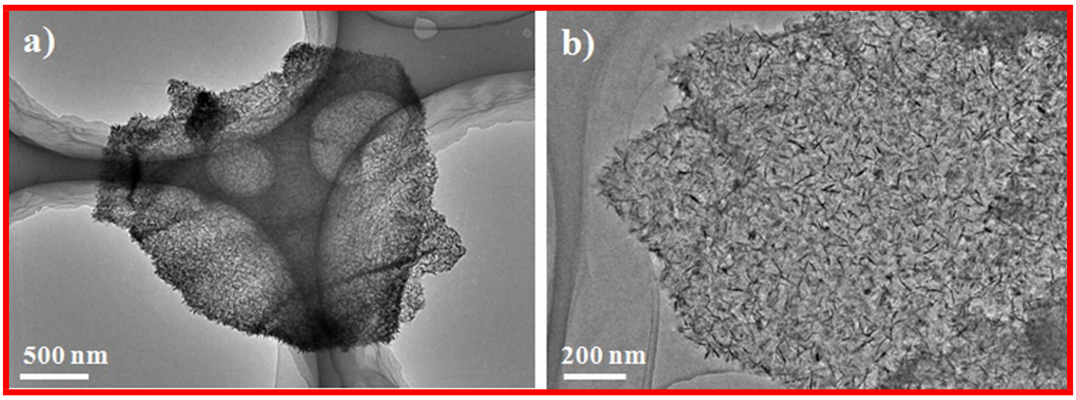

Fig. S3 (a,b) TEM images of graphene@NiO@C composites

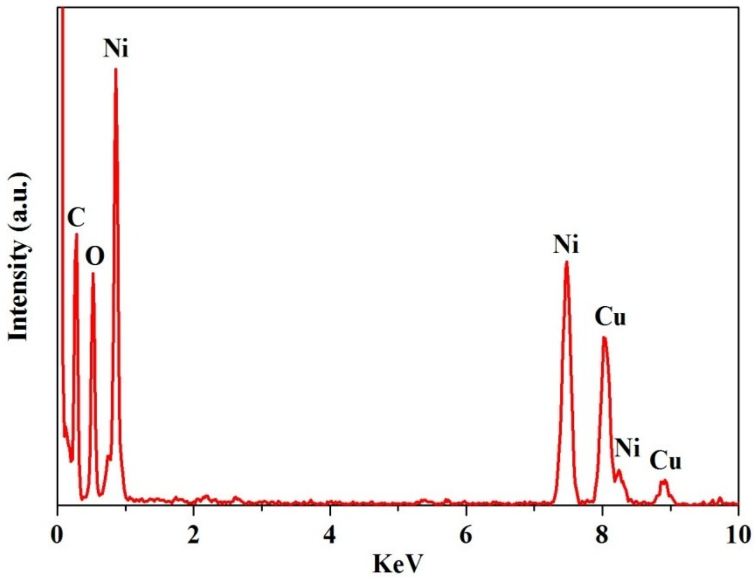

Fig. S4 The energy dispersive X-ray (EDX) spectrum of the graphene@NiO@C composites.

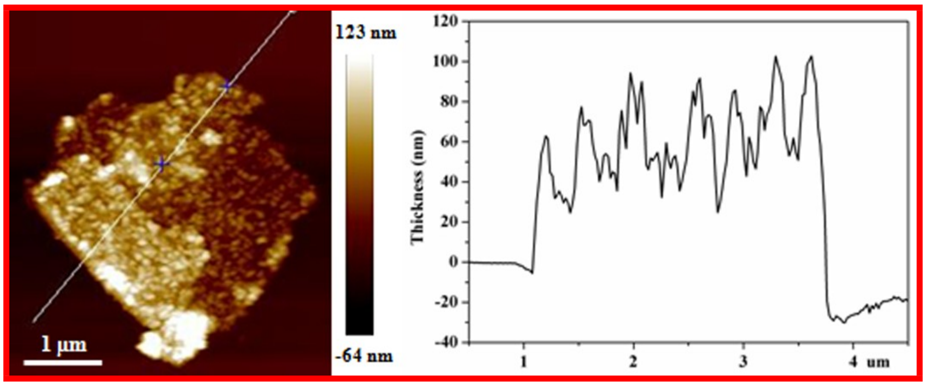

Fig. S5 (a) The morphology of graphene@NiO@C composites in AFM and (b) the corresponding height-profile analysisi along the line in (a)

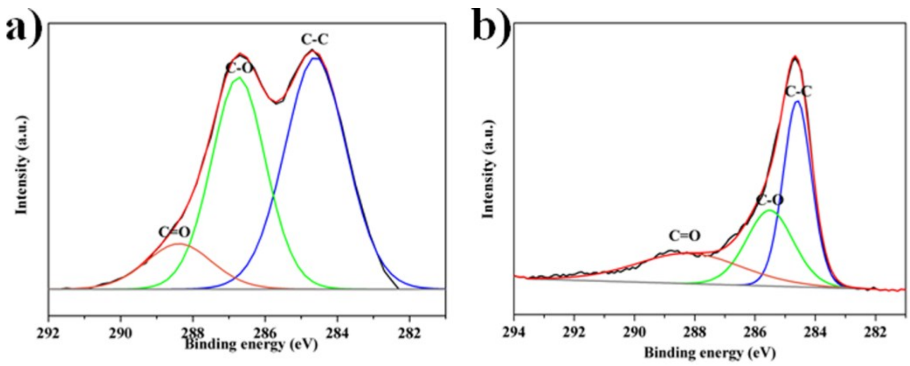

Fig. S6 High resolution C 1s XPS spectra of GO (a) and graphene@NiO@C composites (b)

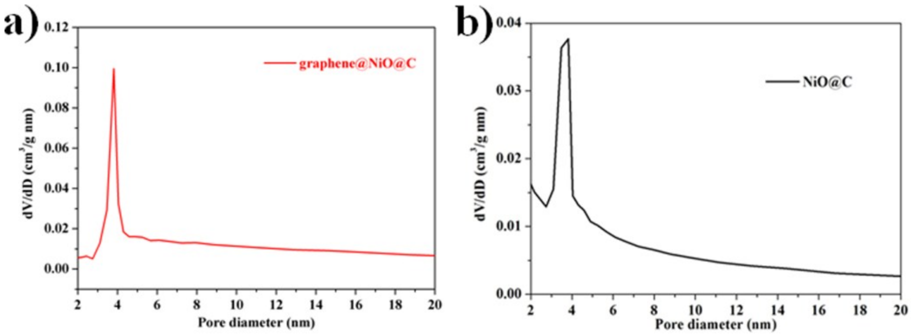

Fig. S7 Pore-size distribution of graphen@NiO@C composites (a) and NiO@C nanoflowers (b)

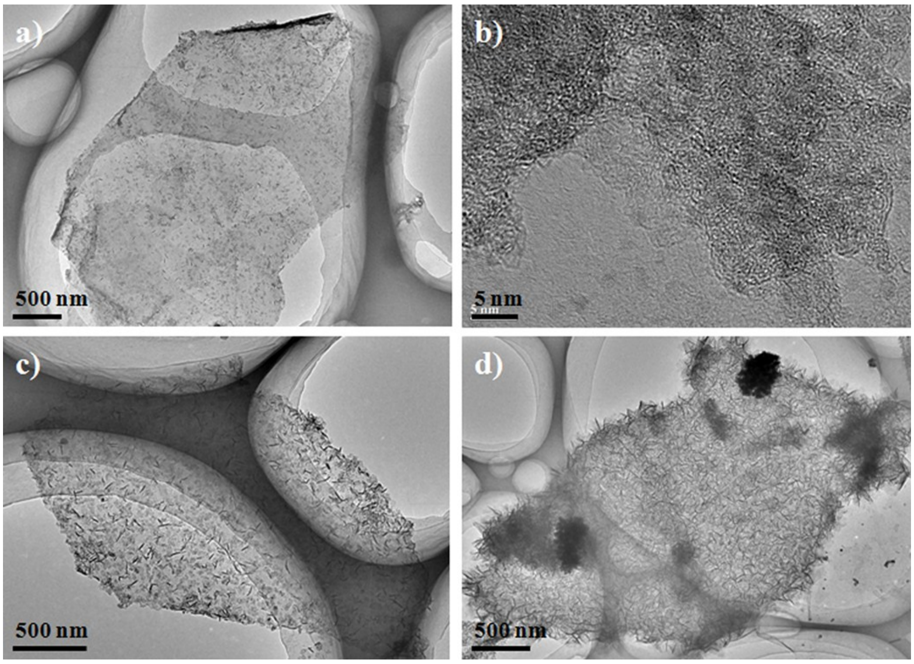

Fig. S8 TEM images of graphene@NiO@C composites prepared by hydrothermal treatment of nickelocene with different dosages: (a,b) 0.045 g, (c) 0.075 g, (d) 0.135 g

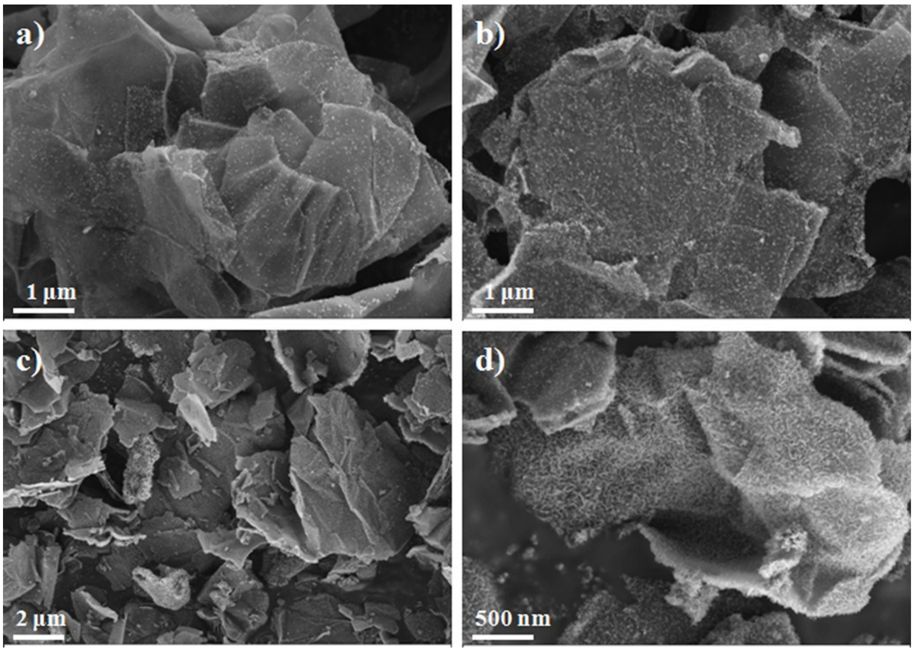

Fig. S9 SEM images of graphene@NiO@C composites prepared by hydrothermal treatment of nickelocene with different dosages: (a) 0.045 g, (b) 0.075 g, (c,d) 0.135 g

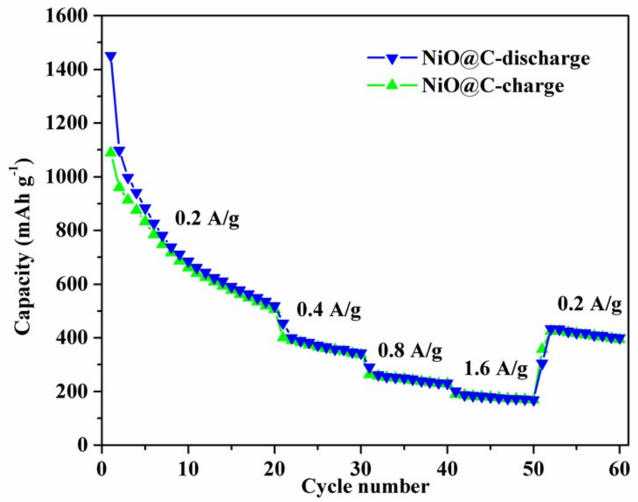

Fig. S10 Rate performance of NiO@C nanoflowers at different current densities

Table S1. Summary of representative nickel oxide/carbon anode materials for lithium-ion batteries for comparsion

Typical examples	1st charge and discharge capacity (mAh g^{-1})	Discharge capacity after 20 cycles (mAh g^{-1})	Discharge capacity after 50 cyles (mAh g^{-1})	Current density (mA g^{-1})	Rate performance	Ref.	year
3D porous NiO@C nanoflakes-graphene	1035 and 1490	915	754	200	A discharge capaity of 721 mAh g^{-1} and 580 mAh g^{-1} was obtained at 800 and 1600 mA g-1, respectively. the recovery ratio was ~90 %	This work	2015
Porous NiO-wrapped graphene sheets	1467 and 2169	~1100	~704	200	A discharge capaity of 403 mAh g^{-1} was obtained at 1600 mA g-1; the recovery ratio was ~50 %	[1]	2013
NiO nanoflakes-graphene	608 and 957	~910	~730	100	A discharge capaity of ~100 mAh g^{-1} was obtained at 4000 mA g-1; the recovery ratio was ~74 %	[2]	2013
NiO nanoparticles -graphene	629 and 967	~820	~800	100	A discharge capaity of ~180 mAh g^{-1} was obtained at 4000 mA g-1; the recovery ratio was ~97 %	[2]	2013
Ni-doping NiO nanoparticels -graphene	731 and 1226	~780	/	142	A discharge capaity of ~720 mAh g^{-1} was obtained at 355 mA g-1	[3]	2014
N-doping carbon coated NiO nanocrystal	952 and 1205	~710	~710	215	A discharge capaity of ~420 mAh g^{-1} was obtained at 7180 mA g-1; the recovery ratio was ~98 %	[4]	2014
graphene encapsulated porous carbon-NiO	~820 and ~1320	~660	~590	71.8	A discharge capaity of ~310 mAh g^{-1} was obtained at 718 mA g-1; the recovery ratio was ~71 %	[5]	2014
NiO nanoparticles-graphene	~745 and ~1125	~680	/	100	A discharge capaity of ~330 mAh g^{-1} was obtained at 800 mA g-1; the recovery ratio was ~83 %	[6]	2012
Carbon coated NiO	677 and 913	~760	~835	100	A discharge capaity of ~600 mAh g^{-1} was obtained at 1000 mA g-1; the recovery ratio was >100 %	[7]	2014
NiO nanosheet anchored on ordered carbon	~820 and 1621	~880	~845	400	A discharge capaity of ~800 mAh g^{-1} was obtained at 800 mA g-1; the recovery ratio was ~93 %	[8]	2015
NiO nanosheets grown on TiC nanowires	~600 and 918	~520	~510	200	A discharge capaity of ~380 mAh g^{-1} was obtained at 3000 mA g-1; the recovery ratio was ~100 %	[9]	2015
NiO nanosheet-graphene	1056 and ~1640	~1050	/	71.8	A discharge capaity of ~470 mAh g^{-1} was obtained at 3590 mA g-1; the recovery ratio was ~90.6 %	[10]	2011
Ni-doping NiO nanoparticles-graphene	751 and 1204	~750	~720	200	A discharge capaity of ~520 mAh g^{-1}	[11]	2013

					was obtained at 1000 mA g-1; the recovery ratio was ~81 %		
Graphene-NiO nanoparticles-graphene	639 and 1164	~720	~630	71.8	A discharge capaity of ~370 mAh g^{-1} was obtained at 718 mA g-1; the recovery ratio was ~84 %	[12]	2013
NiO nanosheets anchored on bowl-like carbon	~1010 and 1513	~1020	1011	200	A discharge capaity of ~600 mAh g^{-1} was obtained at 1600 mA g-1; the recovery ratio was ~90 %	[13]	2015
Porous NiO nanosheets grown on carbon cloth	882 and 1156	~820	~805	100	A discharge capaity of ~400 mAh g^{-1} was obtained at 2000 mA g-1; the recovery ratio was ~90 %	[14]	2014
Ni@NiO nanoparticles loaded on graphene ball	845 and 1156	~805	~770	1500	A discharge capaity of ~680 mAh g^{-1} was obtained at 3000 mA g-1; the recovery ratio was ~85 %	[15]	2014
Porous NiO nanosheets grown o carbon nanotube	925 and 1377	~900	~820	800	A discharge capacity of ~800 mAh g^{-1} was obtained at 800 mA g-1; the recovery ratio was ~100%	[16]	2015
NiO nanosheets-graphene	1000 and 1478	~1050	~910	50	A discharge capacity of ~640 mAh g^{-1} was obtained at 1500 mA g-1; the recovery ratio was ~88%	[17]	2012
Ultrathin carbon coated NiO nanoparticles	1196 and 1689	~1330	~1150	359	A discharge capacity of ~1000 mAh g^{-1} was obtained at 1436 mA g-1; the recovery ratio was ~100 %	[18]	2013
NiO coated WMCNTs	~860 and ~1140	~850	~850	143	A discharge capacity of ~1000 mAh g^{-1} was obtained at 718 mA g-1; the recovery ratio was ~100 %	[19]	2014

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