Supporting Information

Synergistic Effect Induced Ultrafine SnO_2/Graphene Nanocomposite as Advanced Lithium/Sodium-ion Batteries Anodes

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Keywords: SnO_2/graphene, methodology, large scale, synergistic effect, Li/Na-ion batteries

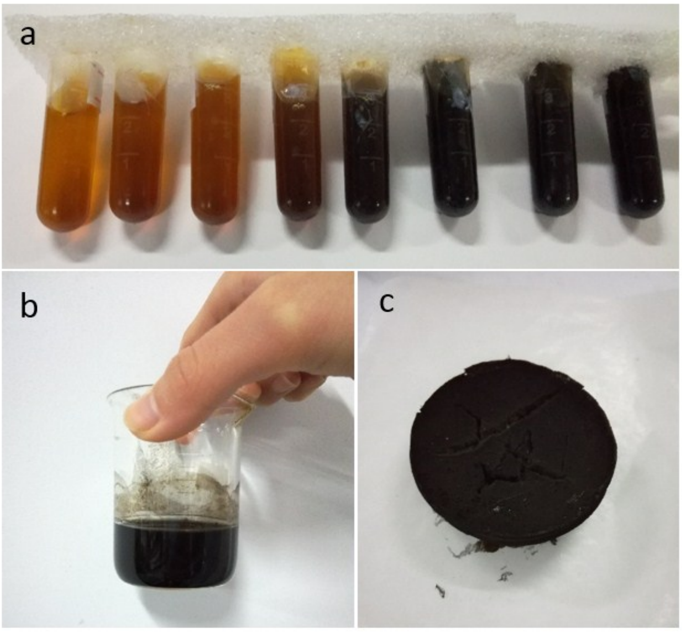

Figure S1. (a), The process that graphene oxide was reduced by $Na_2S_2O_3$, in order from left to right, pristine GO, adding $Na_2S_2O_3$, 5, 10, 15, 30, 60, and 120 min. (b), dispersion of graphene after 24 h, no layer. (c), graphene after freeze-drying.

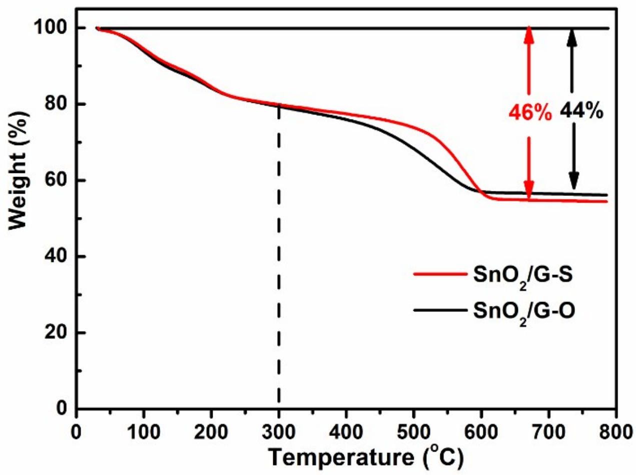

Figure S2. Thermogravimetric analysis curves of prepared SnO_2/G-S through one-step synergetic effect and SnO_2/G-O through two-step method in order of SnO_2 nanoparticles' formation and GO's reduction.

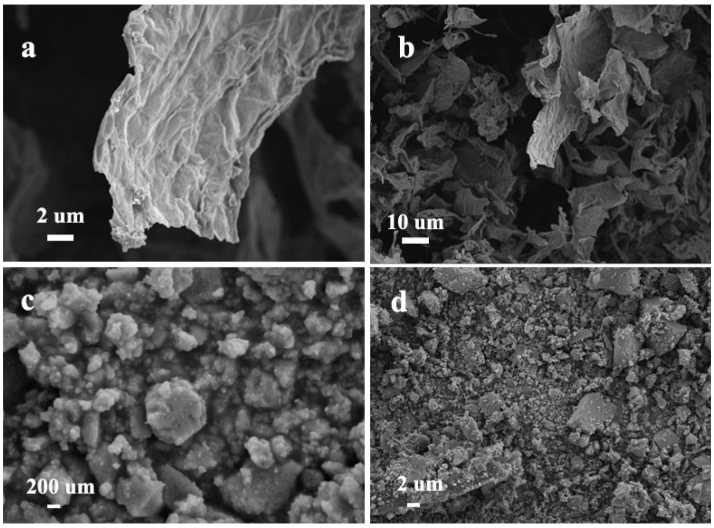

Figure S3. SEM images of prepared pristine graphene (a, b) and SnO_2(c, d)

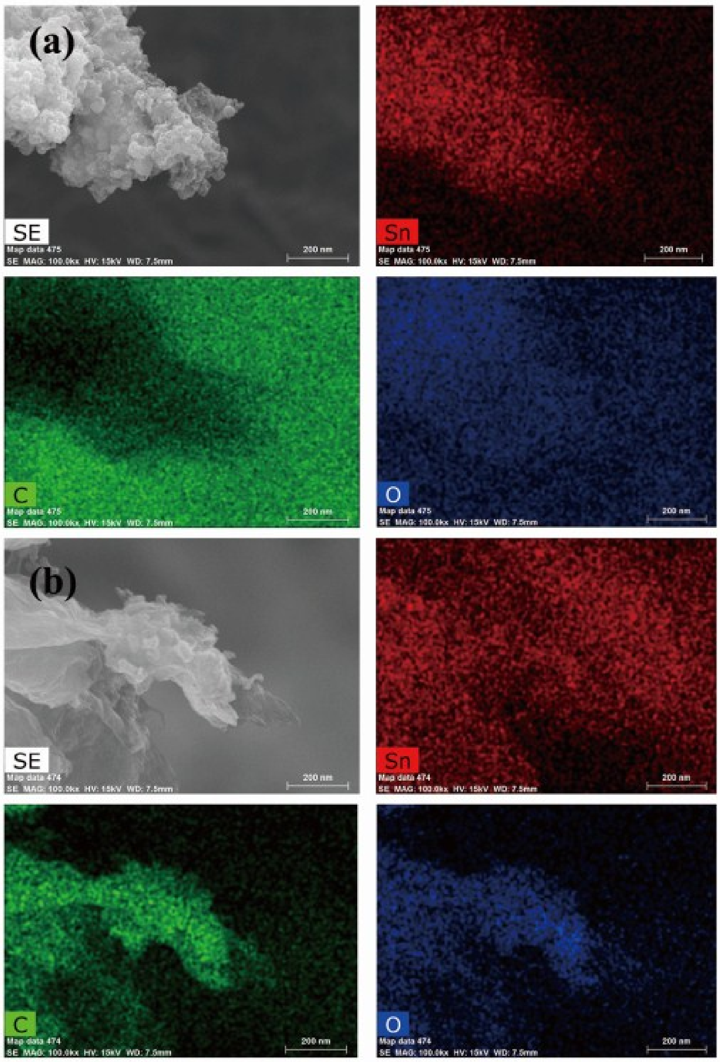

Figure S4. EDS mappings of SnO_2/G-S (a) and SnO_2/G-O (b) composites.

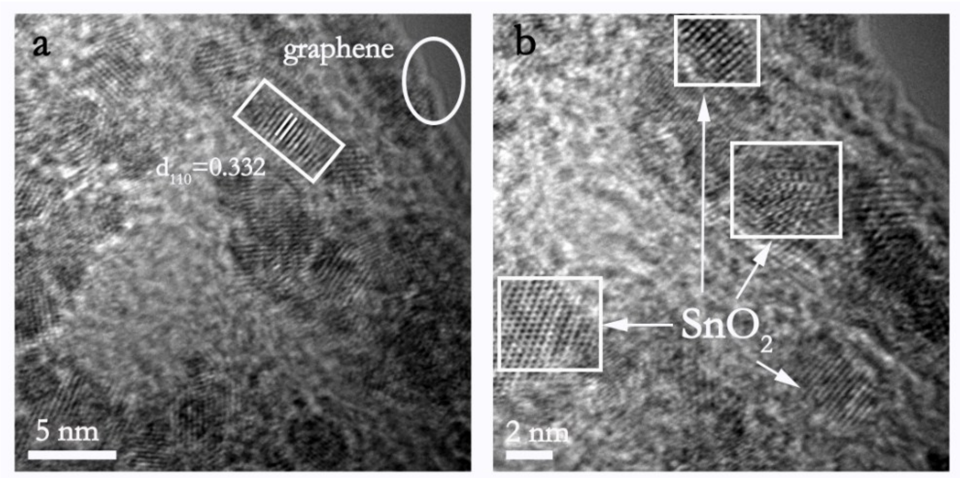

Figure S5. HRTEM images prepared SnO_2/G-S through one-step synergetic effect of SnO_2 nanoparticles' formation and GO's reduction.

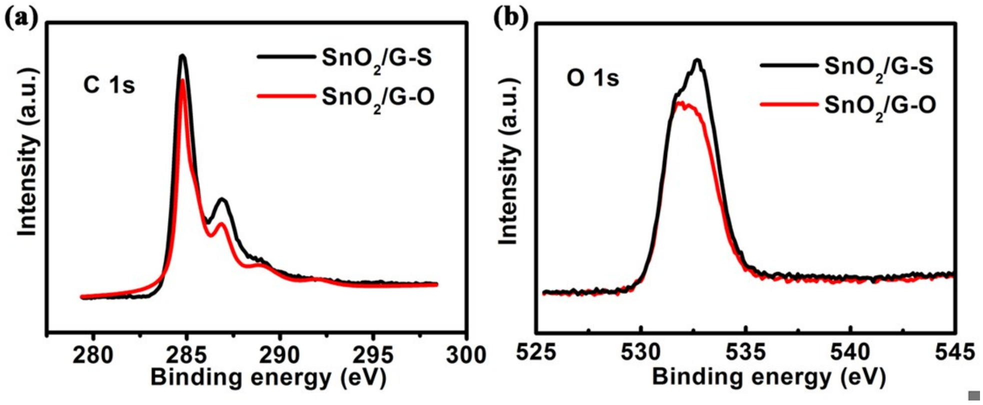

Figure S6. high-resolution C 1s (a) and O 1s (b) XPS spectrum of the SnO_2/G-S and SnO_2/G-O composites.

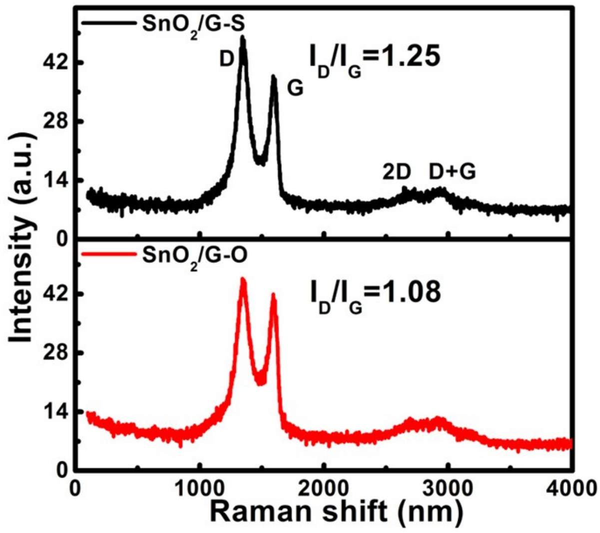

Figure S7. Raman spectras of SnO_2/G-S and SnO_2/G-O, ratio of I_D/I_G is generally used for degree of defect in the graphene roughly.

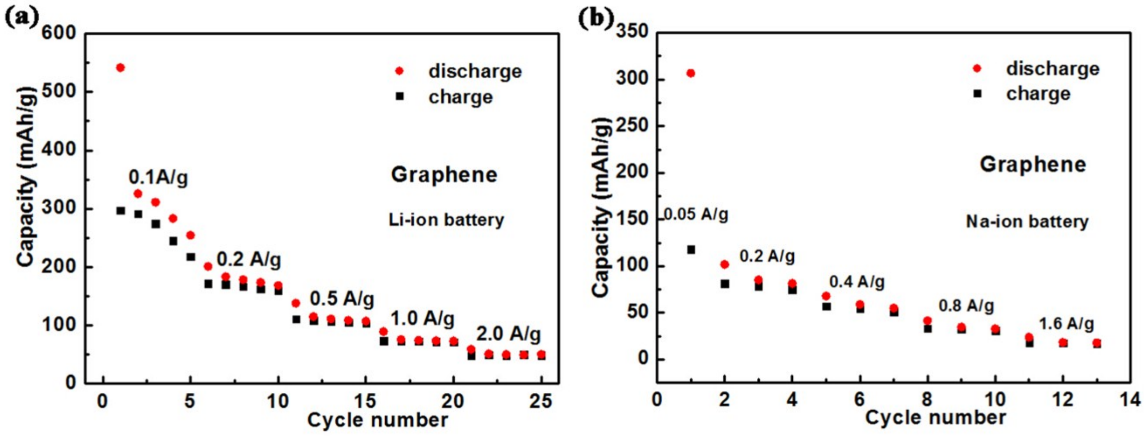

Figure S8. The electrochemical performance of prepared pristine graphene as working electrode in Li-ion batteries (a) and Na-ion batteries (b), respectively.

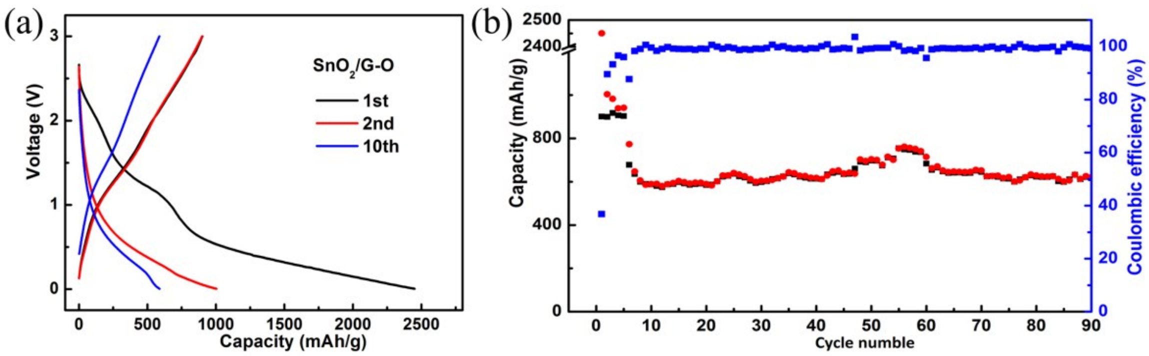

Figure S9. The electrochemical performance of prepared SnO_2/G-O electrode through two-step method in order of SnO_2 nanoparticles' formation and GO's reduction in Na-ion batteries.

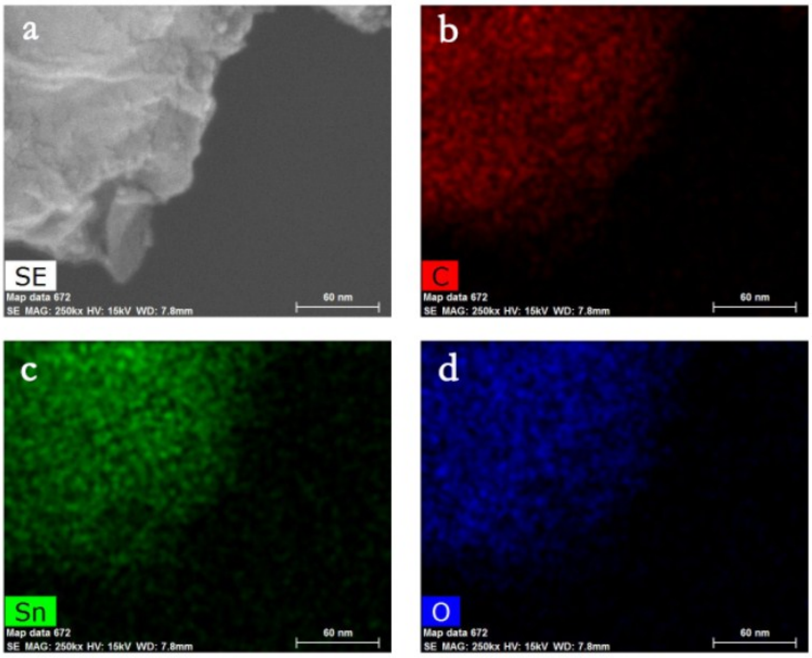

Figure S10. EDS mappings (a, b, c, d) of SnO_2/G-S electrode after 10 cycles in Li-ion batteries.

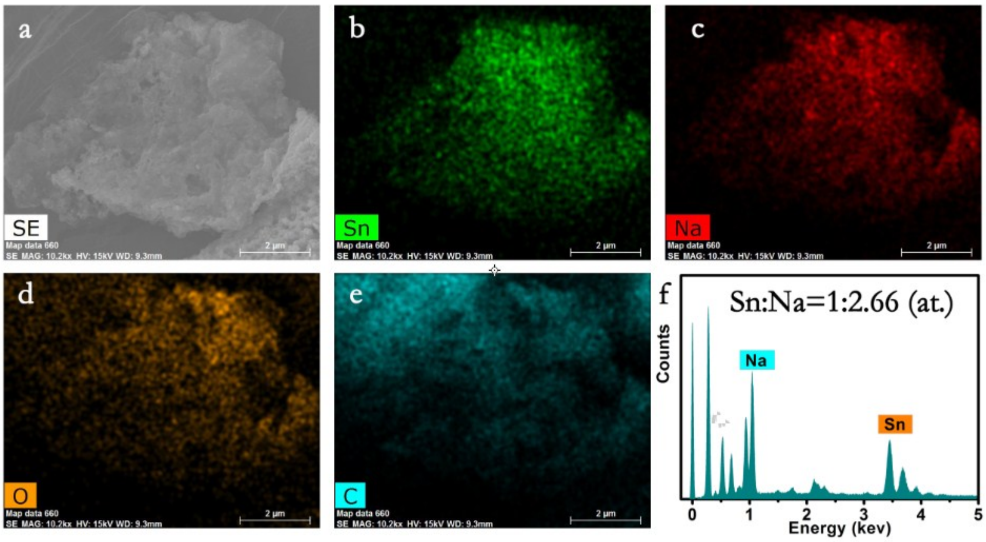

Figure S11. EDS mappings (a, b, c, d, e) and EDS spectra (f) of SnO_2/G-S electrode after sodiation to 0.01V in Na-ion batteries.

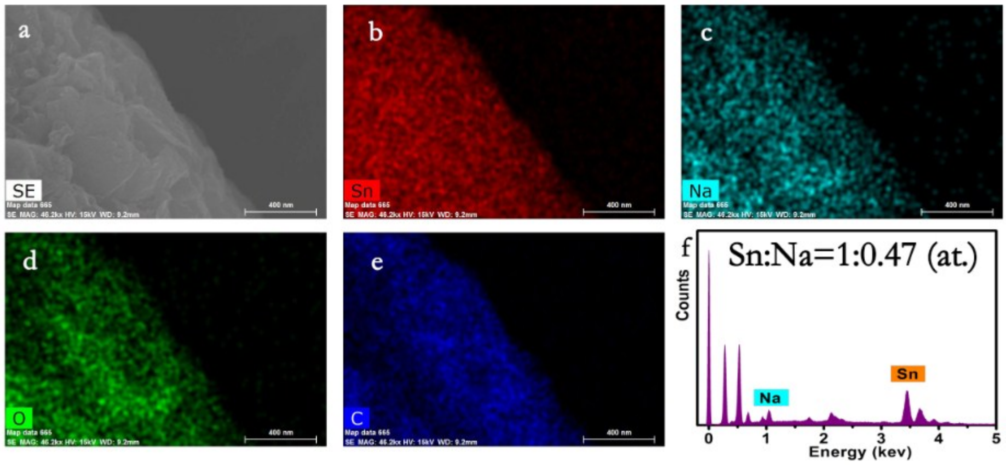

Figure S12. EDS mappings (a, b, c, d, e) and EDS spectra (f) of SnO_2/G-S electrode after desodiation to 3V in Na-ion batteries.

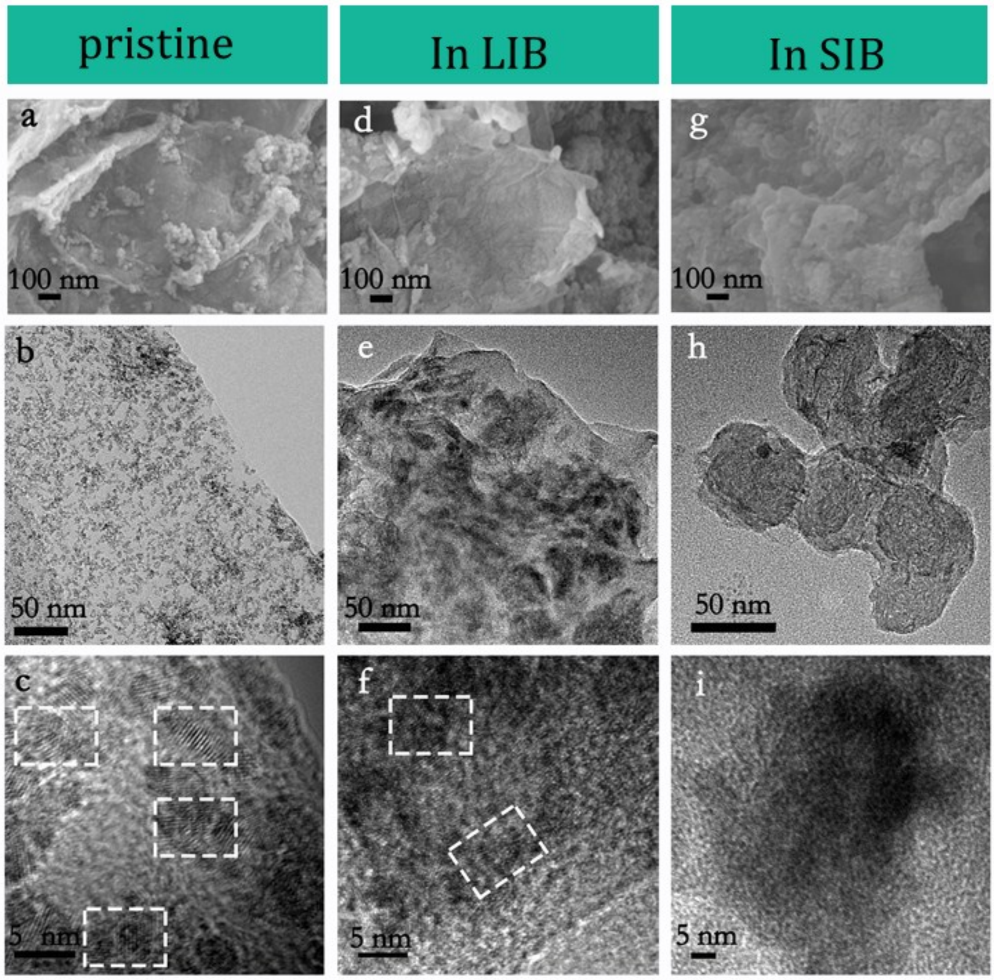

Figure S13. Morphology of pristine SnO_2/G-S through one-step synergetic effect of SnO_2 nanoparticles' formation and GO's reduction.(a, b, c) after 10 cycles in Li-ion batteries.(b, e, f) after 10 cycles in Na-ion batteries.(g, h, i) SEM images.(a, d, g) TEM images.(b, e, h, c, f, i).

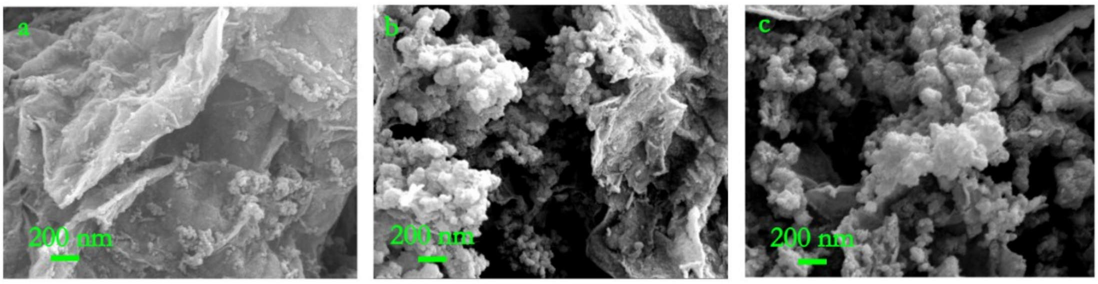

Figure S14. SEM images of SnO_2/G-S-80(a), SnO_2/G-S-60(b) and SnO_2/G-S-40(c) materials

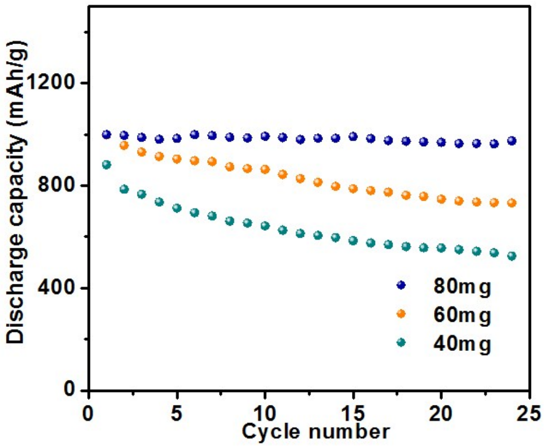

Figure S15. Comparison of cycling stability and reversible capacity of SnO_2/G materials with different loading of SnO_2 active materials.

Table S1. Impedance parameters of the fitting equivalent circuit about SnO_2/G-S and SnO_2/G-O electrodes in Li-ion batteries.

	Rs	CPE-T(E-5)	R1	W1-R
SnO_2/G-S	**3.709**	**2.6**	**117.6**	**55**
SnO_2/G-O	**5.237**	**2.8**	**237.2**	**30**

Table S2. Impedance parameters of the fitting equivalent circuit about SnO_2/G-S and SnO_2/G-O electrodes in Na-ion batteries.

	Rs	CPE-T(E-3)	R1	W1-R
SnO_2/G-S	**19.72**	**2.6**	**24.92**	**18.1**
SnO_2/G-O	**3.287**	**0.19**	**70.44**	**1000**

Table S3. Summary of capacity of reported graphene in Li-ion batteries

Materials	Capacity	Ref
Graphene aerogel	0.1A/g, 300mAh/g 0.5A/g, 200mAh/g 1A/g, 100mAh/g	**2015,** ***Nano Energy***[1]
Graphene sheet	0.1A/g,269mAh/g	**2012,** ***Adv. Funct. Mater.***[2]
EDA-rGO	0.2A/g,20mAh/g	**2016,** ***Energy Environ. Sci.***[3]

Reference

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Table S4. Comparison of electrochemical performance of SnO_2/G-S in this work with reported related materials in Li-ion batteries.

Sample	method	Performance	Ref
SnO_2/G-S	80°C Constant pressure	0.1A/g, 90cycles, 1420mAh/g 0.5A/g, 300cycles, 1170mAh/g 1A/g, 230cycles, 960mAh/g	**This work**
SnO_2 Films	Vacuum- magnetron - sputtering	0.2C,800mAh/g	***Energy Environ. Sci.***[4]
SnO_2 Nanoparticles Superlattices	400°C, Annealing	0.6A/g, 200cycles, 640mAh/g	***Nat. Commun.***[5]
Bowl-like SnO_2 @Carbon	Long-timing stirring	0.4A/g, 100cycles, 963mAh/g	***Angew. Chem. Int. Ed.***[6]
SnO_x /Carbon	Electrospinning	0.5A/g, 200cycles, 608mAh/g	***Adv. Mater***.[7]
SnO_2/N-Doped C	Hydrothermal	0.5A/g, 100cycles, 491mAh/g	***Adv. Energy Mater.***[8]
Graphene Mesoporous SnO_2	Hydrothermal	0.1C, 50cycles, 847.5mAh/g	***Adv. Funct. Mater.***[9]
SnO_2−Carbon Nanosheets	500°C annealing	0.2A/g, 300cycles, 913.3mAh/g	***J. Am. Chem. Soc.***[10]
Sn/SnO_2 Nanocrystals	180-210°C	1A/g, 100cycles, 700mAh/g	***J. Am. Chem. Soc.***[11]
Sandwich-Stacked SnO_2/Cu	Rolled-up nanotechnology	0.2A/g, 150cycles, 535mAh/g	***ACS NANO***[12]
RGO/SnO_2 Aerogel	Hydrothermal	0.1A/g, 200cycles, 718mAh/g	***Nano Lett.***[13]

Reference

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Table S5. Comparison of electrochemical performance of SnO_2/G-S in this work with reported related materials in Na-ion batteries.

Sample	method	Performance	Ref
SnO_2/G-S	80°C Constant pressure	0.2A/g, 90cycles, 650mAh/g	**This work**
Amorphous SnO_2/graphene aerogel	Hydrothermal	0.05A/g, 100cycles, 380.2mAh/g	***Adv. Energy Mater.***[14]
Al_2O_3/ SnO_2/Carbon-Cloth	Hydrothermal	0.1C, 100cycles, 375mAh/g	***Nano Energy***[15]
SnO_2-C	Hydrothermal	0.08A/g, 200cycles, 372mAh/g	***J. Mater. Chem. A***[16]
SnO_2/Cu	Cold-rolling method	0.2C, 200cycles, 326mAh/g	**2016, *J. Power Source***[17]

Reference

[14] L. Fan, X. Li, B. Yan, J. Feng, D. Xiong, D. Li, L. Gu, Y. Wen, S. Lawes, X. Sun, *Adv. Energy Mater.* **2016,** *6*, 1502057.

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Table S6. The reaction parameters of three SnO_2/G-S materials with different loading of active material (the loading value was obtained by calcination at 600 ^{o}C for 2 h in air).

	GO(mg)	**$SnCl_4$(mg)**	**Loading**
SnO_2/G-S-80	80	308	54%
SnO_2/G-S-60	60	308	65%
SnO_2/G-S-40	40	308	77%

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