Tin Nanoparticles Embedded in Carbon Buffer Layer as Preferential Nucleation Sites for Stable Sodium Metal Anodes

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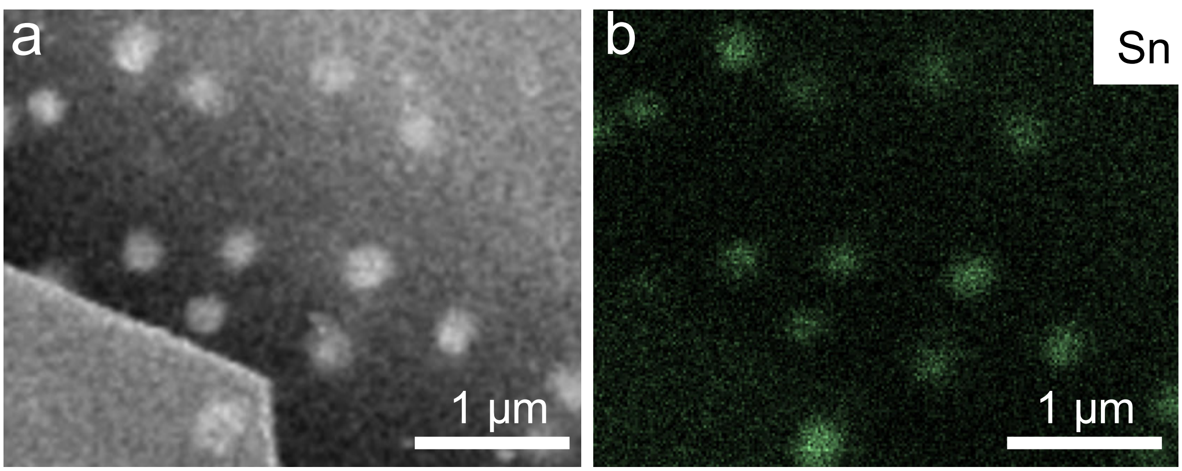

Fig. S1 (a) SEM image of tin (Sn) nanoparticles embedded in carbon network and (b) the corresponding EDS mapping of element Sn.

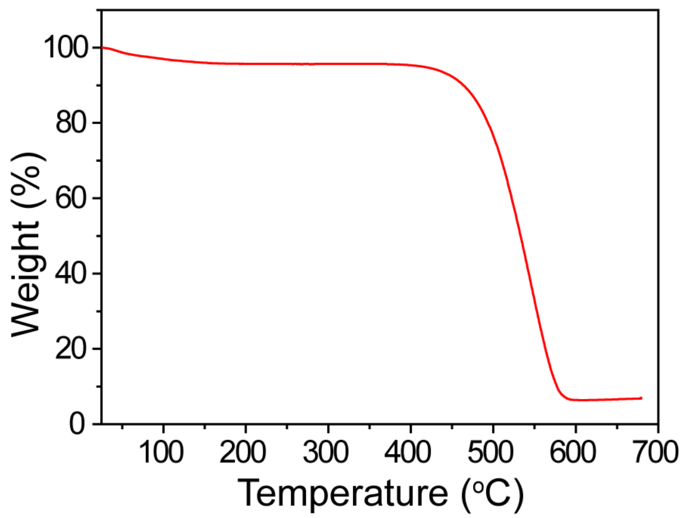

Fig. S2 Thermogravimetric analysis (TGA) curve of the as-prepared Sn@C composite in air at a heating rate of 5 $^{o}C\ min^{-1}$.

Under the condition, the carbon is oxidized into gaseous CO_2 with tin oxide (SnO_2) as final product. In this case, the Sn content can be calculated according to the following equation:[15]

$$\mathrm{Sn\ (wt\%)=100*}\frac{\text{molecular weight of Sn}}{\text{molecular weight of SnO}_2}*\frac{\text{final weight}}{\text{initial weight}}$$

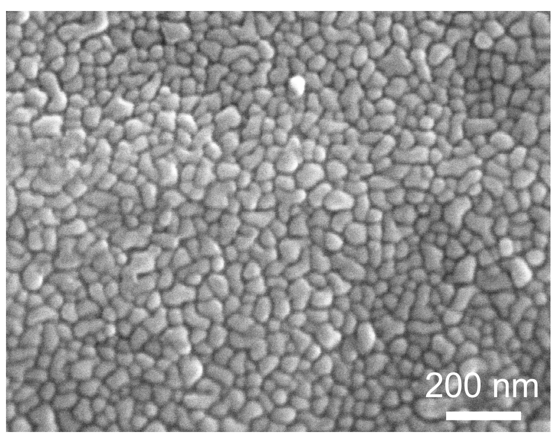

Fig. S3 SEM image of bare Sn nanoparticles on Cu foil.

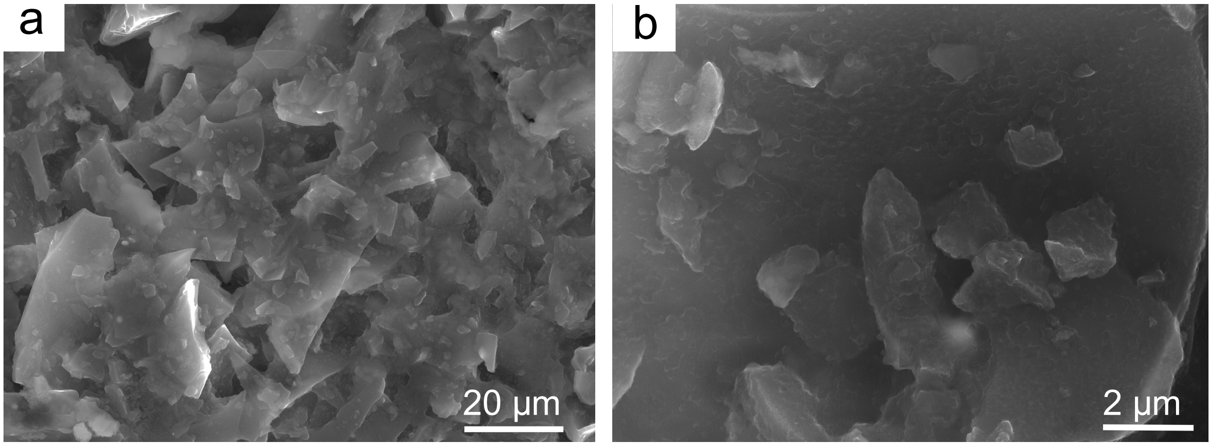

Fig. S4 (a) Low-magnification and (b) high-magnification SEM images of pure carbon network without Sn nanoparticles.

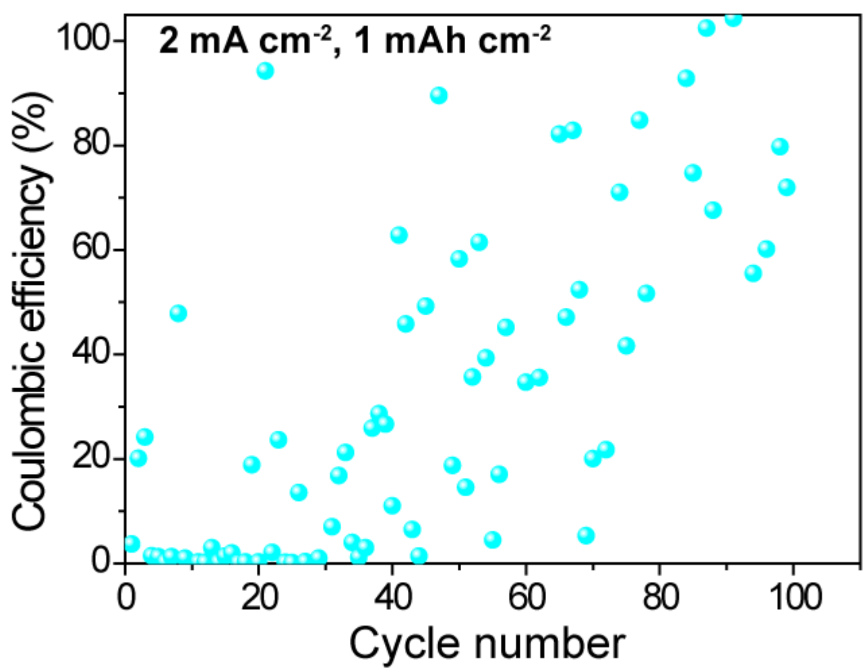

Fig. S5 Coulombic efficiency of Na plating-stripping on pure carbon network without Sn nanoparticles at a current density of 2 mA cm^{-2} and a capacity of 1 mAh cm^{-2}.

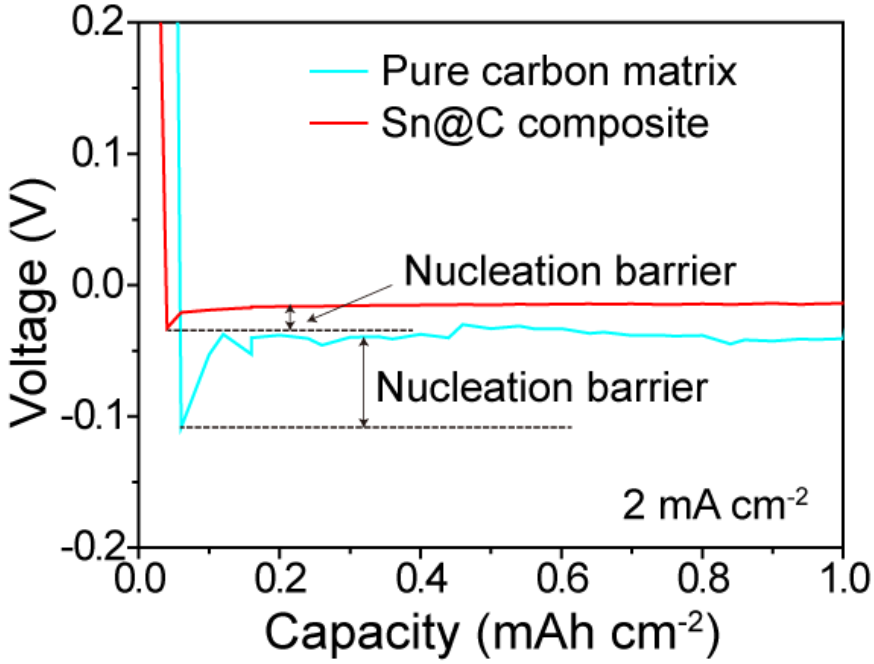

Fig. S6 Na plating curves at a current density of 2 mA cm^{-2} on pure carbon matrix and Sn@C composite, respectively.

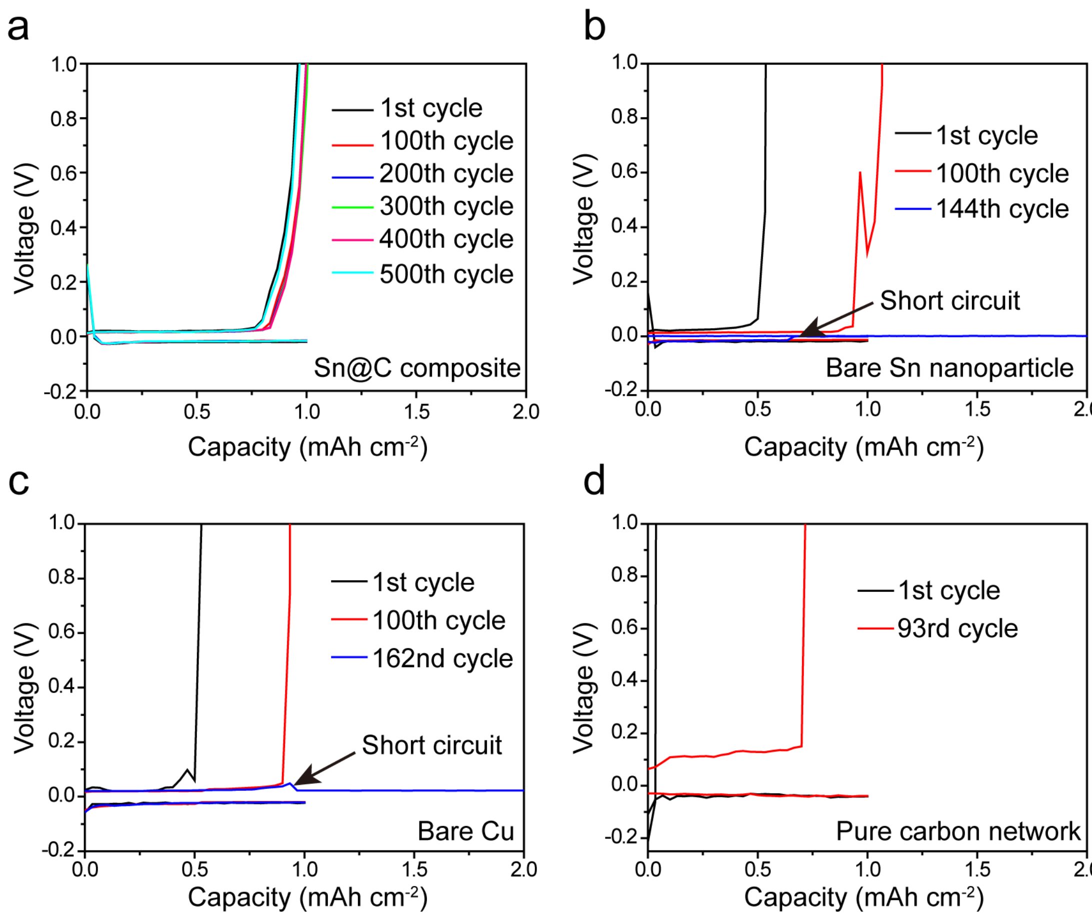

Fig. S7 Voltage profiles of Na plating-stripping at various cycles on (a) Sn@C composite; (b) bare Sn nanoparticle; (c) bare Cu foil; (d) pure carbon network at a current density of 2 mA cm^{-2} and a capacity of 1 mAh cm^{-2}.

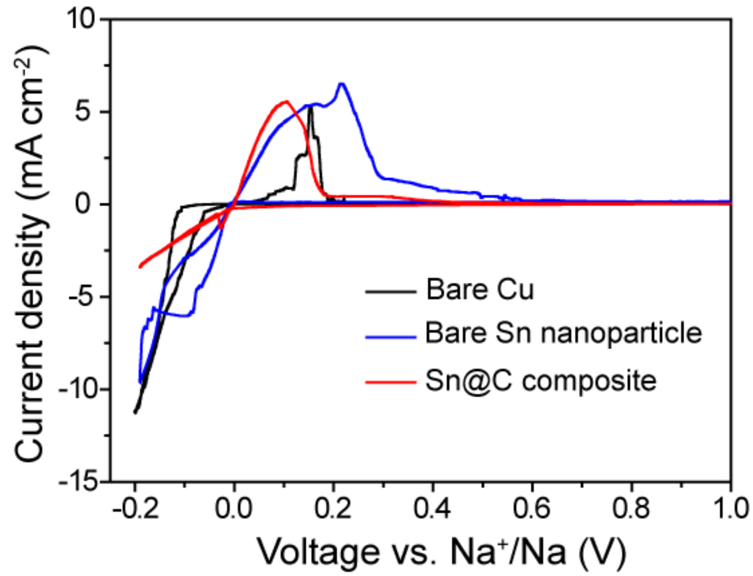

Fig. S8 Typical cyclic voltammetry (CV) curves (versus Na metal electrode) on bare Cu foil, bare Sn nanoparticles and Sn@C composite, respectively.

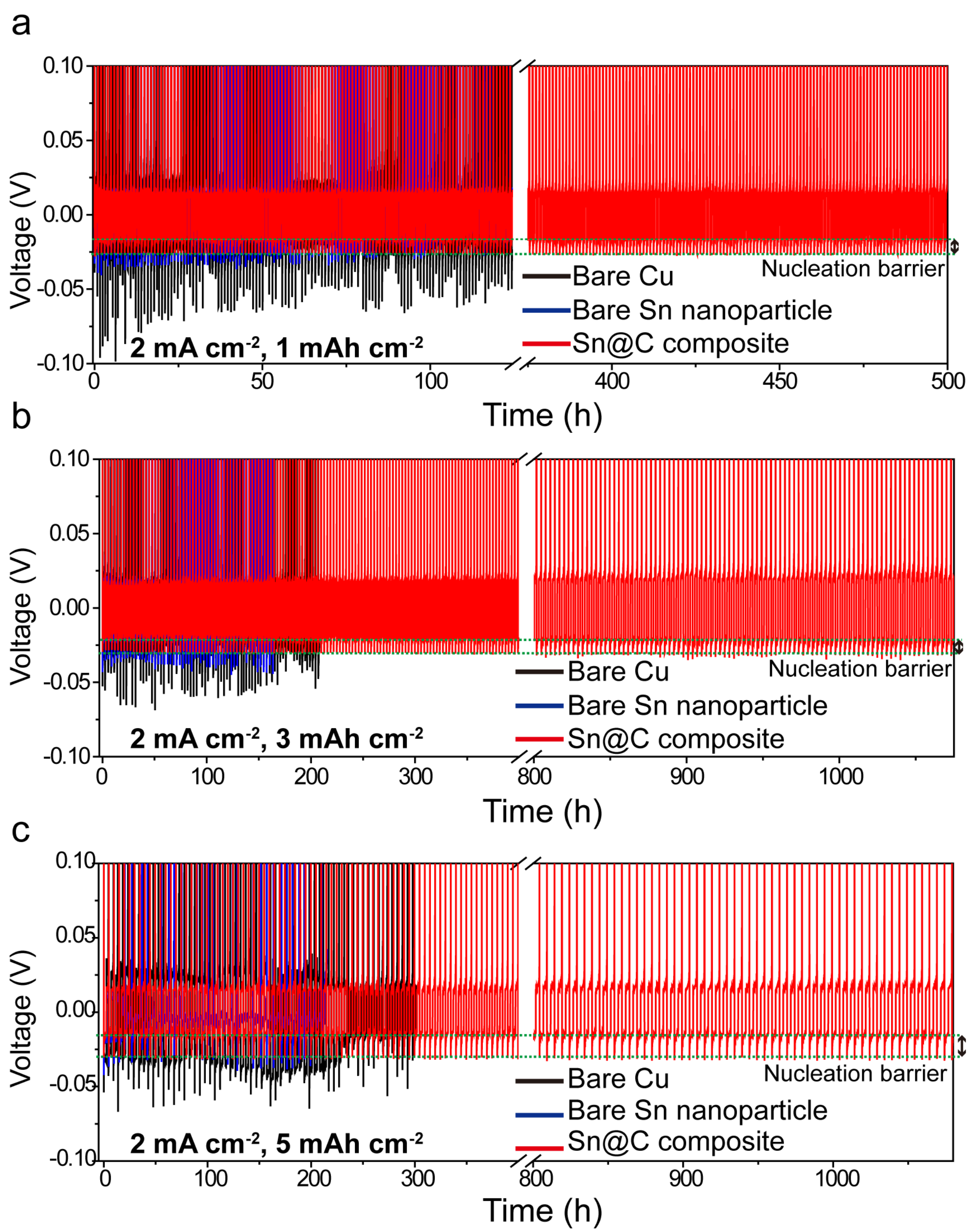

Fig. S9 Long-term voltage profiles of Na plating-stripping on different substrates at a current density and a capacity of (a) 2 mA cm^{-2}, 1 mAh cm^{-2}; (b) 2 mA cm^{-2}, 3 mAh cm^{-2}; (c) 2 mA cm^{-2}, 5 mAh cm^{-2}.

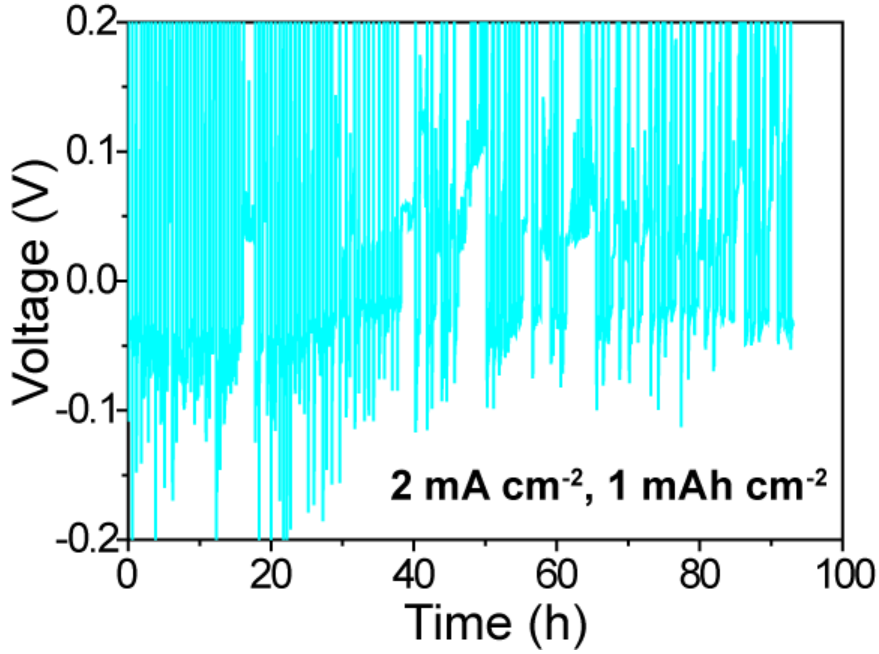

Fig. S10 Voltage profile of Na plating-stripping on pure carbon network without Sn nanoparticles at a current density of 2 mA cm^{-2} and a capacity of 1 mAh cm^{-2}.

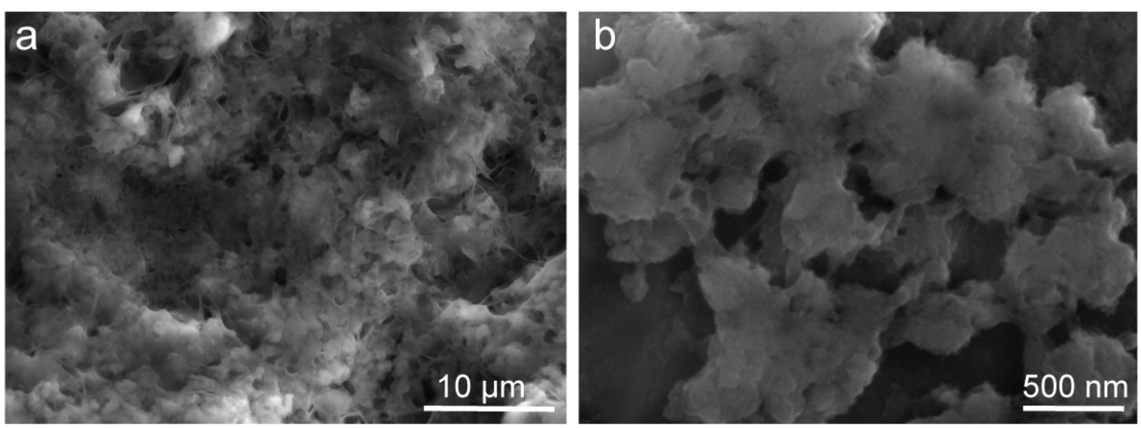

Fig. S11 (a) Low-magnification and (b) high-magnification SEM images of Na cycling at a current density 2 mA cm^{-2} and a capacity of 1 mAh cm^{-2} after the 50th cycle of deposition on pure carbon matrix.

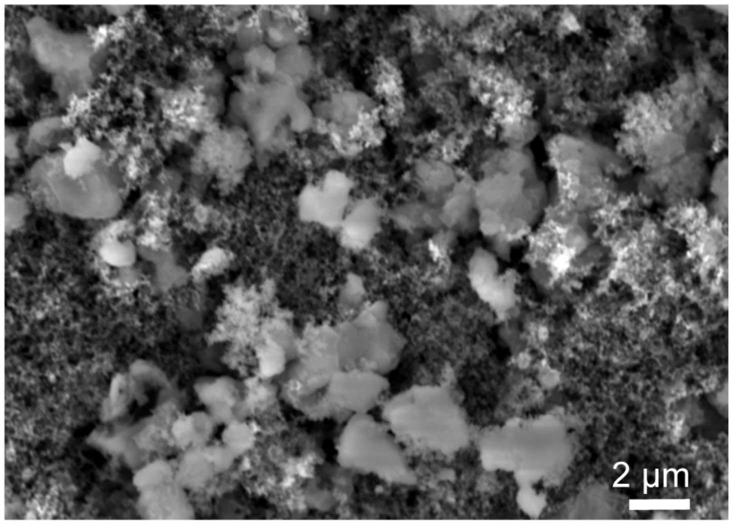

Fig. S12 SEM image of commercial Na_2S cathode after grinding.

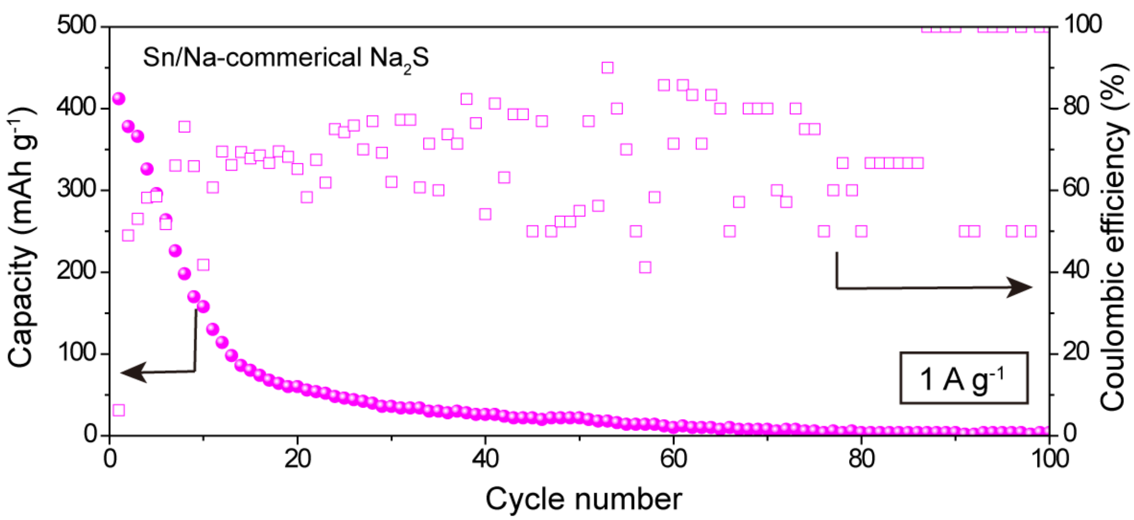

Fig. S13 Cycling performance and Coulombic efficiency of Na-S full cell using commercial Na_2S powder as cathode and Sn/Na as anode at a current rate of 1 A g^{-1} in the potential range of 1-2.6 V.

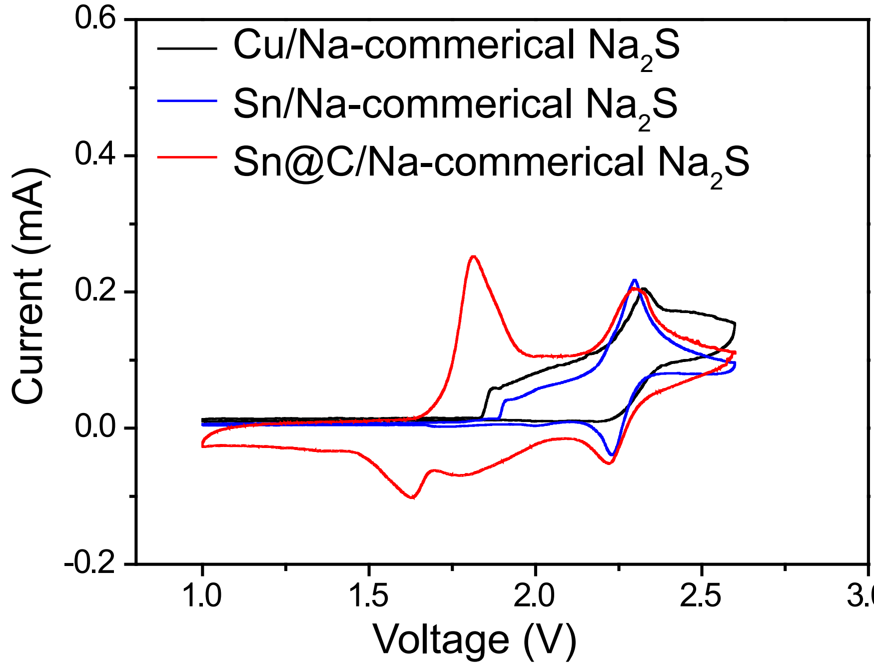

Fig. S14 Typical cyclic voltammetry (CV) curves of Na-S full cells using commercial Na_2S cathode and three kinds of anodes (Sn@C/Na, Cu/Na and Sn/Na), respectively.

Table S1. Comparison of cycling performance of room-temperature Na-S batteries in this work with reported literatures (based on S mass).[1-14]

NO.	Anode material	Cathode material	Current rate ($A\ g^{-1}$)	Initial Capacity	Capacity after 100 cycles	Retention
This work	Sn@C/Na	Commercial Na_2S powder	1	643.7	582.3	~90.5%
1	Na metal	Nano-copper-assisted immobilizing S in high-surface-area mesoporous carbon	0.05	~700	~610	~87.1%
2	Na metal	Carbon nanotubes/Na_2S	0.6	~700	~380	~54.3%
3	Na metal	Activate carbon nanofibers/Na_2S_6	0.3	~800	~500	~62.5%
4	Na metal	Metal organic framework-derived microporous carbon polyhedron/infusing S	0.8	860	600	~69.8%
5	Na metal	Fe nanoclusters wreathed on hollow carbon nanospheres/infusing S	0.1	1023	~500	~48.9%
6	Na metal	N-doped nanoporous carbon/infusing S	0.3	~900	~750	~83.3%
7	Na metal	Porous carbon/$BaTiO_3$ nanofibers/infusing S	1	~952	~450	~47.3%
8	Na metal	Multiporous carbon fibers/infusing S	1.6	~1450	~850	~58.6%
9	Na metal	Cobalt nanoparticles-decorated hollow carbon/infusing S	0.1	~1081	~600	~55.6%
10	Na metal	Sugar-derived carbon spheres/infusing S	1.6	~420	~310	~73.8%
11	Na metal	Carbonized polyacrylonitrile matrix/infusing S	1.6	~350	~220	~62.9%
12	Hard carbon after tailed sodiation	Porous Ketjenblack carbon/infusing S	0.167	~1000	~580	~58%
13	Passivated Na metal	Hollow Na_2S nanospheres embedded in a hierarchical and spongy carbon matrix	2.1	~790	~400	~50.6%
14	Na metal	Activate carbon nanofibers/Na_2S	0.3	580	500	~86.2%

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