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Electronic Supplementary Information

A self-healing of Sn anode with ultra-long cycle life for sodium-ion batteries

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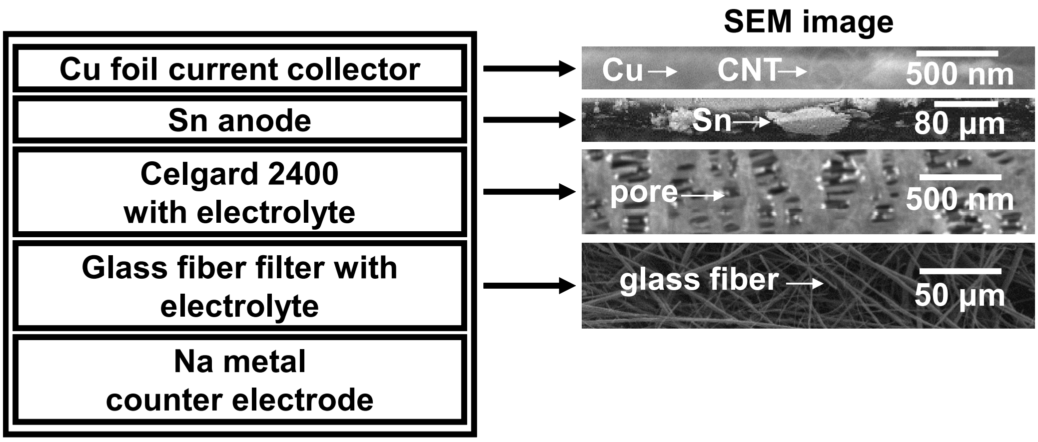


Fig. S1 (a) Schematic structure of Na/Sn cell for electrochemical cycling.

Table S1. Electrochemical performance of Sn based anode for sodium ion batteries.

Active material	First reversible capacity mAh g^{-1}	C-rate for Cycling	Specific capacity after cycling mAh g^{-1} (cycles)	Long term cycleability mAh g^{-1} (cycles)	High rate performance mAh g^{-1}(current density)	Ref.
Sn nanopowder (<150nm)	758	50 mA g^{-1}	21 (10 cycles)	500 (20 cycles)		1
Sn/C (Sn-graphite)	410	50 mA g^{-1}	~359 (20 cycles)	~359 (20 cycles)		2
Sn/woodfiber paper	339	1/10 C	145 (400 cycles)	145 (400 cycles)	~180 (1 C)	3
C/Sn/Ni/TMV1cys nanoforest	730	50 mA g^{-1}	405 (150 cycles)	405 (150 cycles)		4
Al2O3/SnNPs@CNF	625	84.7 mA g^{-1}	650 (40 cycles)	650 (40 cycles)		5
Sn film	618.61	50 mA g^{-1}	608 (40 cycles)	608 (40 cycles)		6
Sn-C nanocomposite	238	12.2 mA g^{-1}	170 (150 cycles)	170 (150 cycles)	88 (610 mA g^{-1})	7
Sn nanofibers	816.37	84.7 mA g^{-1}	776.26(100 cycles)	776.26 (100 cycles)	280 (5 C)	8
Sn nanoparticle	610	1/10 C	621 (10 cycles)	621 (10 cycles)		9
carbonized paper decorated with Sn-C nanospheres	232	10 mA g^{-1}	~60 (100 cycles)	~60 (100 cycles)	~25 (80 mA g^{-1})	10
Sn-C deflated sphere	163	10 mA g^{-1}	~25 (100 cycles)	~25 (100 cycles)	~10 (80 mA g^{-1})	11
hollow Sn nanoparticles	~600	20 mA g^{-1}	220 (50 cycles)	220 (50 cycles)	142 (400 mA g^{-1})	12
Sn powder	400	5 mA g^{-1}	~360 (10 cycles)	~360 (10 cycles)		13
Sn-doped TiO2 nanotubes	~235	50 mA g^{-1}	257 (50 cycles)	103 (700 cycles)	106 (5 A g^{-1})	14
Sn nanodots encapsulated in porous N-doped carbon	631	200 mA g^{-1}	580 (300 cycles)	483 (1300 cycles, 2000 mA g^{-1})	450 (10000 mA g^{-1})	15
Sn-C	493.6	200 mA g^{-1}	445 (200 cycles, 500 mA g^{-1})	415 (500 cycles, 1000 mA g^{-1})	349 (4000 mA g^{-1})	16
Sn-RGO-graphene	615	1/2 C	515 (50 cycles)	~400 (100 cycles)	~160 (20 C)	17
Sn nanopowder (<150nm)	714	25 mA g^{-1}	640 (100 cycles)	640 (100 cycles)		18
Sn-graphene film	366	50 mA g^{-1}	324 (30 cycles)	324 (30 cycles)	~100 (400 mA g^{-1})	19
Sn nanopowder (<150nm)	674	1/2 C	519 (500 cycles)	519 (500 cycles)		20
micro-sized Sn	800	250 mA g^{-1}	768 (100 cycles)	768 (100 cycles)	622 (2 C)	21
porous carbon nanocage-Sn nanocomposite	828	40 mA g^{-1}	583 (200 cycles)	~100 (1000 cycles, 2560 mA g^{-1})	188 (2560 mA g^{-1})	22
graphene/Sn-C	434.2	100 mA g^{-1}	413 (100 cycles)	413 (100 cycles)	106 (3200 mA g^{-1})	23
mutilayered 2D Sn nanodendrites	~750	100 mA g^{-1}	757.38 (300 cycles, 100 mA g^{-1} = 0.12C)	757.38 (300 cycles, 100 mA g^{-1} = 0.12C)	412.84 (5 C)	24
Sn-nitrogen doped carbon nanofibers	~880	1/10 C	601 (200 cycles)	390 (1000 cycles, 1C)	190 (5 C)	25
Sn-CMK3	412	100 mA g^{-1}	337 (200 cycles)	337 (200 cycles)	228 (1000 mA g^{-1})	26
Sn-CNF	220	1/10 C	189 (45 cycles)	~50 (1400 cycles)	24 (5 C)	27
Present work	555	10 C	554 (5000 cycles)	554 (5000 cycles)	619 (8 C) 299 (16 C) 154 (32 C) 45 (64 C)	

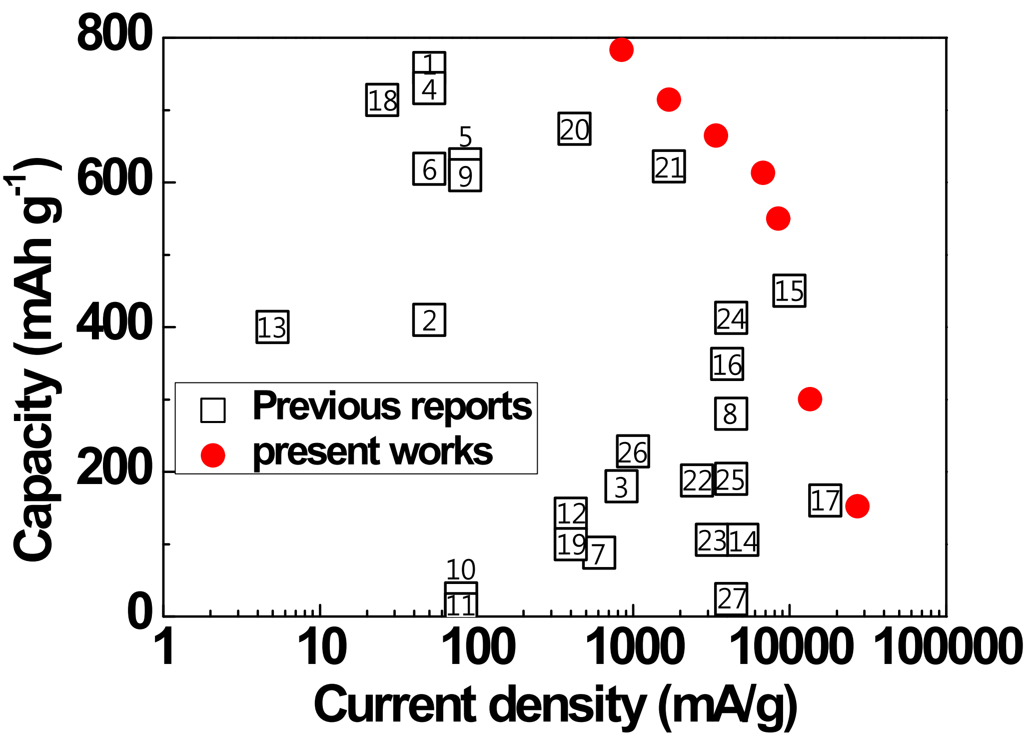


Fig. S2 Comparison of rate capability of Sn anode with previously reported values. The marked numbers on symbol are cited reference number.

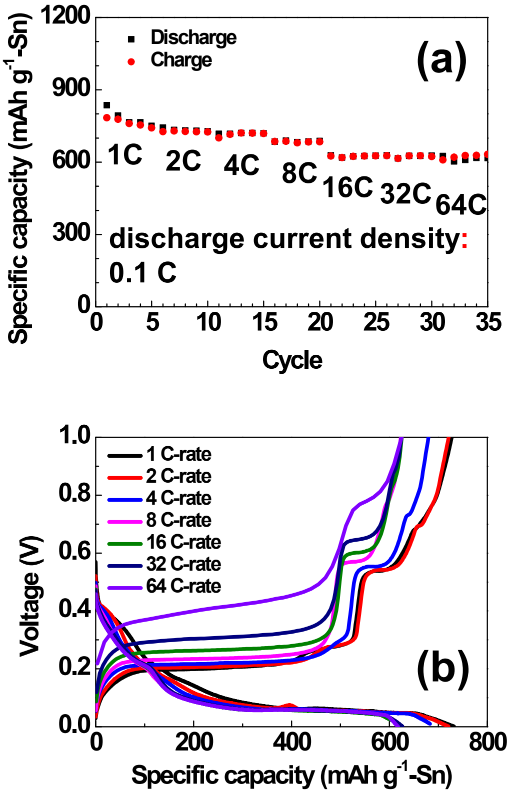


Fig. S3 (a) Rate-capability and (b) discharge-charge curves of Sn anode at a constant discharge current density of 0.1 C-rate.

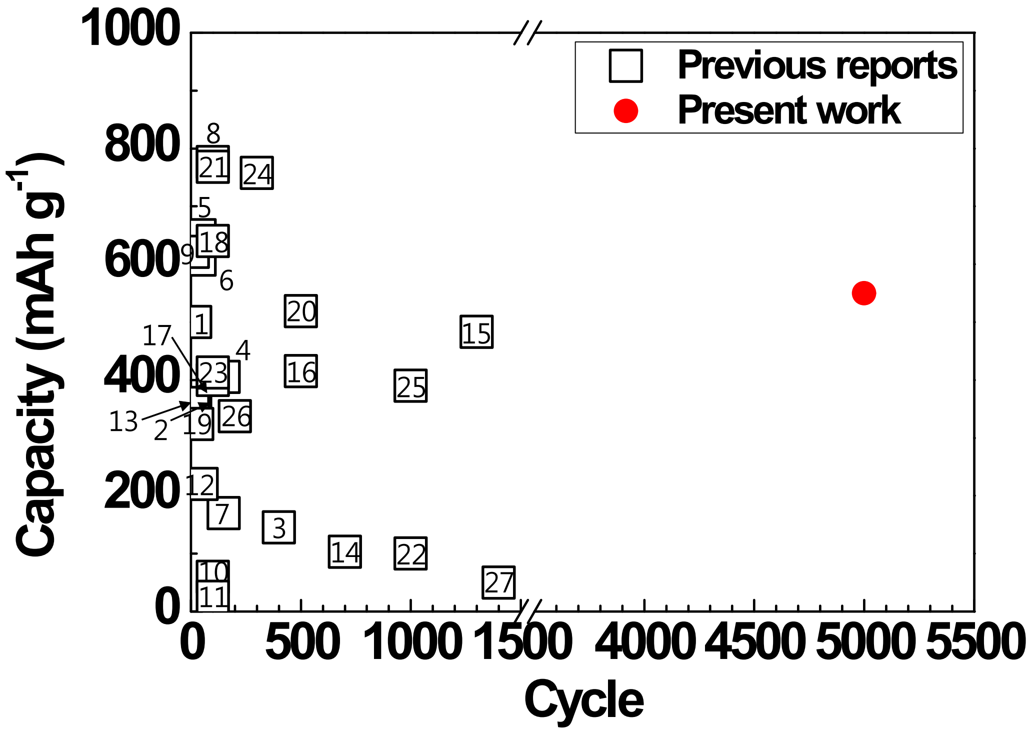


Fig. S4 Comparison of cycleability of Sn anode with previously reported data. The marked numbers on symbol are cited reference number.

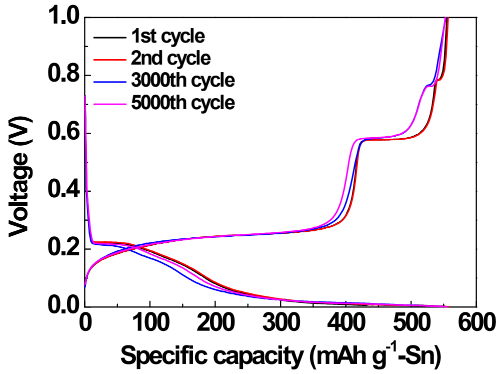


Fig. S5 Discharge-charge curves of the Sn anode over 5000 cycles.

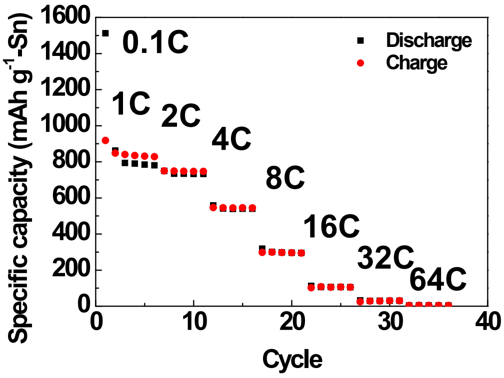


Fig. S6 Rate capability of the Sn anode with Super-P as the conductive additive, instead of MWCNT conductive additive.

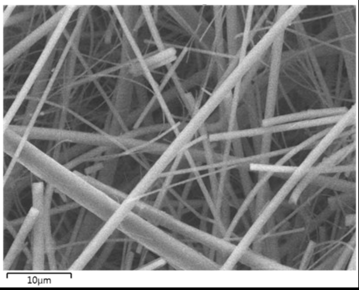
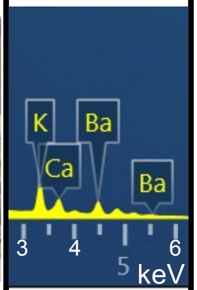
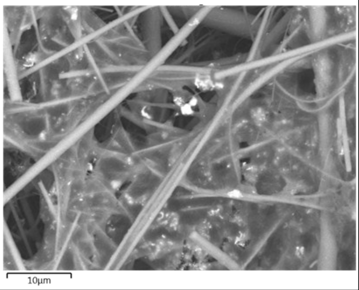
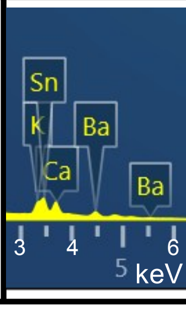
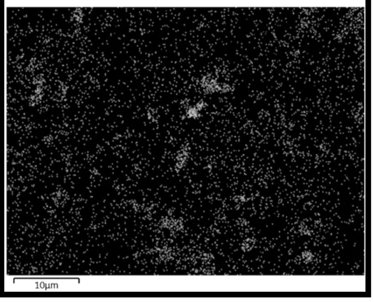
	SEM image	EDS spectrum	Sn elemental mapping
Pristine			**No signal**
Without Celgard 2400 after 200 cycle			

Fig. S7 SEM images, EDS spectra and Sn elemental mapping image of the glass fiber filter.

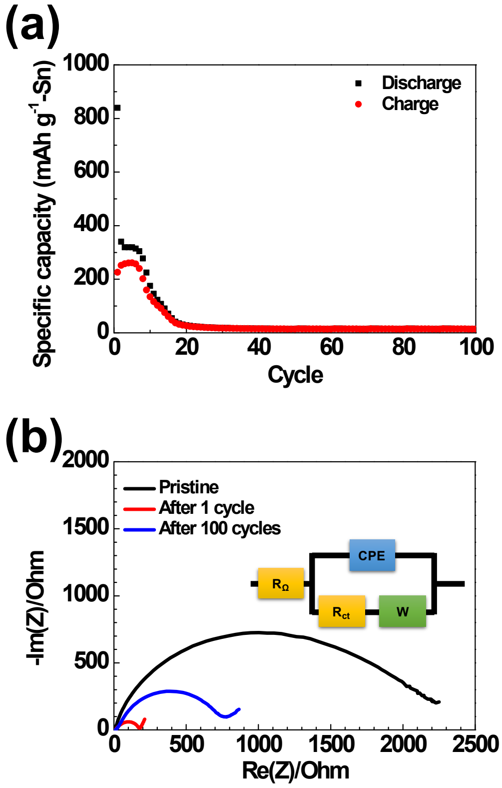


Fig. S8 (a) Cycle properties and (b) Nyquist plots of the Sn anode with 1 M $NaPF_6$ in EC/DEC (1:1, volume ratio) as the electrolyte at 1 C-rate.

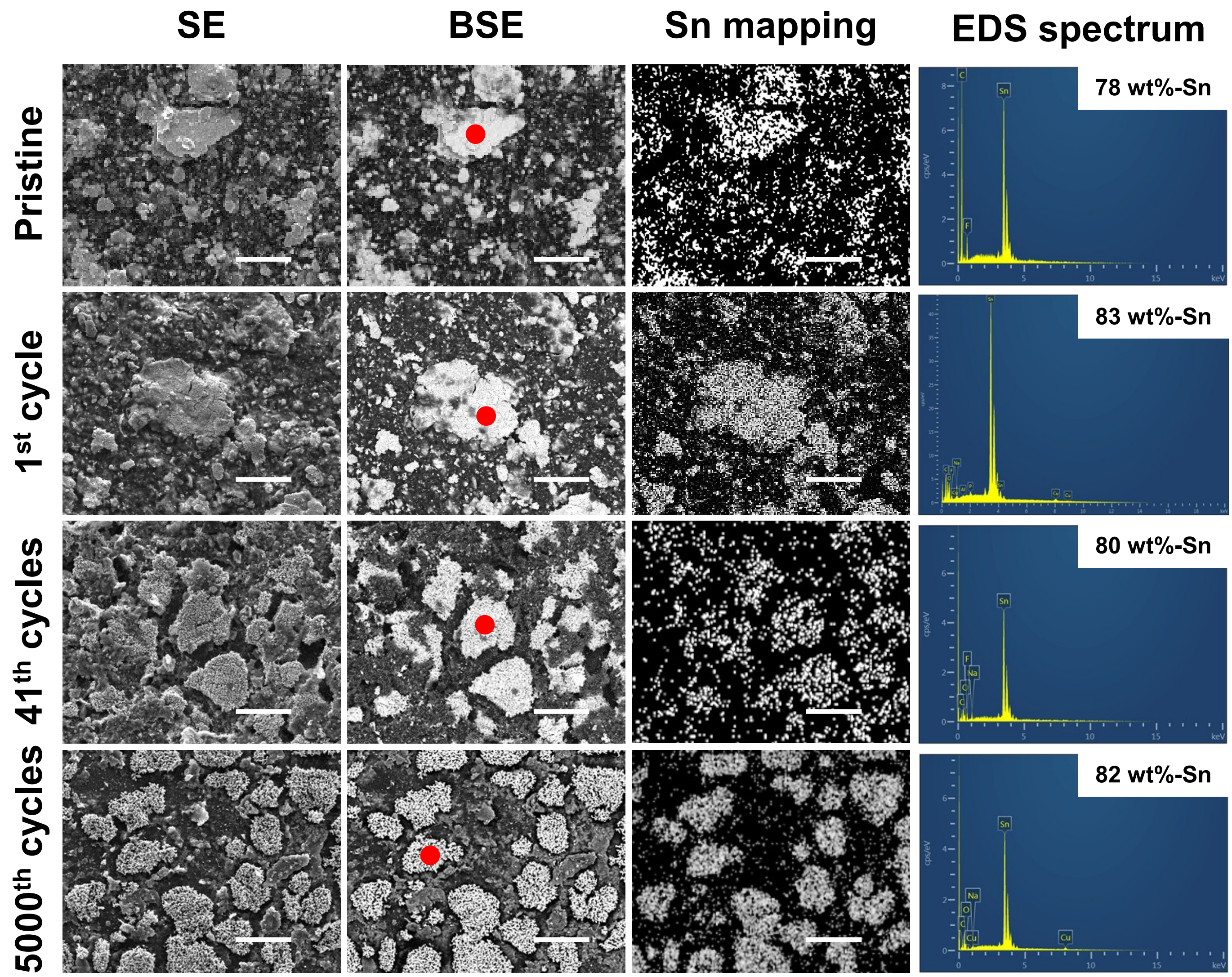


Fig. S9 SEM images of the Sn anodes, EDS mapping images and EDS spectra (red points in BSE image) of elemental Sn. SE is the secondary electron image and BSE is the backscattered electron image. All scale bars represent 40 μm.

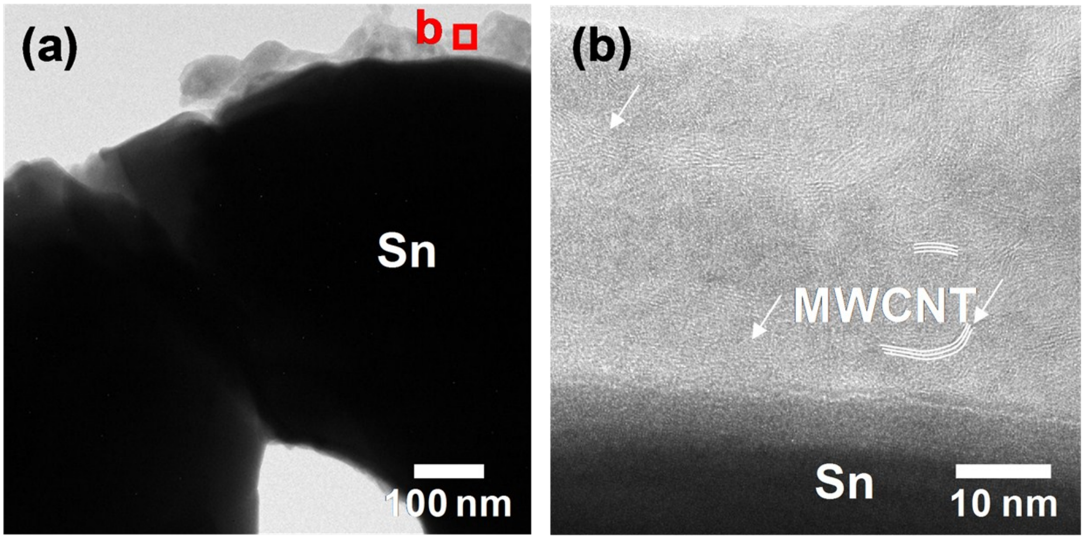


Figure S10. TEM image of MWCNT on the Sn particle.

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