Supporting Information for

High Density Sodium and Lithium Ion Battery Anodes from Banana Peels

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Figure S1. (a) Environmental SEM image of a cross-sectioned dried banana peel. (b)-(c) Low magnification SEM micrographs of banana peel pseudo graphite (BPPG) carbonized at 800°C and activated (b) and at 1400°C and activated (c). (d) SEM images of baseline commercial graphite (CG), and (e) baseline NORIT Supra activated carbon (AC), highlighting the overall morphology of the materials employed as electrochemical testing baselines.

Figure S2. (a) Nitrogen adsorption-desorption isotherms of BPPG. (b) Pore size distribution calculated from the adsorption isotherms, using DFT method. (c) XRD patterns of the unactivated specimens (BPPG). (d) Raman spectra of BPPG.

Figure S3. Fitted Raman spectra of BPPG-A specimens. (a) BPPG-800-A, (b) BPPGA-1100-A, and (c) BPPG-1400-A.

Figure S4. XPS survey spectra of the (a) and (b) as-synthesized, (c) and (d) mechanically ground BPPGA and BPPG specimens.

Table S1. Elemental composition information for BPPG and BPPG-A, XPS performed on as-synthesized powders.

Samples	elemental analysis				XPS				
	C	O	N	H	C	O	N	Si	Cl
	[wt%]	[wt%]	[wt%]	[wt%]	[wt%]	[wt%]	[wt%]	[wt%]	[wt%]
BPPG-800	82.44	8.12	1.93	1.03	88.47	7.83	2.10	1.45	0.15
BPPG-1100	87.44	5.24	0.76	0.39	92.02	6.10	1.06	0.57	0.25
BPPG-1400	92.42	3.98	0.19	0.16	92.53	5.55	0.48	1.3	0.14
BPPG-800-A	83.42	9.14	2.07	1.24	87.34	9.31	2.82	0.25	0.28
BPPG-1100-A	88.34	5.95	0.97	1.57	89.51	6.72	2.75	0.8	0.22
BPPG-1400-A	92.87	3.57	0.37	0.32	92.19	5.70	1.29	0.64	0.18

Table S2. XPS results on BPPG and BPPG-A that were mechanically ground after synthesis so as to expose bulk material to surface analysis.

Samples	XPS (After grinding)							
	K	Mg	P	C	O	N	Si	Cl
	[wt%]	[wt%]	[wt%]	[wt%]	[wt%]	[wt%]	[wt%]	[wt%]
BPPG-800	0.1	0.17	0.08	87.95	8.02	2.17	1.31	0.2
BPPG-1100	0.18	0.15	0.13	92.03	5.83	1.01	0.42	0.25
BPPG-1400	0.82	0.1	0.06	91.82	5.53	0.39	1.08	0.2
BPPG-800-A	0.77	0.16	0.09	87.17	9.06	2.27	0.1	0.38
BPPG-1100-A	0.51	0.13	0.12	89.14	6.98	2.31	0.47	0.34
BPPG-1400-A	0.08	0.1	0.07	91.68	5.85	0.98	1.0	0.24

Figure S5. CV and galvanostatic discharge/charge profiles of (a)-(c) BPPG-800-A, and (d)-(f) BPPG-1400-A electrodes. CVs were done between 0.001 and 2.8 V vs. Na/Na^{+} at a scanning rate of 0.1 mVs^{-1} . Galvanostatic discharge/charge profiles are obtained at current density of 50 mA g^{-1} .

Figure S6. CV and galvanostatic discharge/charge profiles of (a)-(c) BPPG-800, (d)-(f) BPPG-1100, and (g)-(i) BPPG-1400 electrodes *versus* Na.

Table S3. Coulombic efficiency and cycling capacity of BPPG and BPPG-A, *versus* Na.

Samples were activated at 0.05 A g⁻¹ for 10 cycles and were subsequently tested at 0.1 A g⁻¹

Samples	Initial CE (%)	Cycle 2 (mAhg⁻¹)	Cycle 50 (mAhg⁻¹)	Cycle 300 (mAhg⁻¹)
BPPG-800 (Na)	63	328	277	254
BPPG-1100 (Na)	70	362	316	288
BPPG-1400 (Na)	73	351	292	245
BPPG-800-A (Na)	61	336	288	254
BPPG-1100-A (Na)	68	384	330	299
BPPG-1400-A (Na)	71	371	304	239

Figure S7. (a) Volumetric capacity of BPPG-1100-A tested against Na, at a current density of 50 mA g⁻¹. Capacity calculation is based on the true density of BPPG, which is ~ 2 g/cm³. (b) Cross section SEM image of a drop-cast BPPG-1100-A electrode, as electrochemically tested in this study. (c) Cross section SEM image of a pressed high mass loading BPPG-1100-A electrode.

Figure S8. (a) XRD spectra for BPPG-1400-A at different discharge and charge voltages *versus* Na. (b) Raman spectra for BPPG-1400-A at different discharge and charge voltages *versus* Na. (c)-(f) High resolution Na 1s, and C 1s XPS spectra for sodiated and desodiated BPPG-1400-A, analyzed after 10 cycles. S8(c) and S8(d) show spectra for samples where the electrode's top SEI covered surface was removed by the scotch tape method. S8(e) and S8(f) show spectra for samples without the top layer removed, *i.e.* intact electrode covered by SEI.

Figure S9. Low magnification SEM micrograph of BPPG-1400-A desodiated to 2.8 V, after 10 cycles. S9(a) shows the electrode morphology after the electrode's top layer was removed by the scotch tape method, S9(b) shows the morphology of an intact electrode that is covered by SEI.

Figure S10. Equivalent electronic circuits used to simulate the electrochemical impedance spectra (EIS) results. For the spectra of all the as- prepared specimens, equivalent circuit (a) was used. For the cycled specimens with an SEI layer formed, equivalent circuit (b) was used.

Figure S11. Experimental EIS of as-prepared BPPG-A, and BPPG electrodes *versus* Na.

Figure S12. Experimental EIS of as-prepared BPPG-A, and BPPG electrodes *versus* Li.

Figure S13. Experimental EIS of BPPG-A, and BPPG electrodes after 300 cycles *versus* Na.

Figure S14. Experimental EIS of BPPG-A electrodes after 300 cycles *versus* Li.

Table S4. Resistance values simulated from modeling the experimental impedance (Figure S10-S12) using the equivalent circuits shown in Figure S9

Samples	As-prepared		After 300cycles	
	R_{el}	R_{ct}	R_{el}	$R_{ct}+R_f$
BPPG-800-A (Na)	10.1	102.1	16.8	166.1
BPPG-1100-A (Na)	8.3	94.7	14.5	124
BPPG-1400-A (Na)	6.4	79.7	23.6	202.2
BPPG-800 (Na)	8.3	175.5	30.3	302.6
BPPG-1100 (Na)	8.6	126.4	24.6	246.4
BPPG-1400 (Na)	7.7	94.6	38.8	381.5
BPPG-800-A (Li)	4.6	80.3	9.4	232.4
BPPG-1100-A (Li)	4.3	65.3	8.9	262.4
BPPG-1400-A (Li)	6	50.5	7.1	210.1
BPPG-800 (Li)	5.9	19.5		
BPPG-1100 (Li)	4.1	18.2		
BPPG-1400 (Li)	4.5	14.2

Figure S15. (a)-(c) EIS of BPPG-800-A, BPPG-1100-A, and BPPG-1400-A *versus* Na, for cycles 20 – 300. (d) EIS of BPPG-1100-A *versus* Li for cycles 10 - 300. (e) The total charge transfer resistance within all the interfaces ($R_{ct}+R_f$), as a function of cycle number. (f) R_{el} as a function of the cycle number.

Figure S16. Electrochemical performance of BPPG-A, tested in a half cell against Li metal from 0.001 and 2.8 V. (a) CV of BPPG-1100-A, tested at 0.1 mV s^{-1} . Galvanostatic discharge/charge curves of (b) and (c) BPPG-800-A, (d) and (e) BPPG-1100-A, (f) and (g) BPPG-1400-A at a current density of 50 mA g^{-1} .

Figure S17. Galvanostatic discharge/charge curves of (a) and (b) BPPG-800, (c) and (d) BPPG-1100, (e) and (f) BPPG-1400, versus Li.

Table S5. Coulombic efficiency and cycling capacity of BPPG and BPPG-A, *versus* Li. Samples were activated at 0.05 A g⁻¹ for 10 cycles and were subsequently tested at 0.1 A g⁻¹.

Samples	Initial CE (%)	Cycle 2 (mAhg ⁻¹)	Cycle 50 (mAhg ⁻¹)	Cycle 300 (mAhg ⁻¹)
BPPG-800-A (Li)	50	1268	779	801
BPPG-1100-A (Li)	55	1184	681	717
BPPG-1400-A (Li)	61	1020	637	641
BPPG-800 (Li)	58	1029	730	
BPPG-1100 (Li)	63	901	652	
BPPG-1400 (Li)	69	826	593

Figure S18. Electrochemical performance of BPPG, tested in a half cell against Li, 10th cycle at 50 mA g⁻¹. (a) Potential profiles of BPPG and BPPG-A electrodes, (b) Summary of capacity above and below 0.1 V in BPPG and BPPG-A.

Figure S19. (a) Raman spectra for BPPG-1400-A at different discharge and charge voltages *versus* Li. The electrodes were galvanostatically discharged/charged to 0.2, 0.1, 0.05, and 0.001 V. (b) The Raman integral intensity ratio (I_G/I_D) as a function of discharge/charge voltage demonstrating intercalation-induced ordering of the carbon, values derived from Raman spectra in Figure S19(a).

Figure S20. High resolution Li 1s, and C 1s XPS spectra for lithiated and delithiated BPPG-1400-A, analyzed after 10 cycles. S20(a) and S20(b) show spectra for samples where the electrode's top SEI covered surface was removed by the scotch tape method. S8(c) and S8(d) show spectra for samples without the top layer removed, *i.e.* intact electrode covered by SEI.

Figure S21. Low magnification SEM micrograph of BPPG-1400-A delithiated to 2.8 V, after 10 cycles. S21(a) shows the electrode morphology after the electrode's top layer was removed by the scotch tape method, S21(b) shows the morphology of an intact electrode that is covered by SEI.

Table S6. Performance comparison of BPPG-1100-A *versus* state of the art LIB carbons reported in literature

Material	Initial coulombic efficiency (%)	Cyclability (discharge capacity)	Rate performance
<i>BPPG-1100-A (this work)</i>	55	790 mAhg ⁻¹ at 11 th cycle 717 mAhg ⁻¹ at 300 th cycle 91% capacity retention over 290 cycles at 100 mA g ⁻¹	738 mAhg ⁻¹ at 200 mA g ⁻¹ 634 mAhg ⁻¹ at 500 mA g ⁻¹ 518 mAhg ⁻¹ at 1 Ag ⁻¹ 385 mAhg ⁻¹ at 2 Ag ⁻¹ 243 mAhg ⁻¹ at 5 Ag ⁻¹
Mesoporus carbon (Ref. 94)	35	900 mAhg ⁻¹ at 10 th cycle 800 mAhg ⁻¹ at 20 th cycle 89% retention over 10 cycles at 100 mA g ⁻¹	Not reported
Graphene (Ref. 96)	38	580 mAhg ⁻¹ at 2 nd cycle, 410 mAhg ⁻¹ at 40 th cycle 71% retention over 38 cycles at 25 mA g ⁻¹	Not reported
Graphene nanosheets (Ref. 97)	Not reported	784 mAhg ⁻¹ at 2 nd cycle 600 mAhg ⁻¹ at 22 th cycle 76% retention over 20 cycles at 50 mA g ⁻¹	Not reported
Graphene sheets (Ref. 98)	53	1450 mAhg ⁻¹ at 10 th cycle, 1150 mAhg ⁻¹ at 50 th cycle 79% retention over 40 cycles at 50 mA g ⁻¹	1500 mAhg ⁻¹ at 50 mA g ⁻¹ 1400 mAhg ⁻¹ at 150 mA g ⁻¹ 1200 mAhg ⁻¹ at 300 Ag ⁻¹
CNTs/graphene (Ref. 99)	50	650 mAhg ⁻¹ at 10 th cycle 650 mAhg ⁻¹ at 20 th cycle At 600 mA g ⁻¹	750 mAhg ⁻¹ at 100 mA g ⁻¹ 550 mAhg ⁻¹ at 300 mA g ⁻¹ 480 mAhg ⁻¹ at 600 mA g ⁻¹ 420 mAhg ⁻¹ at 900 mA g ⁻¹ 400 mAhg ⁻¹ at 1.2 Ag ⁻¹ 370 mAhg ⁻¹ at 1.5 Ag ⁻¹
Graphene nanosheets (Ref. 100)	48	1050 mAhg ⁻¹ at 10 th cycle 691 mAhg ⁻¹ at 100 th cycle 66% retention over 90 cycles at 100 mA g ⁻¹	1200 mAhg ⁻¹ at 100 mA g ⁻¹ 900 mAhg ⁻¹ at 200 mA g ⁻¹ 740 mAhg ⁻¹ at 400 mA g ⁻¹ 600 mAhg ⁻¹ at 800 mA g ⁻¹ 500 mAhg ⁻¹ at 1.2 Ag ⁻¹
CNTs on graphene paper (Ref. 101)	Not reported	300 mAhg ⁻¹ at 10 th cycle 290 mAhg ⁻¹ at 40 th cycle 97% retention over 30 cycles at 30 mA g ⁻¹	290 mAhg ⁻¹ at 30 mA g ⁻¹ 275 mAhg ⁻¹ at 60 mA g ⁻¹ 190 mAhg ⁻¹ at 300 mA g ⁻¹ 140 mAhg ⁻¹ at 600 mA g ⁻¹ 90 mAhg ⁻¹ at 1.5 Ag ⁻¹ 70 mAhg ⁻¹ at 3 Ag ⁻¹

			60 mAhg ⁻¹ at 3 Ag ⁻¹
Graphene nanoribbons (Ref. 102)	53	750 mAhg ⁻¹ at 2 nd cycle 510 mAhg ⁻¹ at 14 th cycle 68% retention over 12 cycles at 0.1C	Not reported
Graphene/carbon nanofibers (Ref. 103)	55	700 mAhg ⁻¹ at 2 nd cycle 650 mAhg ⁻¹ at 30 th cycle 93% retention over 20 cycles at 0.12 mAcm ⁻²	420 mAhg ⁻¹ at 0.36 mAcm ⁻² 385 mAhg ⁻¹ at 0.6 mAcm ⁻² 329 mAhg ⁻¹ at 1.2 mAcm ⁻² 229 mAhg ⁻¹ at 2.4 mAcm ⁻² 180 mAhg ⁻¹ at 6 mAcm ⁻²
Monolithic carbon (Ref. 104)	47	400 mAhg ⁻¹ at 2 nd cycle 352 mAhg ⁻¹ at 50 th cycle 88% capacity retention over 48 cycles at 100 mA g ⁻¹	250 mAhg ⁻¹ at 200 mA g ⁻¹ 210 mAhg ⁻¹ at 500 mA g ⁻¹ 190 mAhg ⁻¹ at 800 mA g ⁻¹ 180 mAhg ⁻¹ at 1 Ag ⁻¹
Mesoporous carbon (Ref. 105)	59	900 mAhg ⁻¹ at 10 th cycle 786 mAhg ⁻¹ at 20 th cycle 87% capacity retention over 10 cycles at 37.2 mA g ⁻¹	190 mAhg ⁻¹ at 372 mA g ⁻¹ 140 mAhg ⁻¹ at 744 mA g ⁻¹ 90 mAhg ⁻¹ at 1.86 Ag ⁻¹ 70 mAhg ⁻¹ at 3.72 Ag ⁻¹
CNTs on carbon fibre (Ref. 106)	>80	550 mAhg ⁻¹ at 10 th cycle 550 mAhg ⁻¹ at 50 th cycle at 0.05 mAcm ⁻²	550 mAhg ⁻¹ at 0.05 mAcm ⁻² 450 mAhg ⁻¹ at 0.2 mAcm ⁻² 350 mAhg ⁻¹ at 0.5 mAcm ⁻²
Macroporous carbon (Ref. 107)	43	200 mAhg ⁻¹ at 10 th cycle 190 mAhg ⁻¹ at 30 th cycle 95% capacity retention over 20 cycles at 40 mA g ⁻¹	300 mAhg ⁻¹ at 15 mA g ⁻¹ 230 mAhg ⁻¹ at 32 mA g ⁻¹ 200 mAhg ⁻¹ at 61 mA g ⁻¹ 175 mAhg ⁻¹ at 90 mA g ⁻¹
Carbon nanospheres (Ref. 108)	72	800 mAhg ⁻¹ at 2 nd cycle 700 mAhg ⁻¹ at 50 th cycle 88% capacity retention over 48 cycles at 50 mA g ⁻¹	750 mAhg ⁻¹ at 48 mA g ⁻¹ 410 mAhg ⁻¹ at 82 mA g ⁻¹ 360 mAhg ⁻¹ at 2 Ag ⁻¹ 300 mAhg ⁻¹ at 3 Ag ⁻¹
Photothermally reduced grapheme (Ref. 109)	95.3 (at 14.8 Ag ⁻¹)	550 mAhg ⁻¹ at 2 nd cycle 540 mAhg ⁻¹ at 50 th cycle 98% capacity retention over 48 cycles at 50 mA g ⁻¹	550 mAhg ⁻¹ at 372 mA g ⁻¹ 380 mAhg ⁻¹ at 1.86 Ag ⁻¹ 160 mAhg ⁻¹ at 14.8 Ag ⁻¹ 90 mAhg ⁻¹ at 37.2 Ag ⁻¹ 88 mAhg ⁻¹ at 44.6 Ag ⁻¹ 60 mAhg ⁻¹ at 55.8 Ag ⁻¹

Figure S22. (a) Volumetric capacity of BPPG-1100-A tested against Li, at a current density of 50mA g^{-1} . Capacity calculation is based on the true density of BPPG, which is $\sim 2\text{ g/cm}^3$.