Development of Bixbyite Micro Dice Fabricated Cathode for Aqueous Rechargeable Zinc Ion Batteries

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Supplementary file

Table S1: Rate capability of fabricated coin cell (List of specific charging-discharging capacities w.r.to applied current densities)

Cycle no.	Applied current density (Ag^{-1})	Specific charging capacity ($mAhg^{-1}$)					Specific discharging capacity ($mAhg^{-1}$)				
		Test-1	Test-2	Test-3	Mean ± Standard deviation	Standard Error	Test-1	Test-2	Test-3	Mean ± Standard Deviation	Standard Error
1	0.1	300.54	291.24	298.57	296.78±4.90	2.83	297.14	288.19	295.43	293.59±4.75	2.74
2		300.52	291.32	298.53	296.79±4.84	2.79	297.15	288.25	295.65	293.68±4.76	2.75
3		302.54	293.44	300.55	298.84±4.78	2.76	296.19	287.36	294.17	292.57±4.63	2.67
4		301.55	292.15	299.56	297.75±4.95	2.86	298.10	289.31	296.27	294.56±4.64	2.68
5		300.51	291.21	298.52	296.75±4.90	2.83	297.08	288.57	295.12	293.59±4.46	2.57
6	0.2	276.9	267.29	274.92	273.04±5.07	2.93	273.06	264.26	271.09	269.47±4.62	2.67
7		275.88	266.48	273.87	272.08±4.95	2.86	272.16	263.19	270.25	268.53±4.72	2.73
8		275.81	266.21	273.83	271.95±5.07	2.93	273.36	264.25	271.62	269.74±4.84	2.79
9		274.64	265.34	272.65	270.88±4.90	2.83	271.03	262.09	269.08	267.40±4.70	2.71

10		275.56	266.76	273.57	271.96±4.61	2.66	270.26	261.36	268.62	266.75±4.74	2.73
11	0.3	260.51	251.61	258.53	256.88±4.67	2.70	255.72	246.84	253.75	252.10±4.66	2.69
12		259.45	250.25	257.48	255.73±4.84	2.80	253.66	244.77	251.63	250.02±4.66	2.69
13		258.38	249.58	256.39	254.78±4.61	2.66	254.52	245.44	252.55	250.84±4.78	2.76
14		258.36	249.66	256.37	254.80±4.56	2.63	251.54	242.56	249.44	247.85±4.70	2.71
15		256.23	247.13	254.25	252.54±4.79	2.76	253.42	244.36	251.71	249.83±4.81	2.78
16	0.4	235.48	226.58	233.45	231.84±4.66	2.69	229.41	220.22	227.82	225.82±4.91	2.84
17		234.38	225.48	232.54	230.80±4.70	2.71	228.55	219.56	226.54	224.88±4.72	2.72
18		233.20	224.22	231.32	229.58±4.74	2.73	227.31	218.29	225.38	223.66±4.75	2.74
19		233.23	224.33	231.33	229.63±4.69	2.71	227.25	218.57	225.85	223.89±4.66	2.69
20		232.21	223.31	230.22	228.58±4.67	2.70	226.16	217.63	224.21	222.67±4.47	2.58
21	0.5	202.35	193.55	200.45	198.78±4.63	2.67	199.04	190.74	197.29	195.69±4.38	2.53
22		201.25	192.55	199.67	197.82±4.63	2.68	198.34	189.57	196.44	194.78±4.61	2.66
23		201.15	192.25	199.17	197.52±4.67	2.70	197.03	188.15	195.25	193.48±4.70	2.71
24		200.38	191.48	198.74	196.87±4.74	2.73	197.01	188.27	195.19	193.49±4.61	2.66
25		200.26	191.56	198.28	196.70±4.56	2.63	196.32	187.21	194.17	192.57±4.76	2.75
26	0.6	179.62	170.42	177.54	175.86±4.82	2.79	177.69	168.98	175.26	173.98±4.49	2.59
27		178.61	169.51	176.59	174.90±4.78	2.76	177.52	168.41	175.23	173.72±4.74	2.74
28		178.55	169.95	176.34	174.95±4.47	2.58	176.41	167.44	174.39	172.75±4.71	2.72
29		179.42	170.72	177.38	175.84±4.55	2.63	175.39	166.37	173.35	171.70±4.73	2.73
30		177.32	168.52	175.29	173.71±4.61	2.66	174.36	165.65	172.62	170.88±4.61	2.66
31	0.7	150.71	141.61	148.62	146.98±4.77	2.75	148.09	139.73	146.67	144.83±4.47	2.58
32		149.37	140.57	147.48	145.81±4.63	2.67	147.12	138.62	145.68	143.81±4.55	2.63
33		148.01	139.41	146.22	144.55±4.54	2.62	146.09	137.52	144.85	142.82±4.63	2.67
34		147.41	138.61	145.33	143.78±4.60	2.66	146.25	137.44	144.32	142.67±4.63	2.67
35		147.56	138.66	145.67	143.96±4.69	2.71	145.19	136.42	143.37	141.66±4.63	2.67
36	0.1	290.83	281.73	288.94	287.17±4.80	2.77	288.56	279.37	286.96	284.96±4.91	2.83
37		289.63	280.53	287.65	285.94±4.79	2.76	287.32	278.75	285.22	283.76±4.47	2.58
38		288.61	279.71	286.19	284.84±4.60	2.66	287.49	278.44	285.99	283.97±4.85	2.80
39		288.53	279.43	286.45	284.80±4.77	2.75	286.44	277.48	284.67	282.86±4.75	2.74
40		287.52	278.32	285.88	283.91±4.91	2.83	285.19	276.54	283.61	281.78±4.61	2.66

Table S2: Cycling performance of fabricated coin cell at 0.3 Ag^{-1} current density (List of specific charging-discharging capacities and columbic efficiencies w.r.to cycle numbers)

Cycle no.	Specific charging capacity ($mAhg^{-1}$)					Specific discharging capacity ($mAhg^{-1}$)					Columbic efficiency (%)				
	Test-1	Test-2	Test-3	Mean ± Standard deviation	Standard Error	Test-1	Test-2	Test-3	Mean ± Standard deviation	Standard Error	Test-1	Test-2	Test-3	Mean ± Standard deviation	Standard Error
1	262.13	254.13	270.25	262.17±8.06	4.65	260.65	253.54	266.99	260.39±6.73	3.88	99.44	99.77	98.79	99.33±0.50	0.29
10	262.94	255.74	271.06	263.25±7.66	4.43	259.51	252.13	265.83	259.16±6.86	3.96	98.70	98.59	98.07	98.45±0.33	0.19
20	262.47	256.77	270.59	263.28±6.95	4.01	259.51	252.14	265.82	259.16±6.85	3.95	98.87	98.20	98.24	98.44±0.38	0.22
30	261.71	255.98	269.83	262.51±6.96	4.02	259.53	252.52	265.81	259.29±6.65	3.84	99.17	98.65	98.51	98.78±0.35	0.20
40	260.48	254.88	268.56	261.31±6.88	3.97	257.77	250.75	264.09	257.54±6.67	3.85	98.96	98.38	98.34	98.56±0.35	0.20
50	259.56	251.62	267.64	259.61±8.01	4.62	256.78	249.85	263.07	256.57±6.61	3.82	98.93	99.30	98.29	98.84±0.51	0.29
60	258.47	252.76	266.59	259.27±6.95	4.01	255.85	248.56	262.13	255.51±6.79	3.92	98.99	98.34	98.33	98.55±0.38	0.22
70	257.31	250.61	265.43	257.78±7.42	4.28	254.54	247.43	260.81	254.26±6.69	3.87	98.92	98.73	98.26	98.64±0.34	0.20
80	257.17	250.97	265.29	257.81±7.18	4.15	254.32	247.21	260.63	254.05±6.71	3.88	98.89	98.50	98.24	98.55±0.33	0.19
90	257.98	252.58	266.11	258.89±6.81	3.93	255.17	247.79	261.41	254.79±6.82	3.94	98.91	98.10	98.23	98.42±0.43	0.25
100	258.96	253.61	267.82	260.13±7.18	4.14	255.31	248.13	261.69	255.04±6.78	3.92	98.59	97.84	97.71	98.05±0.48	0.27
110	258.85	252.64	266.97	259.49±7.19	4.15	255.24	248.41	261.55	255.07±6.57	3.79	98.61	98.33	97.97	98.30±0.32	0.18
120	258.75	252.59	266.83	259.39±7.14	4.12	255.13	247.39	261.44	254.65±7.04	4.06	98.60	97.94	97.98	98.17±0.37	0.21
130	257.71	251.19	265.79	258.23±7.31	4.22	255.04	247.48	261.31	254.61±6.93	4.00	98.96	98.52	98.31	98.60±0.33	0.19
140	257.35	251.05	265.43	257.94±7.21	4.16	254.97	247.73	261.29	254.66±6.79	3.92	99.08	98.68	98.44	98.73±0.32	0.19
150	257.79	251.69	265.87	258.45±7.11	4.11	254.83	247.36	261.15	254.45±6.90	3.99	98.85	98.28	98.22	98.45±0.35	0.20
160	257.73	252.02	265.81	258.52±6.93	4.00	254.74	247.45	261.08	254.42±6.82	3.94	98.84	98.19	98.22	98.42±0.37	0.21
170	256.74	250.55	264.82	257.37±7.16	4.13	253.68	246.84	259.93	253.48±6.55	3.78	98.81	98.52	98.15	98.49±0.33	0.19
180	256.89	252.72	264.97	258.19±6.23	3.60	253.82	246.26	260.17	253.42±6.96	4.02	98.80	97.44	98.19	98.15±0.68	0.39
190	256.43	249.36	264.51	256.77±7.58	4.38	252.35	245.51	258.69	252.18±6.59	3.81	98.41	98.46	97.80	98.22±0.37	0.21
200	255.67	248.97	263.75	256.13±7.40	4.27	252.43	245.32	258.78	252.18±6.73	3.89	98.73	98.53	98.12	98.46±0.31	0.18
210	255.59	248.69	263.67	255.98±7.50	4.33	252.31	245.19	258.62	252.04±6.72	3.88	98.72	98.59	98.08	98.46±0.33	0.19
220	255.51	248.53	263.63	255.89±7.56	4.36	252.12	244.29	258.41	251.61±7.07	4.08	98.67	98.29	98.02	98.33±0.33	0.19
230	255.08	249.51	263.16	255.92±6.86	3.96	252.09	244.98	258.33	251.80±6.68	3.86	98.83	98.18	98.16	98.39±0.38	0.22
240	254.46	248.63	262.58	255.22±7.01	4.05	251.02	243.28	257.31	250.54±7.03	4.06	98.65	97.85	97.99	98.16±0.43	0.25

250	254.79	248.09	262.87	255.25±7.40	4.27	251.60	244.48	257.91	251.33±6.72	3.88	98.75	98.54	98.11	98.47±0.32	0.19
260	254.67	248.72	262.75	255.38±7.04	4.07	251.45	244.52	257.76	251.24±6.62	3.82	98.74	98.31	98.10	98.38±0.32	0.19
270	253.59	247.88	261.67	254.38±6.93	4.00	251.41	244.12	257.73	251.09±6.81	3.93	99.14	98.48	98.49	98.71±0.38	0.22
280	253.26	247.62	261.34	254.07±6.90	3.98	250.34	243.41	256.66	250.14±6.63	3.83	98.85	98.30	98.21	98.45±0.35	0.20
290	253.82	249.51	261.94	255.09±6.31	3.64	251.12	243.29	257.49	250.63±7.11	4.11	98.94	97.51	98.30	98.25±0.72	0.41
300	253.53	246.37	261.65	253.85±7.65	4.41	250.48	243.82	256.77	250.36±6.48	3.74	98.80	98.96	98.13	98.63±0.44	0.25
310	253.94	245.95	262.06	253.98±8.06	4.65	250.17	242.79	256.45	249.80±6.84	3.95	98.52	98.72	97.86	98.36±0.45	0.26
320	253.83	248.35	261.95	254.71±6.84	3.95	250.72	243.25	257.08	250.35±6.92	4.00	98.77	97.95	98.14	98.29±0.43	0.25
330	253.76	247.29	261.88	254.31±7.31	4.22	250.54	243.46	256.83	250.28±6.69	3.86	98.73	98.45	98.07	98.42±0.33	0.19
340	253.06	247.53	261.15	253.91±6.85	3.95	251.02	243.28	257.31	250.54±7.03	4.06	99.19	98.28	98.53	98.67±0.47	0.27
350	253.68	247.51	261.79	254.33±7.16	4.13	250.30	243.17	256.68	250.05±6.76	3.90	98.67	98.25	98.05	98.32±0.32	0.18
360	252.07	246.39	260.15	252.87±6.91	3.99	249.25	242.56	255.52	249.11±6.48	3.74	98.88	98.45	98.22	98.52±0.34	0.19
370	252.67	246.35	260.74	253.25±7.21	4.16	249.45	242.52	255.77	249.25±6.63	3.83	98.73	98.45	98.09	98.42±0.32	0.18
380	252.87	246.97	260.93	253.59±7.01	4.05	249.41	242.12	255.75	249.09±6.82	3.94	98.63	98.04	98.01	98.23±0.35	0.20
390	252.49	245.74	260.53	252.92±7.40	4.27	249.77	242.75	256.03	249.52±6.64	3.84	98.92	98.78	98.27	98.66±0.34	0.20
400	252.71	245.95	260.84	253.17±7.46	4.30	249.46	242.62	255.77	249.28±6.58	3.80	98.71	98.65	98.06	98.47±0.36	0.21
410	251.32	244.55	259.44	251.77±7.46	4.30	249.03	241.38	255.35	248.59±7.00	4.04	99.09	98.70	98.42	98.74±0.33	0.19
420	251.01	244.33	259.13	251.49±7.41	4.28	248.94	241.47	255.26	248.56±6.90	3.99	99.18	98.83	98.51	98.84±0.33	0.19
430	251.65	244.81	259.73	252.06±7.47	4.31	248.67	241.74	254.99	248.47±6.63	3.83	98.82	98.75	98.18	98.58±0.35	0.20
440	251.03	244.39	259.15	251.52±7.39	4.27	248.98	241.87	255.23	248.69±6.68	3.86	99.18	98.97	98.49	98.88±0.36	0.21
450	250.96	244.42	259.04	251.47±7.32	4.23	248.56	241.63	254.87	248.35±6.62	3.82	99.04	98.86	98.39	98.76±0.34	0.19
460	250.67	243.96	258.79	251.14±7.43	4.29	247.98	240.87	254.21	247.69±6.67	3.85	98.93	98.73	98.23	98.63±0.36	0.21
470	250.98	244.77	259.06	251.60±7.17	4.14	247.45	240.52	253.77	247.25±6.63	3.83	98.59	98.26	97.96	98.27±0.32	0.18
480	250.73	244.28	258.85	251.29±7.30	4.22	247.9	240.71	254.22	247.61±6.76	3.90	98.87	98.54	98.21	98.54±0.33	0.19
490	250.97	244.85	259.05	251.62±7.12	4.11	247.78	240.85	254.07	247.57±6.61	3.82	98.73	98.37	98.08	98.39±0.33	0.19
500	250.65	244.37	258.77	251.26±7.22	4.17	247.25	240.53	253.54	247.11±6.51	3.76	98.64	98.43	97.98	98.35±0.34	0.20
510	250.73	243.98	258.85	251.19±7.45	4.30	247.89	240.96	254.18	247.68±6.61	3.82	98.87	98.76	98.20	98.61±0.36	0.21
520	250.14	243.51	258.26	250.64±7.39	4.27	247.36	240.61	253.65	247.21±6.52	3.77	98.89	98.81	98.21	98.64±0.37	0.21
530	249.67	242.81	257.79	250.09±7.50	4.33	247.04	239.48	253.33	246.62±6.93	4.00	98.95	98.63	98.27	98.62±0.34	0.20
540	249.53	242.62	257.65	249.93±7.52	4.34	246.93	239.37	253.26	246.52±6.95	4.01	98.96	98.66	98.30	98.64±0.33	0.19
550	249.67	242.52	257.79	249.99±7.64	4.41	246.04	238.48	252.36	245.63±6.95	4.01	98.55	98.33	97.89	98.26±0.33	0.19
560	249.12	242.31	257.24	249.56±7.47	4.32	246.77	239.75	253.04	246.52±6.65	3.84	99.06	98.94	98.37	98.79±0.37	0.21
570	249.68	242.78	257.79	250.08±7.51	4.34	246.78	239.85	253.06	246.56±6.61	3.81	98.84	98.79	98.17	98.60±0.38	0.22
580	249.57	242.17	257.69	249.81±7.76	4.48	246.57	239.73	252.81	246.37±6.54	3.78	98.80	98.99	98.11	98.63±0.47	0.27

590	248.76	241.96	256.89	249.20±7.47	4.32	245.99	238.97	252.22	245.73±6.63	3.83	98.89	98.76	98.18	98.61±0.38	0.22
600	248.77	241.97	256.85	249.20±7.45	4.30	245.72	238.25	252.07	245.35±6.92	3.99	98.77	98.46	98.14	98.46±0.32	0.18
610	248.59	241.79	256.65	249.01±7.44	4.29	245.59	238.93	251.88	245.47±6.48	3.74	98.79	98.82	98.14	98.58±0.38	0.22
620	248.67	241.78	256.74	249.06±7.49	4.32	245.54	238.43	251.86	245.28±6.72	3.88	98.74	98.61	98.10	98.48±0.34	0.20
630	248.24	241.41	256.35	248.67±7.48	4.32	245.52	238.23	251.81	245.19±6.80	3.92	98.90	98.68	98.23	98.61±0.34	0.20
640	248.86	242.26	256.95	249.36±7.36	4.25	245.46	238.62	251.79	245.29±6.59	3.80	98.63	98.50	97.99	98.37±0.34	0.20
650	247.68	240.66	255.73	248.02±7.54	4.35	244.98	237.87	251.24	244.70±6.69	3.86	98.91	98.84	98.24	98.66±0.37	0.21
660	247.66	240.68	255.75	248.03±7.54	4.35	244.52	237.23	250.81	244.19±6.80	3.92	98.73	98.57	98.07	98.46±0.35	0.20
670	247.51	240.17	255.63	247.77±7.73	4.46	244.13	236.39	250.44	243.65±7.04	4.06	98.63	98.43	97.97	98.34±0.34	0.20
680	247.89	241.98	255.98	248.62±7.03	4.06	244.67	237.74	250.99	244.47±6.63	3.83	98.70	98.25	98.05	98.33±0.33	0.19
690	247.45	240.56	255.57	247.86±7.51	4.34	244.97	237.75	251.25	244.66±6.76	3.90	99.00	98.83	98.31	98.71±0.36	0.21
700	246.64	239.48	254.77	246.96±7.65	4.42	243.72	236.25	250.07	243.35±6.92	3.99	98.82	98.65	98.16	98.54±0.34	0.20
710	246.14	239.43	254.25	246.61±7.42	4.28	243.89	236.71	250.15	243.58±6.73	3.88	99.09	98.86	98.39	98.78±0.36	0.21
720	246.77	239.79	254.88	247.15±7.55	4.36	243.68	236.84	249.99	243.50±6.58	3.80	98.75	98.77	98.08	98.53±0.39	0.23
730	246.67	239.78	254.76	247.07±7.50	4.33	243.29	236.97	249.56	243.27±6.30	3.63	98.63	98.83	97.96	98.47±0.46	0.26
740	246.65	239.58	254.74	246.99±7.59	4.38	243.98	236.87	250.26	243.70±6.70	3.87	98.92	98.87	98.24	98.68±0.38	0.22
750	246.46	239.62	254.57	246.88±7.48	4.32	243.03	235.38	249.35	242.59±7.00	4.04	98.61	98.23	97.95	98.26±0.33	0.19
760	245.78	238.89	253.85	246.17±7.49	4.32	242.73	235.35	249.05	242.38±6.86	3.96	98.76	98.52	98.11	98.46±0.33	0.19
770	245.56	238.67	253.67	245.97±7.51	4.33	242.57	235.73	248.88	242.39±6.58	3.80	98.78	98.77	98.11	98.55±0.38	0.22
780	245.16	238.63	253.23	245.67±7.31	4.22	242.14	234.49	248.45	241.69±6.99	4.04	98.77	98.27	98.11	98.38±0.34	0.20
790	245.88	239.84	253.95	246.56±7.08	4.09	242.98	235.87	249.26	242.70±6.70	3.87	98.82	98.34	98.15	98.44±0.34	0.20
800	245.67	238.78	253.71	246.05±7.47	4.31	242.88	235.86	249.19	242.64±6.67	3.85	98.86	98.78	98.22	98.62±0.35	0.20
810	245.56	238.67	253.63	245.95±7.49	4.32	242.67	235.74	248.92	242.44±6.59	3.81	98.82	98.77	98.14	98.58±0.38	0.22
820	245.04	238.42	253.15	245.54±7.38	4.26	242.48	235.82	248.71	242.34±6.45	3.72	98.96	98.91	98.25	98.70±0.40	0.23
830	244.69	237.98	252.73	245.13±7.38	4.26	242.22	235.21	248.55	241.99±6.67	3.85	98.99	98.84	98.35	98.72±0.34	0.19
840	244.85	238.56	252.93	245.45±7.20	4.16	241.55	234.53	247.88	241.32±6.68	3.86	98.65	98.31	98.00	98.32±0.32	0.19
850	244.38	237.85	252.47	244.90±7.32	4.23	241.33	234.31	247.61	241.08±6.65	3.84	98.75	98.51	98.08	98.45±0.34	0.20
860	243.77	236.79	251.81	244.12±7.52	4.34	240.71	233.15	247.02	240.29±6.94	4.01	98.74	98.46	98.10	98.44±0.32	0.19
870	243.39	236.95	251.45	243.93±7.27	4.19	240.48	233.82	246.77	240.36±6.48	3.74	98.80	98.68	98.14	98.54±0.35	0.20
880	243.99	237.91	252.04	244.65±7.09	4.09	239.44	232.42	245.75	239.20±6.67	3.85	98.14	97.69	97.50	97.78±0.32	0.19
890	242.97	236.71	251.06	243.58±7.19	4.15	239.51	232.13	245.82	239.15±6.85	3.96	98.58	98.07	97.91	98.18±0.35	0.20
900	242.57	235.73	250.61	242.97±7.45	4.30	239.49	232.92	245.78	239.40±6.43	3.71	98.73	98.81	98.07	98.54±0.40	0.23
910	242.75	235.59	250.84	243.06±7.63	4.41	238.46	231.62	244.75	238.28±6.57	3.79	98.23	98.31	97.57	98.04±0.41	0.24
920	242.67	235.78	250.75	243.07±7.49	4.33	238.35	231.51	244.66	238.17±6.58	3.80	98.22	98.19	97.57	97.99±0.37	0.21

930	242.08	235.82	250.16	242.69±7.19	4.15	238.56	231.63	244.81	238.33±6.59	3.81	98.55	98.22	97.86	98.21±0.34	0.20
940	242.09	235.92	250.18	242.73±7.15	4.13	238.05	230.58	244.33	237.65±6.88	3.97	98.33	97.74	97.66	97.91±0.37	0.21
950	242.16	235.63	250.23	242.67±7.31	4.22	237.14	229.49	243.41	236.68±6.97	4.02	97.93	97.39	97.27	97.53±0.35	0.20
960	241.17	234.73	249.26	241.72±7.28	4.20	237.33	230.31	243.62	237.09±6.66	3.84	98.41	98.12	97.74	98.09±0.34	0.19
970	241.19	234.93	249.25	241.79±7.18	4.14	237.52	230.23	243.88	237.21±6.83	3.94	98.48	98.00	97.85	98.11±0.33	0.19
980	241.21	234.41	249.33	241.65±7.47	4.31	236.77	229.75	243.05	236.52±6.65	3.84	98.16	98.01	97.48	97.88±0.36	0.21
990	241.23	234.34	249.31	241.63±7.49	4.33	236.66	229.64	242.93	236.41±6.65	3.84	98.11	97.99	97.44	97.85±0.36	0.21
1000	240.29	233.94	248.38	240.87±7.24	4.18	235.62	228.24	241.96	235.27±6.87	3.96	98.06	97.56	97.42	97.68±0.34	0.19