Supporting Information

RSC Advances

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Dispersed MnO_2 Nanoparticle/Sugarcane Bagasse Derived Carbon Composite as the Anode Material for Lithium-ion Batteries

K. Pongpanyanate[a], S. Roddecha*[a,c], C. Piyanirund[a], T. Phraewphiphat[d] and P. Hasin[b,c]

[a] Department of Chemical Engineering, Faculty of Engineering, Kasetsart University, Thailand.

[b] Department of Chemistry and Center of Excellence for Innovation in Chemistry (PERCH-CIC), Ministry of Higher Education, Science, Research and Innovation, Faculty of Science, Kasetsart University, Thailand.

[c] Kasetsart University Research and Development Institute, Kasetsart University, Thailand.

[d] National Energy Technology Center (ENTEC), 114 Thailand Science Park, Phaholyothin Road, Klong 1, Klongluang, Pathumthani, Thailand 12120.

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Part I. Material Characterization

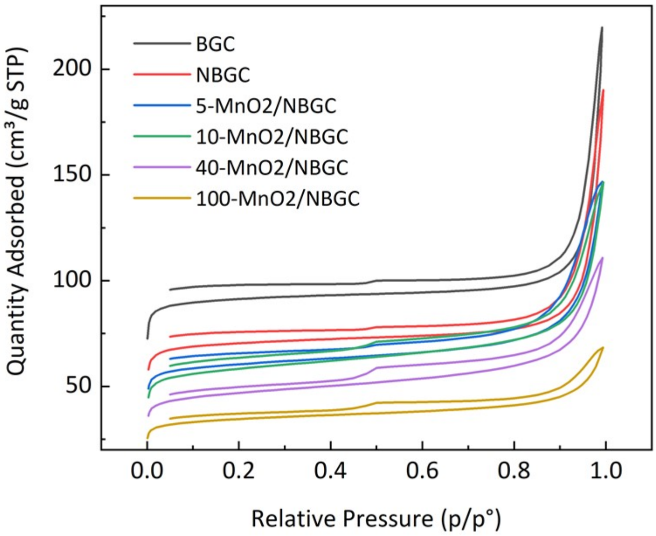

Figure S1. N_2 adsorption-desorption isotherms of BGC, NBGC, 5-MnO_2/NBGC, 10-MnO_2/NBGC, 40-MnO_2/NBGC and 100-MnO_2/NBGC

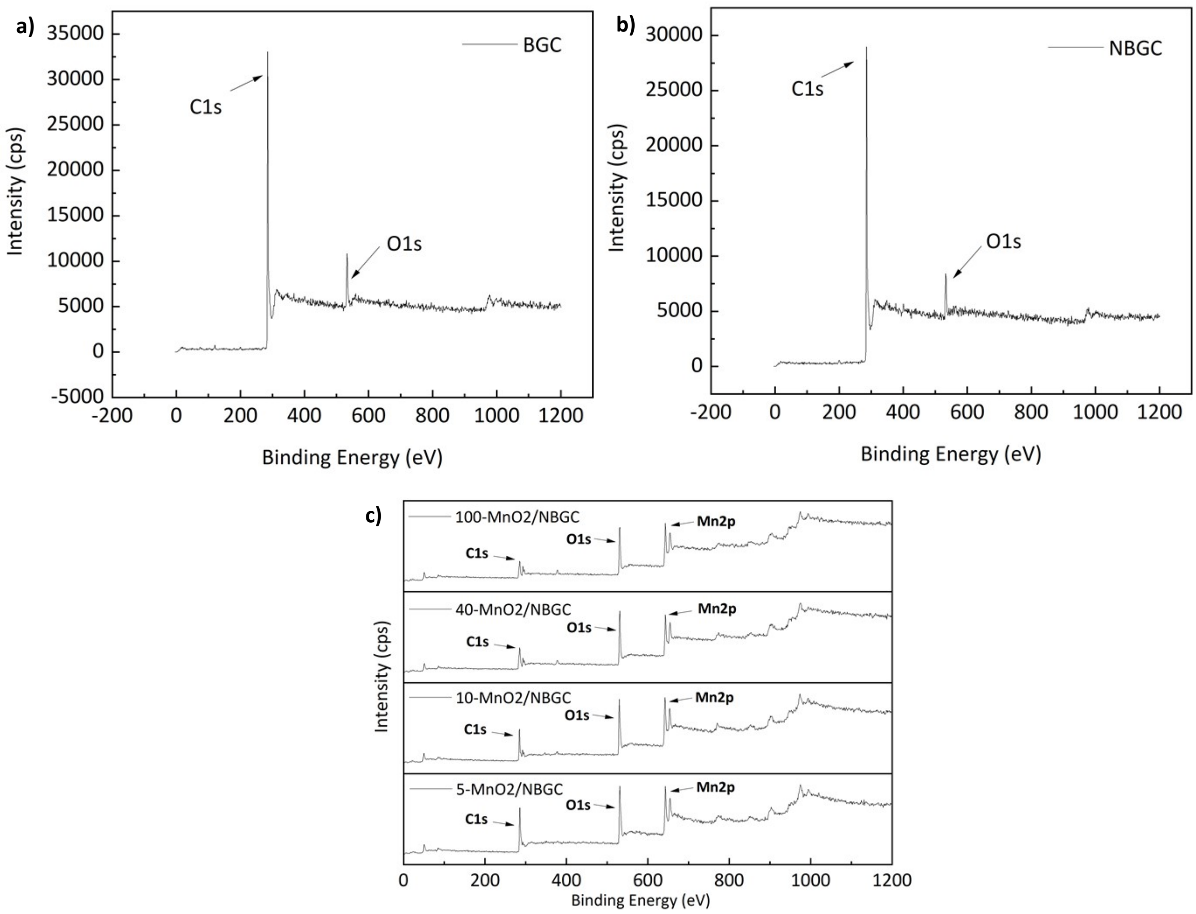

Figure S2. XPS scans of: a) bagasse-derived carbon material (BGC), b) N-containing bagasse-derived carbon material (NBGC), and c) MnO_2/NBGC composite with various MnO_2 loading concentrations

Table S1. Elemental analysis of the bagasse-derived carbon material and the composite with MnO_2 nanoparticles analyzed by electron dispersive spectroscopy and C H N analyzer

	EDS elemental mapping (wt%)						C H N analyzer (wt%)		
sample	**C**	**O**	**N**	**Mn**	**Cl**	**Ca**	**C**	**H**	**N**
BGC	91.84	6.68			1.48		58.56	0.69	0.43
NBGC	84.69	8.67	5.01		0.99		76.01	1.21	0.87
5-MnO_2/NBGC	70.05	18.23	6.15	4.75	0.17	0.65	65.85	1.42	0.77
10-MnO_2/NBGC	65.68	20.28	6.62	6.77	0.19	0.46	60.30	1.20	0.71
40-MnO_2/NBGC	44.24	33.06	1.86	20.39	0.21	0.24	38.82	1.28	0.47
100-MnO_2/NBGC	44.54	13.12	1.84	39.25	0.34	0.91	30.07	1.12	0.43

Table S2. Binding energies analyzed by X-ray photoelectron spectroscopy (XPS) of the bagasse-derived carbon material and MnO_2/NBGC composites.

peak position	**position BE (eV)**					
	BGC	**NBGC**	**5-MnO_2/NBGC**	**10-MnO_2/NBGC**	**40-MnO_2/NBGC**	**100-MnO_2/NBGC**
C1s	285	285	285	285	285	285
O1s	533	533	531	530	531	531
Mn2p			644	642	643	643
Mn2p3/2			643	643	642	642
Mn2p1/2			654	654	654	654

Part II. Electrochemical performance assessment

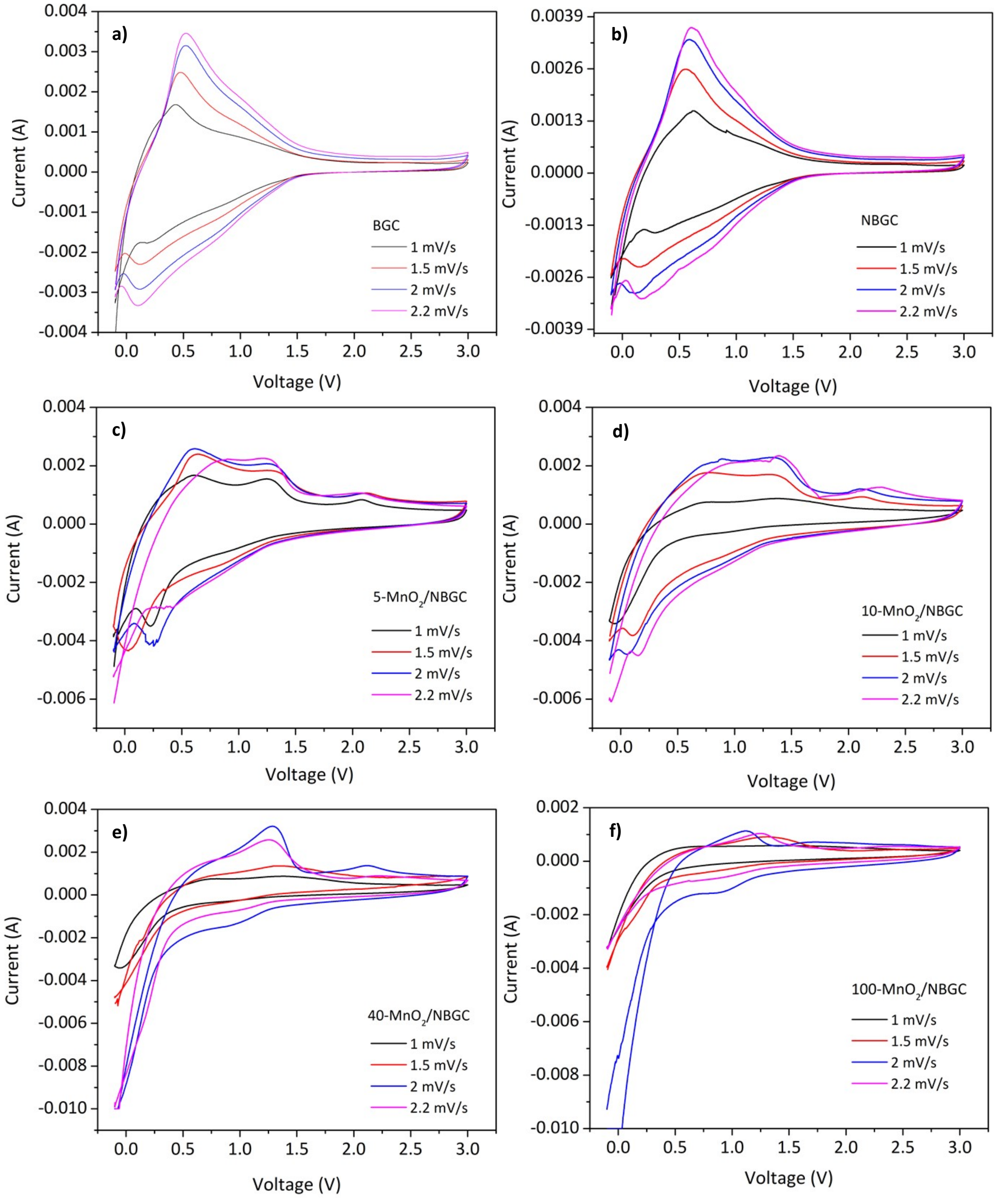

Figure S3. Cyclic voltametric scans (CVs) at various scan rates of: a) BGC, b) NBGC, c) 5-MnO_2/NBGC, d) 10-MnO_2/NBGC**,** e) 40-MnO_2/NBGC, f) 100-MnO_2/NBGC

S4. Energy density calculation

Energy density at the electrode level for the full cell including current collector can basically be approximated based on the following formulation[1].

$$\text{Full-cell gravimetric energy density} = \text{SE in material level} \times \text{Active material ratio} \times \frac{\text{Mass loading (cathode)}}{\text{Mass loading (Cathode+Anode)} + \text{Areal Weight (Al+Cu)foil}} \times \text{Nominal voltage}$$

In case of the LFP-the proposed 5-MnO_2/NBGC full-cell, the gravimetric energy density can be calculated as:

$$\begin{aligned}\text{LFP-5}MnO_2\text{/NBGC gravimetric energy density} &= 155\ \text{mAh/g}^{a} \times 80\%^{b} \times \frac{12.36\ \text{mg.cm}^{-2}}{(12.36^{c} + 12.36^{c})\ \text{mg.cm}^{-2} + (6.97^{d} + 1.77^{e})\ \text{mg.cm}^{-2}} \times 3.45^{f} - 0.45^{g}\ \text{V} \\ &= 137.42\ \text{Ah/kg}\end{aligned}$$

For the LFP-graphite full-cell, the gravimetric energy density can be calculated as:

$$\begin{aligned}\text{LFP-graphite gravimetric energy density} &= 155\ \text{mAh/g}^{a} \times 80\%^{b} \times \frac{12.36\ \text{mg.cm}^{-2}}{(12.36^{c} + 12.36^{c})\ \text{mg.cm}^{-2} + (6.97^{d} + 1.77^{e})\ \text{mg.cm}^{-2}} \times 3.45^{f} - 0.15^{h}\ \text{V} \\ &= 151.16\ \text{Ah/kg}\end{aligned}$$

Note: The nominal voltage of the full cell can be approximately calculated from the difference potential between the nominal voltages achieved from the half-cell testing of each anode and cathode electrode material relative to the Li/Li^+ metal. **a** is the theoretical capacity of LFP cathode based on ref.[1] **b** is the active material ratio within the electrode mixture that is typically prepared from active material of 80 wt%. **c** is the approximate mass loading of cathode and anode material based on ref.[2] **d** is the approximate arial weight of the common aluminum foil current collector. **e** is the approximate arial weight of the common copper foil current collector. **f** is the average plateau voltage from half-cell testing of LFP VS. Li/Li^+ based on ref.[3] **g** is the average plateau voltage from half-cell testing of 5MnO_2/NBGC anode VS. Li/Li^+ of this work. **h** is the average plateau voltage from half-cell testing of graphite anode VS. Li/Li^+ based on ref.[4]

References

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