Supplementary Information

Multifunctional nanoporous biocarbon derived from ginger: a promising material for CO_2 capture and supercapacitor

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Table S1: Synthesis conditions of non-porous carbon and porous activated carbon

S.No	Sample Name	Porous carbon synthesis		Sample Name	Activated carbon synthesis		Activation GPC:KOH (g)
		Temperature (°C)	Ramp/time		Temperature (°C)	Ramp/time	
1	GPC2	200	5 °C/2 h	GNBC2	800	5 °C/2 h	1:3
2	GPC3	300	5 °C/2 h	GNBC3	800	5 °C/2 h	1:3
3	GPC4	400	5 °C/2 h	GNBC4	800	5 °C/2 h	1:3
4	GPC5	500	5 °C/2 h	GNBC5	800	5 °C/2 h	1:3
5	GPC6	600	5 °C/2 h	GNBC6	800	5 °C/2 h	1:3

Table S2: Textural parameters and X-ray diffraction data of ginger-activated carbon.

S.No	Sample Name	SA_{BET} (m^2/g)	t-plot micropore area (m^2/g)	Pore volume (cm^3/g)	Micropore volume (cm^3/g)	Pore size HK method (nm)	XRD (002) peak position (2θ)	*d*-spacing (nm)
1	GNBC2	1426.1	1344.6	0.6638	0.5606	1.33	24.05	0.369
2	GNBC3	1328.5	1245.9	0.6215	0.5255	1.39	24.56	0.362
3	GNBC4	1915.9	1702.5	0.9723	0.7832	1.73	24.69	0.359
4	GNBC5	2140.4	1956.8	1.0438	0.8794	1.61	24.73	0.359
5	GNBC6	2330.6	2224.6	1.1017	0.9953	1.55	23.4	0.381

Table S3: Summary of XPS deconvolution

S.No	Sample Name	C 1s spectra			Composition from XPS (At.%)		Composition from EDS (At.%)	
		C-C	C-OH, C-O-C	COOH	Carbon (C 1s)	Oxygen (O 1s)	Carbon (C K)	Oxygen (O K)
1	GNBC4	284.3/51.31	285.5/18.54	288.6/30.15	94.38	5.62	96.95	3.05
2	GNBC5	284.3/45.38	285.2/23.01	288.3/31.61	94.29	5.71	96.44	3.56
3	GNBC6	284.2/52.57	285.2/24.02	288.2/23.41	93.24	6.76	95.93	4.07

Table S4: Comparison of specific capacitance of various waste-derived biomass carbon samples with GNBC

S.No	Biomass	Surface area (m^2/g)	Pore volume (cm^3/g)	Electrolyte	Specific capacitance (F/g)	Reference
1	N-BPPCF	1357.6	0.765	6M KOH	210.6/0.5 A/g	[1]
2	P-AC	1535.9	-	6M KOH	155/0.5 A/g	[2]
3	Banana Fibers (10% $ZnCl_2$)	1097	-	1M Na_2SO_4	74/0.5 A/g	[3]
4	N-APSB	1447.65	0.994	1M H_2SO_4	200/1 A/g	[4]
5	KOH-CG-700	1622.7	0.83	6M KOH	175/ 1 A/g	[5]
6	$DSAC_{1/2}$	180	0.093	1M KOH	178/1 A/g	[6]
7	EGS-900	2388.38	-	1 M KOH	150/ 1 A.g	[7]
8	CSC-700	2349.37	-	3M KOH	140 / 1A/g	[8]
9	HDPC	1582		6M KOH	180/ 0.5 A/g	[9]
10	GNBC6	2330.6	1.1017	3M KOH	244/0.5 A/g	**This work**

N-BPPCF-nitrogen-doped banana peel derived porous carbon, **P-AC**- peanut shell-derived porous activated carbon, **N-APSB** – nitrogen-doped peanut shell derived biochar, **KOH-CG-700** – KOH activated waste coffee grounds, **$DSAC_{1/2}$** – durian shell activated carbon, **EGS-900**- Eucalyptus globulus seeds derived activated carbon, **CSC-700** – corn stalk core derived activated carbon, **HDPC** – pomelo peel-derived porous carbon.

Table S5 Summary of CO_2 adsorption

Sample	Surface area (m^2/g)	Temperature (°C)	**CO_2 adsorption** (mmol/g)						
			1 bar	**2 bar**	**3 bar**	**4 bar**	**5 bar**	**10 bar**	**30 bar**
GNBC4	1915.9	0	2.65	4.39	5.83	7.02	8.04	11.92	20.1
GNBC5	2140.4	0	3.82	6.38	8.4	10.2	11.6	17.3	25.8
		10	2.98	5.13	6.9	8.39	9.67	14.5	24.1
		25	2.07	3.66	5.03	6.22	7.28	11.31	20.21
GNBC6	2330.6	0	4.87	7.52	9.37	10.79	11.9	15.73	21.7
		10	3.88	6.2	7.88	9.22	10.28	13.8	20.2
		25	2.65	4.46	4.46	5.9	8.01	11.435	17.74

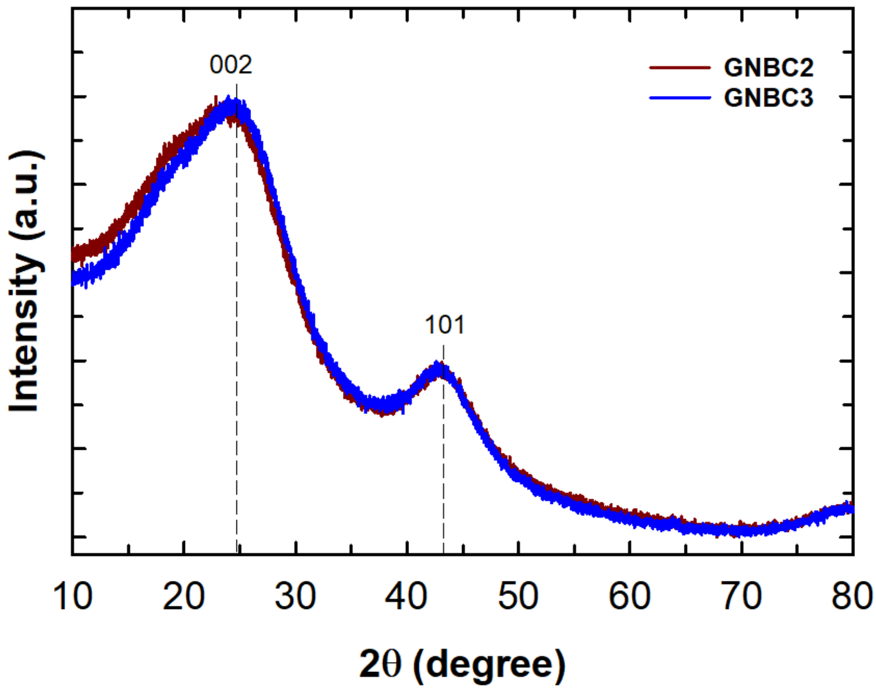

Figure S1: X-ray diffraction patterns of GNBC2 and GNBC3 samples.

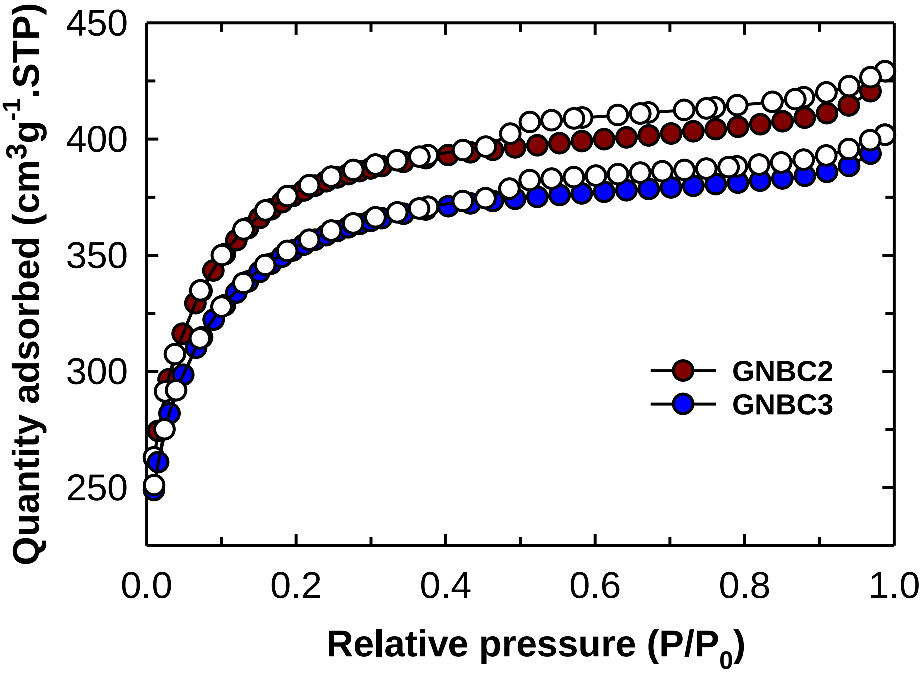

Figure S2: N_2 adsorption-desorption isotherms of GNBC2 and GNBC3 samples.

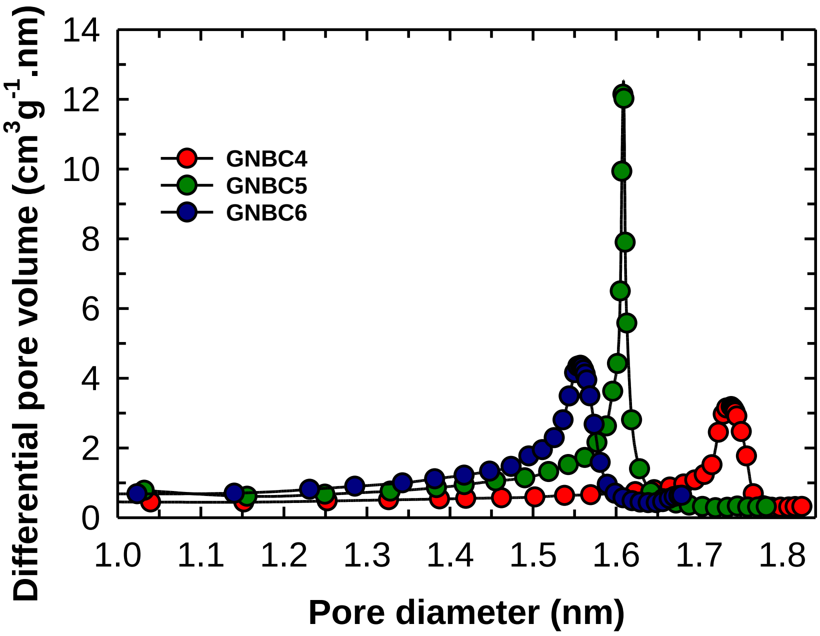

Figure S3: Pore size distribution using Horvath-Kawazoe (HK) method.

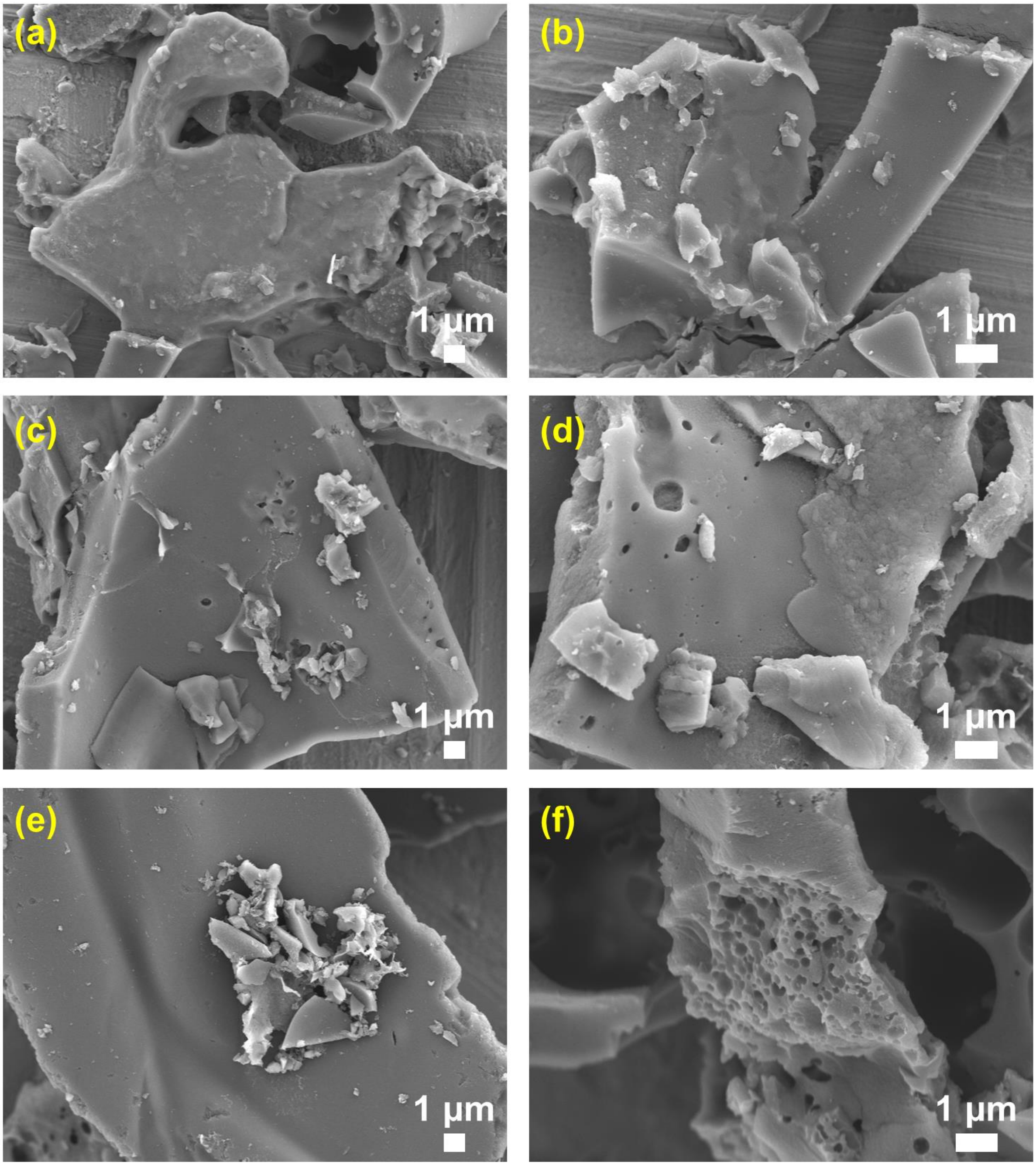

Figure S4: SEM images of (**a & b**) GNBC4, (**c & d**) GNBC5, and (**e & f**) GNBC6 samples.

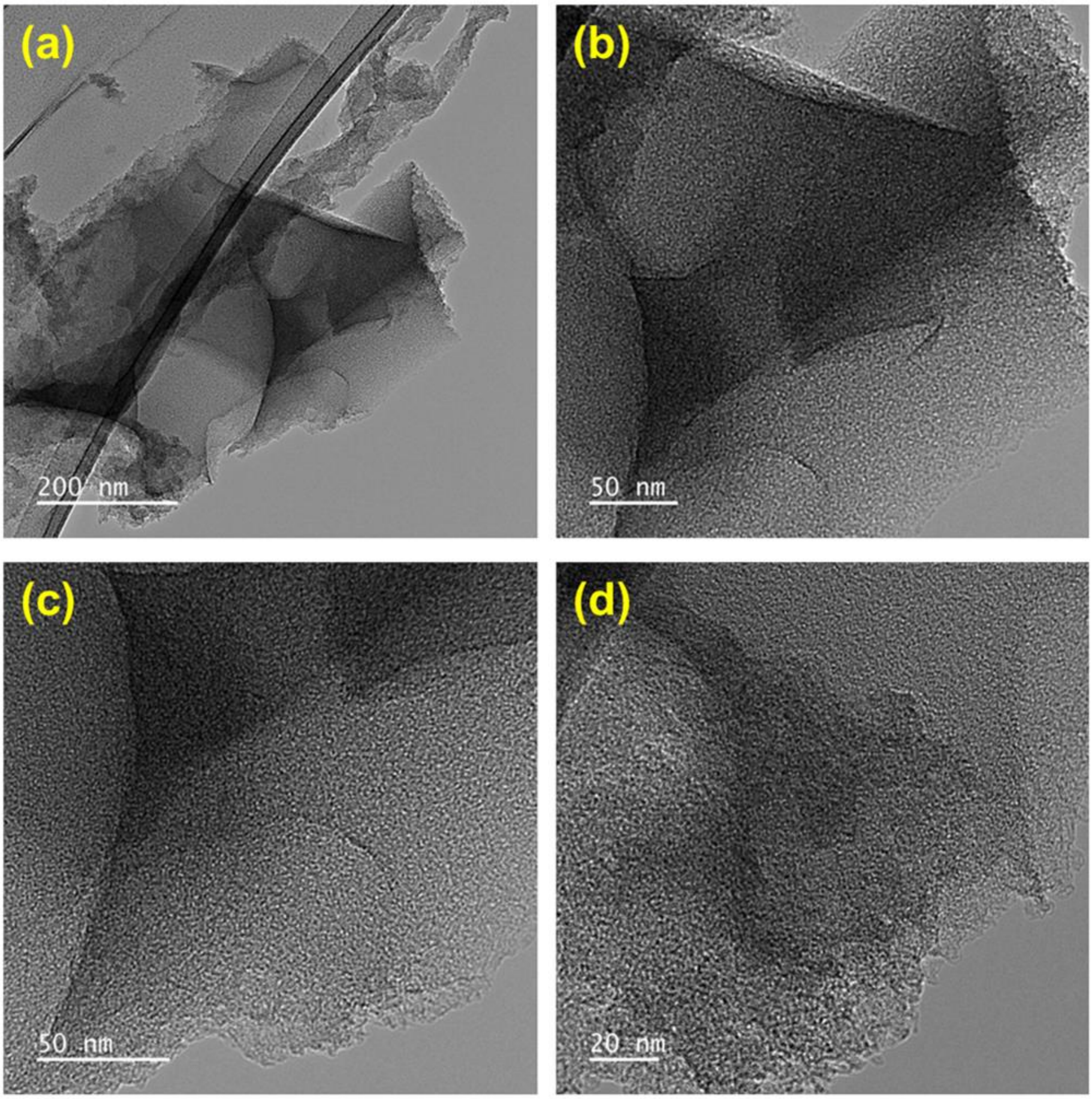

Figure S5: Low and high magnification TEM images of GNBC6 sample.

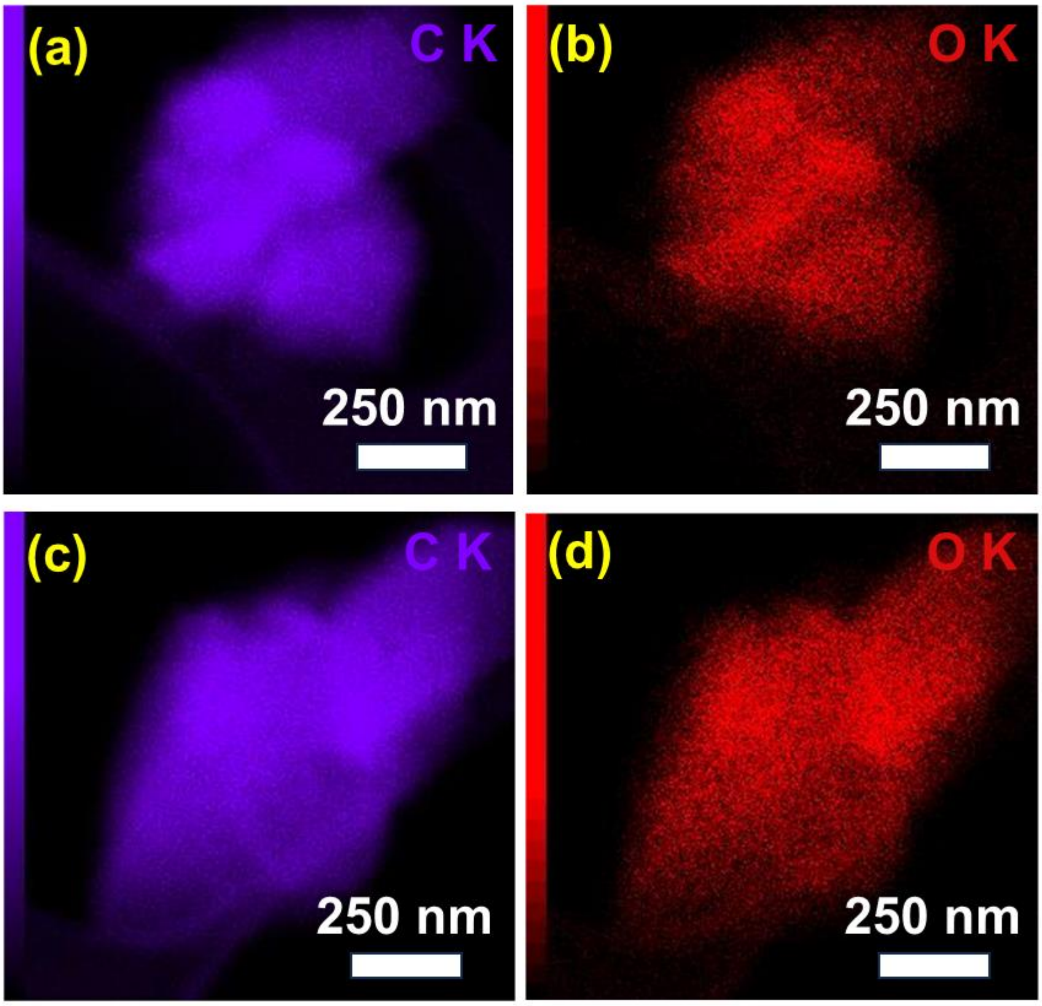

Figure S6: EDS mapping of (a & b) GNBC4, and (c & d) GNBC5 samples.

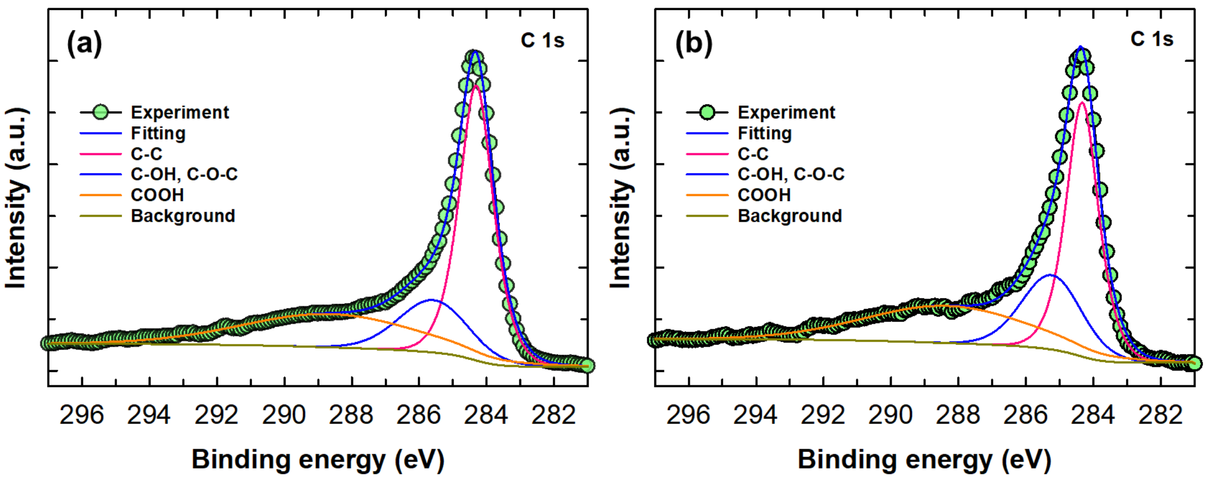

Figure S7: XPS C 1s spectral deconvolutions of (a) GNBC4, and (b) GNBC5 samples.

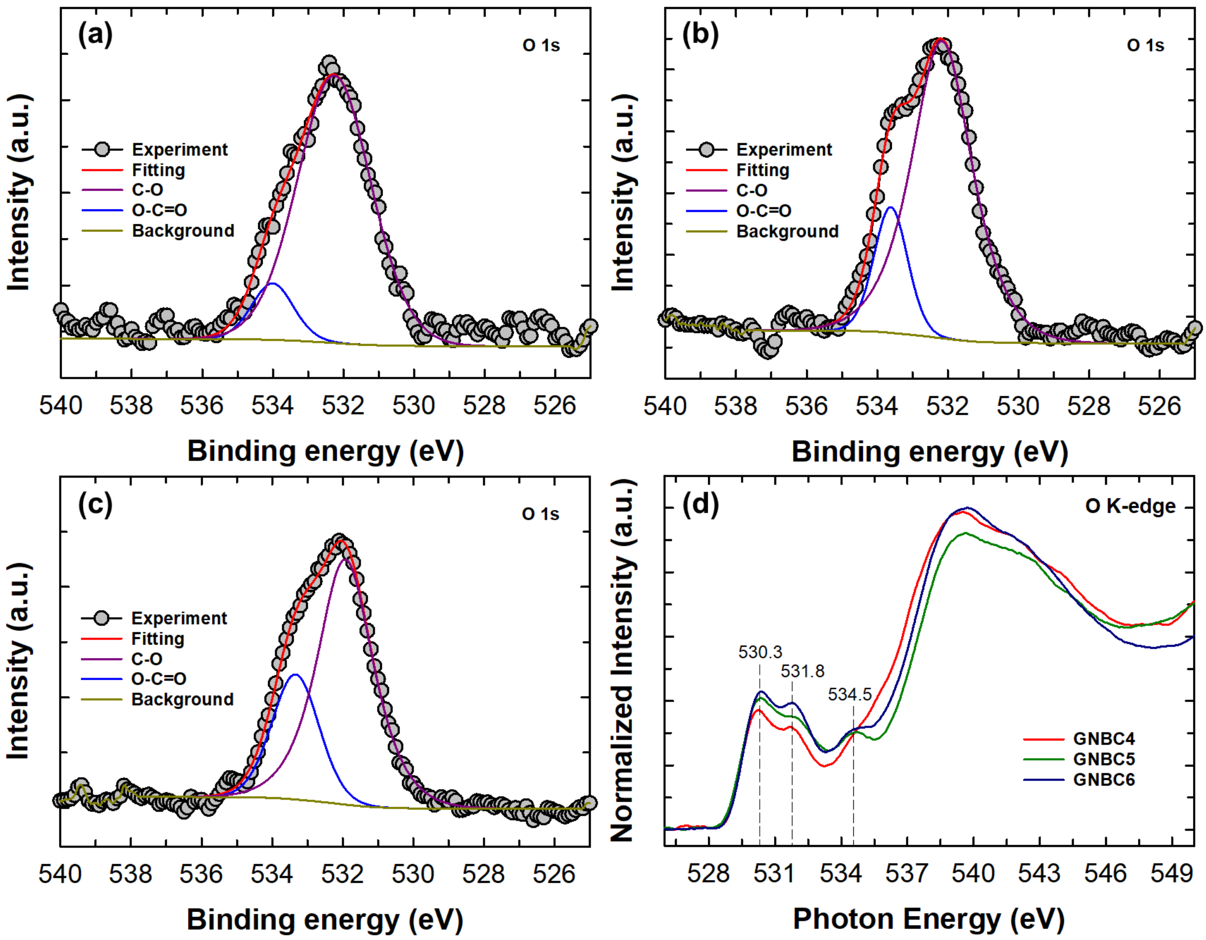

Figure S8: XPS O 1s spectral deconvolutions of (a) GNBC4, (b) GNBC5, & (c) GNBC6 and (d) C K-edge NEXAFS spectra of GNBC samples.

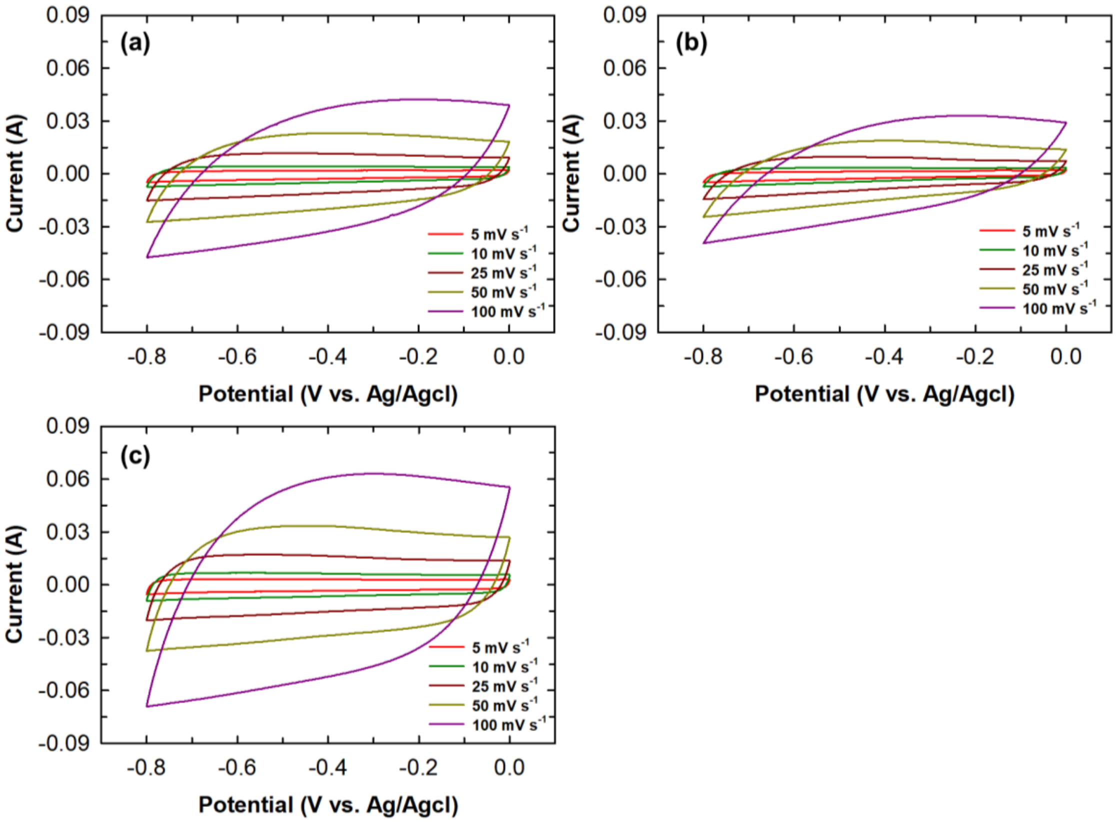

Figure S9: Cyclic voltammetry curves of GNBC samples measured at different current densities (a) GNBC4, (b) GNBC5 and (c) GNBC6.

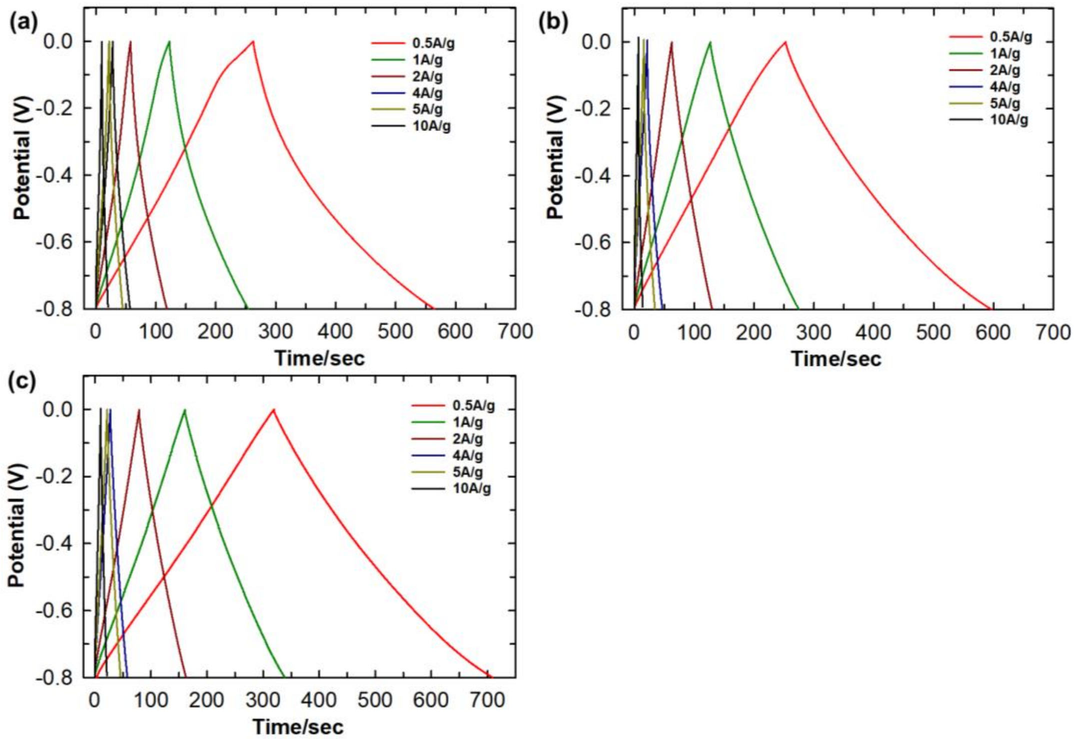

Figure S10: Charge-discharge profile of GNBC samples at different current densities of 0.5 to 10 A/g (a) GNBC4, (b) GNBC5 and (c) GNBC6.

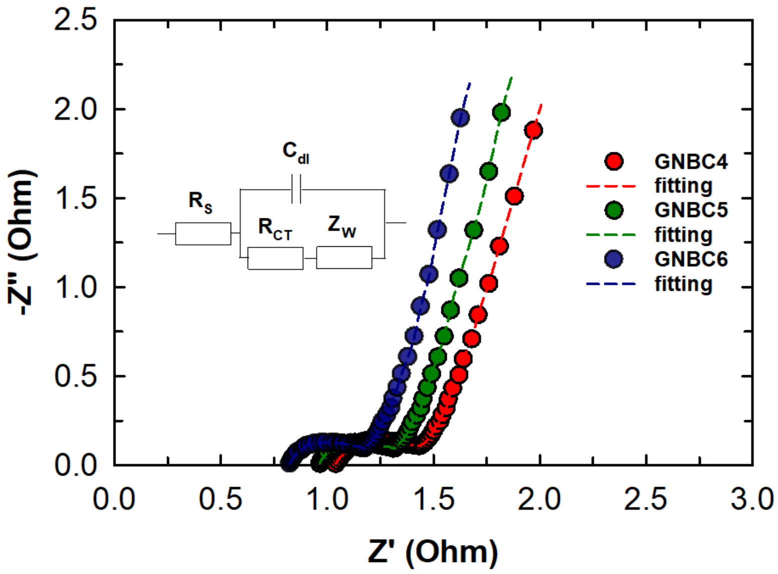

Figure S11: Three-electrode EIS of GNBC samples.

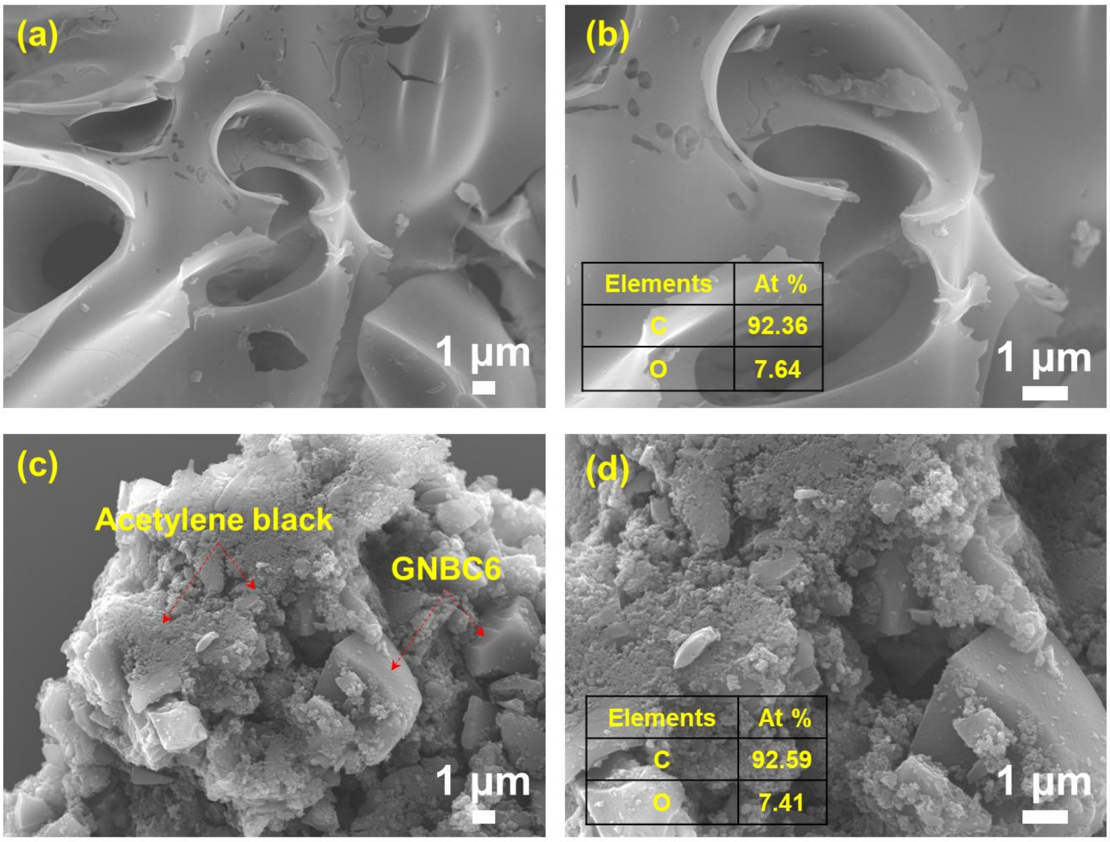

Figure S12: SEM images of GNBC6 sample (a & b) before and (c & d) after preparing electrode. Table insets on (b) and (d) are the EDS chemical compositions before and after preparing electrodes.

References:

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