**Supplementary Information**

**Effect of an activating agent on the physicochemical properties and supercapacitor performance of naturally nitrogen-enriched carbon derived from *Albizia procera* leaves**

**Amar K. Mohamedkhaira,b, Md. Abdul Aziza,\*, Syed Shaheen Shaha,b, M. Nasiruzzaman Shaikha, Anas Karrar Jamila, Mohammed Ameen Ahmed Qasem a,c, Ismail A. Buliyaminua,b, Zain H. Yamania,b**

a Center of Research Excellence in Nanotechnology (CENT), King Fahd University of Petroleum and Minerals, Dhahran, 31261, Saudi Arabia

b Physics Department, King Fahd University of Petroleum and Minerals, Dhahran, 31261, Saudi Arabia

c Chemical Engineering Department, King Fahd University of Petroleum and Minerals, Dhahran, 31261, Saudi Arabia

**S1 XPS analysis**

The compositional analysis of WANC and ZnNC samples were carried out using XPS analysis and described in Figure S1. The survey scans of WANC and ZnNC carbon are shown in Figure S1 (a) and (b), respectively. The quantitative test shows that the composition percentages are 61% for C 1s, 37% for O 1s, and 2% for N 1s in case of WANC sample, and 82% for C 1s, 15.5% for O 1s and 2.5% for N 1s in case of ZnNC sample. The Sn 3d peaks present in both figures are related to the substrate (FTO), used during the XPS analysis. Figure S1 (b) and (f) show the high-resolution XPS spectra for C 1s of WANC and ZnNC samples, respectively. In which, the deconvoluted peaks shown at 284.6, 285.6, and 288.1 eV are related to sp2 C-C and C=C graphitic carbon, C-O phenol or alcohol bonding, and N-C=O linkages, respectively (Bogdanowicz et al., 2014). O 1s high-resolution spectra of WANC and ZnNC samples are illustrated in Figure S1 (c) and (g). Both samples show binding energy peaks related to C=O group at 529.2 eV and C-O-C or C-OH group at 531.8 eV (Biniak et al., 1997; Hu et al., 2013). Figure S1 (d) and (h) show the XPS spectra for N 1s for WANC and ZnNC samples. The deconvoluted peaks centered at around 398.5, 400.3, and 402.4 eV are attributed to pyridinic, pyrrolic and /or pyridonic nitrogen (Goel et al., 2015; Lu et al., 2013; Wang et al., 2012).



**Figure S 1.** Figure S 1. XPS analysis of WANC (a-d) and ZnNC (e-h): Survey spectra (a, e) and corresponding high-resolution deconvoluted spectra of C 1s (b, f), O 1s (c, g), and N 1s (d, h). Insets of figure 1 a and e are the corresponding magnified views of N 1s zone.

**S2 Measurement of ECSA**

ECSA of NaNC was quantitatively estimated from the electrochemical-double-layer-capacitance (Cdl) of the catalytic surface. The ECSA is proportional to the Cdl and can be estimated from equation (S1) (Aziz et al., 2017; Deb Nath et al., 2019).

where, Cs is the electrochemical areal-specific capacitance, and its values are variable from few µF/cm2 to sub-mF/cm2, depending on the type of carbon materials (Aziz et al., 2017; Deb Nath et al., 2019). It is reported the value of Cs for nanosheets type multi-layered carbon materials is 0.076 mF/cm2 (Aziz et al., 2017). The slope of the plot in Figure S1b of the anodic current of the CVs (Figure S2a) at 0.4 V vs. scan rate is 104.6 mF which is equal to Cdl. The ECSA of NaNC was estimated by using equation (S1) with the above-mentioned values for Cs and Cdl. The NaNC-modified steel foil electrode exhibited significantly high ECSA of ca. 1376 cm2.



**(b)**

**(a)**

**Figure S2:** (a) CVs of NaNC in 1 M H2SO4 aqueous solution at different scan rates and (b) corresponding plot of anodic charging current vs. scan rate at 0.4 V.



**Figure S3:** Cycling stability of the NaNC electrode at 20 A g-1.



**Figure S4:** Ragone plot of the NaNC electrode from the GCD profiles.

**References**

Aziz, M. A., Theleritis, D., Al‐Shehri, M. O., Ahmed, M. I., Qamaruddin, M., Hakeem, A. S., Helal, A., & Qasem, M. A. A. 2017. A Simple and Direct Preparation of a Substrate‐Free Interconnected Nanostructured Carbon Electrode from Date Palm Leaflets for Detecting Hydroquinone. *ChemistrySelect, 2*(17), 4787-4793.

Biniak, S., Szymański, G., Siedlewski, J., & Świątkowski, A. 1997. The characterization of activated carbons with oxygen and nitrogen surface groups. *Carbon, 35*(12), 1799-1810.

Bogdanowicz, R., Sawczak, M., Niedzialkowski, P., Zieba, P., Finke, B., Ryl, J., Karczewski, J., & Ossowski, T. 2014. Novel functionalization of boron-doped diamond by microwave pulsed-plasma polymerized allylamine film. *The Journal of Physical Chemistry C, 118*(15), 8014-8025.

Deb Nath, N. C., Shah, S. S., Qasem, M. A. A., Zahir, M. H., & Aziz, M. A. 2019. Defective carbon nanosheets derived from syzygium cumini leaves for electrochemical energy‐storage. *ChemistrySelect, 4*(31), 9079-9083.

Goel, C., Bhunia, H., & Bajpai, P. K. 2015. Synthesis of nitrogen doped mesoporous carbons for carbon dioxide capture. *RSC advances, 5*(58), 46568-46582.

Hu, C., Liu, Y., Yang, Y., Cui, J., Huang, Z., Wang, Y., Yang, L., Wang, H., Xiao, Y., & Rong, J. 2013. One-step preparation of nitrogen-doped graphene quantum dots from oxidized debris of graphene oxide. *Journal of Materials Chemistry B, 1*(1), 39-42.

Lu, Z.-J., Xu, M.-W., Bao, S.-J., Tan, K., Chai, H., Cai, C.-J., Ji, C.-C., & Zhang, Q. 2013. Facile preparation of nitrogen-doped reduced graphene oxide as a metal-free catalyst for oxygen reduction reaction. *Journal of materials science, 48*(23), 8101-8107.

Wang, H., Maiyalagan, T., & Wang, X. 2012. Review on recent progress in nitrogen-doped graphene: synthesis, characterization, and its potential applications. *ACS Catalysis, 2*(5), 781-794.