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Abstract

Molten Base Carbonisation and Activation of Bamboo Shoots to Generate Capacitive Carbon †

Ishioma Laurene Egun [1,2,3], Di Hu [1,*], Haiyong He [2] and George Zhen Chen [4,*]

[1] Department of Chemical and Environmental Engineering, Faculty of Science and Engineering, University of Nottingham Ningbo China, Ningbo 315100, China; isiegun@yahoo.com
[2] Ningbo Institute of Materials Technology and Engineering, Chinese Academy of Sciences, Ningbo 315201, China; hehaiyong@nimte.ac.cn
[3] School of Biological and Chemical Engineering, NingboTech University, Ningbo 315100, China
[4] Department of Chemical and Environmental Engineering, Faculty of Engineering, University of Nottingham, Nottingham NG7 2RD, UK
* Correspondence: di.hu@nottingham.edu.cn (D.H.); george.chen@nottingham.ac.uk (G.Z.C.)
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Porous carbon with hierarchical pores has been produced from wet bamboo shoots via molten base carbonization and activation at 700 °C, with a short residence time of 1 h, using two different reactor configurations. The produced carbon exhibited a notable specific surface area (SSA) of 1198.47 m^2 g^{-1} from the vertical reactor (V-1) and a surface area of 1190.51 m^2 g^{-1} from the horizontal reactor (H-1), approaching that of the commercial YP50F (1425.89 m^2 g^{-1}). The SSA of derived carbon material is linked to abundant micropores developed during in situ carbon activation at elevated temperatures facilitated by KOH and the interaction of biomass components at room temperature. Also, elemental analysis revealed increased oxygen and nitrogen content in V-1 (27.04% and 2.74%, respectively) compared to H-1 (25.88% and 1.65%, respectively), and XPS analysis revealed different bond states for oxygen and nitrogen in V-1 compared to H-1. These differences in chemical composition were possibly influenced by reaction environments, compounds, and gases released during carbonisation, possibly affecting their behaviour towards eletrolytes. Further testing of derived carbons in an electrochemical double-layer capacitor showed that V-1 exhibited the highest specific capacitance (164.75 F g^{-1}) compared to H-1 (160.26 F g^{-1}) in an organic electrolyte (1 M $TEABF_4$/AN). This increased capacitance is attributed to its larger SSA, hierarchical pores, and increased oxygen and nitrogen content that enhances capacitance resulting from some reversible electro-adsorption processes that do not involve electron transfer. Both H-1 and V-1 carbons exhibited better capacitance compared to YP50F (143.08 F g^{-1}) and demonstrated cycling stability of 10,000 cycles with a capacity retention ability of 98 % at a specific current of 0.1 A g^{-1}, demonstrating their potential as an alternative electrode material. These results highlight the potential for achieving hierarchical porous carbon from wet biomass via a process route that saves both time and energy towards biomass to carbon conversion.

Supplementary Materials: The presentation materials can be downloaded at: https://www.mdpi.com/article/10.3390/proceedings2024105037/s1.

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