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Biomass-based nitrogen-doped carbon/polyaniline composite as electrode material for supercapacitor devices

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Abstract

Nitrogen-doped activated carbon (N-AC) was prepared from water hyacinth stems for loading polyaniline (PANI) by in-situ polymerization to synthesize N-AC/PANI composites for utilization as electrode materials in supercapacitors. Using potassium hydroxide as the activating agent, stems of water hyacinth were carbonized and activated in a single step to produce N-AC powders. Raman, FTIR, SEM, BET, TGA, and XPS techniques were used to characterize the resultant N-AC materials. The findings revealed that the N-AC materials had a porous structure and high specific surface area. Neat PANI was synthesized by varying the reaction time to 8, 16, and 24 h. During the reaction time of 16 h, the maximum specific capacitance was obtained. For the synthesis of N-AC/PANI composites, in-situ polymerization of aniline was performed for 16 h. Tests of cyclic voltammetry and galvanostatic charge/discharge were conducted on the electrode materials to assess their electrochemical performance for supercapacitors. Because of the synergistic effect of PANI and N-AC, the produced N-AC/PANI composite showed good supercapacitor performance compared with neat PANI and N-AC. In the case of the N-AC/PANI composite, the specific capacitance was determined by the electrochemical double-layer capacitance (EDLC) of N-AC and the pseudocapacitance resulting from the redox reaction of PANI.

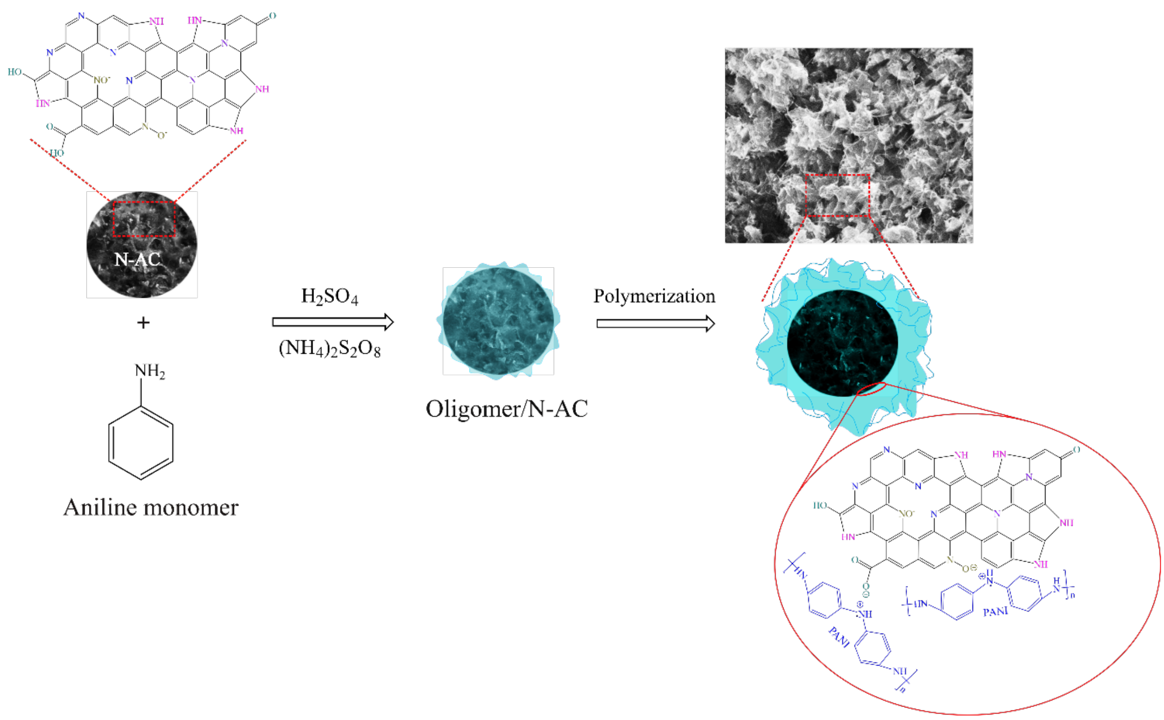

Figure S1. The mechanism of N-AC/PANI formation.

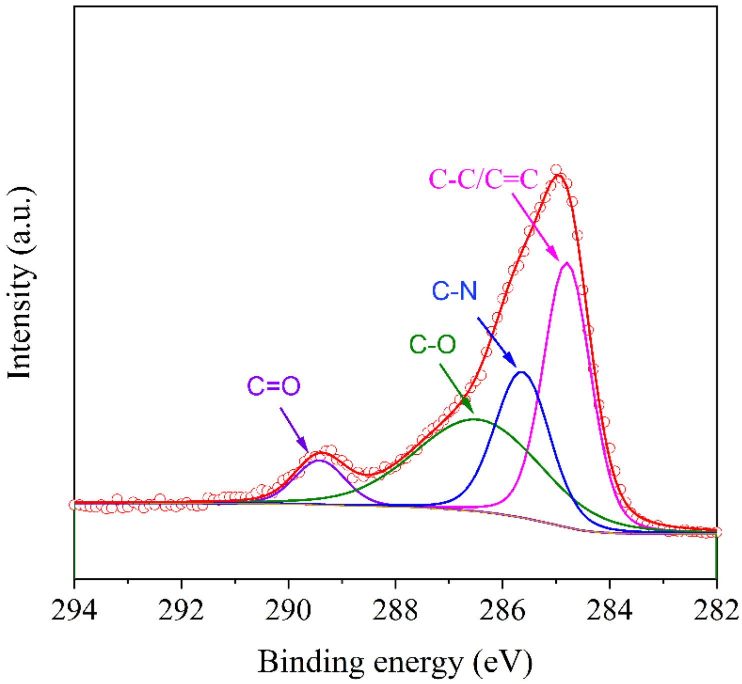

Figure S2. High-resolution XPS spectrum of C1s for N-AC.

Table S1. Comparison of the specific capacitance of the N-AC/PANI composite with previously reported electrode materials.

Electrode material	Electrolyte	Specific capacitance ($F \cdot g^{-1}$)	Ref
3D-rGO/PANI	1 M H_2SO_4	385 (0.5 $A \cdot g^{-1}$)	[45]
3D-rGO-PANI	1 M H_2SO_4	263 (0.1 $A \cdot g^{-1}$)	[46]
Graphene/CNT/PANI	1 M H_2SO_4	432 (0.5 $A \cdot g^{-1}$)	[47]
PANI-CNT nanofiber	1 M H_2SO_4	385 (0.5 $A \cdot g^{-1}$)	[48]
Pristine graphene/ PANI nanocone composite	1 M H_2SO_4	370 (0.5 $A \cdot g^{-1}$)	[49]
PANI/porous carbon spheres	1 M H_2SO_4	339 (1.0 $A \cdot g^{-1}$)	[8]
N-AC/PANI-16h	1 M H_2SO_4	431 (0.5 $A \cdot g^{-1}$)	This work