Biomass-derived activated carbon for High-Performance Supercapacitors Using V_2O_5 Mediated Redox Electrolytes

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Abstract

In recent years, biomass-derived 2D-like graphene materials have gained interest owing to their potential applications in energy storage [1]. However, to improve the storage performance, biomass-derived materials need to activate their porosity and the charge storage capacity of porous carbon materials, which mostly rely on non-faradaic electric double-layer mechanisms, can be significantly increased by adding a redox additive to the electrolyte that promotes faradaic reactions [2][3]. Biomass extracted from banana fiber was used to produce activated carbon. Vanadium pentoxide (V_2O_5) was used as a redox-active electrolyte additive with the electric double-layer capacitor (EDLC) electrode material to increase capacitance via reversible oxidation–reduction reactions. The activated carbon derived from banana fibers featured a hierarchical micro and mesoporous structure with a high specific surface area of approximately 2500 m^2 g^{-1}. GCD measurements carried out in non-redox and redox electrolytes were used to determine the specific capacitance. The results exhibit capacitances of nearly 450 F g^{-1} and 1050 F g^{-1}, for non-redox and redox electrolytes, respectively. Notably, the capacitance of the activated carbon derived from banana fiber improved (from 450 F g^{-1} and 1050 F g^{-1}) upon the introduction of the redox electrolyte and remained stable over 1000 charge/discharge cycles without significant degradation.

References

[1] Yucheng Zhou, Jiajun He, Ruoxi Chen, Xiaodong Li. Materials Today Sustainability, 18, (2022), 100138.
[2] M. Li, G. Sun, P. Yin, C. Ruan, and K. Ai. ACS Appl. Mater. Interfaces, 5 (2013)11462–11470.
[3] B. Akinwolemiwa, C. Peng, and G. Z. Chen. J. Electrochem. Soc.,162, (2015) 5054.

Figures

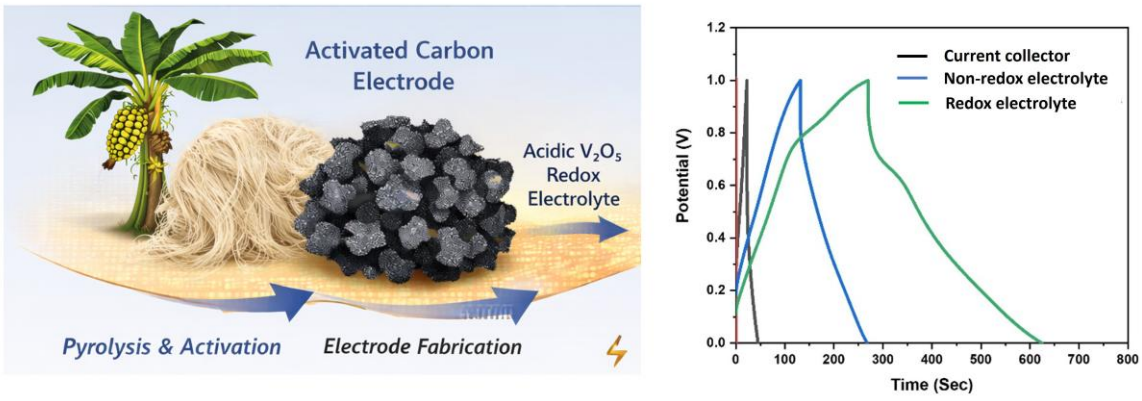

Figure 1: Schematic representation of biomass-derived activated carbon and its enhanced capacitance using non-redox and redox electrolyte.