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Coffee-driven green activation of cellulose and its use for all-paper flexible supercapacitors

Jae-Gyoung Gwon[1], Sun-Young Lee[1], Dong-Gue Lee[2] and Sang-Young Lee[2]
Morinomiya University of Medical Sciences, Japan

Cellulose, which is one of the most-abundant and renewable natural resources, has been extensively explored as an alternative substance for electrode materials such as activated carbons. Here, we demonstrate a new class of coffee-mediated green activation of cellulose as a new environmentally benign chemical-activation strategy and its potential use for all-paper flexible supercapacitors. A piece of paper towel is soaked in espresso coffee (acting as a natural activating agent) and then pyrolyzed to yield paper-derived activated carbons (denoted as EK-ACs). Potassium ions (K^+), a core ingredient of espresso, play a viable role in facilitating pyrolysis kinetics and in achieving a well-developed microporous structure in the EK-ACs. As a result, the EK-ACs showed significant improvement in specific capacitance (131 F g^{-1} at a scan rate of 1.0 mV s^{-1}) over control ACs (64 Fg^{-1}) obtained from the carbonization of a pristine paper towel. All-paper flexible supercapacitors are fabricated by assembling EK-ACs/carbon nanotube mixture-embedded paper towels (as electrodes), poly (vinyl alcohol)/KOH mixture-impregnated paper towels (as electrolytes) and polydimethylsiloxane-infiltrated paper towels (as packaging substances). The introduction of the EK-ACs (as an electrode material) and the paper towel (as a deformable and compliant substrate) enables the resulting all-paper supercapacitor to provide reliable and sustainable cell performance as well as exceptional mechanical flexibility. Notably, no appreciable loss in the cell capacitance is observed after repeated bending (over 5000 cycles) or multiple folding. The coffee mediated green activation of cellulose and the resultant all-paper flexible supercapacitors open new material and system opportunities for eco-friendly high-performance flexible power sources.

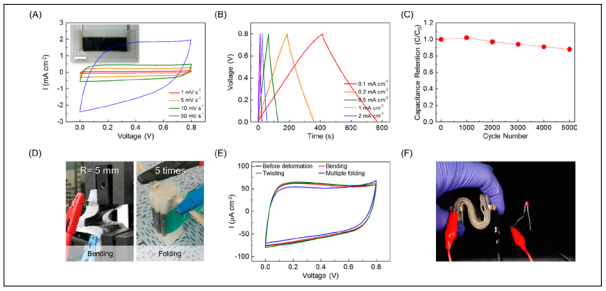

Figure-1: *Electrochemical performance and mechanical flexibility of solid-state all-paper supercapacitors.*

Recent Publications

1. S J Cho, Sun-Young Lee, et al. (2015) Hetero-nanonet rechargeable paper batteries: toward ultrahigh energy density and origami foldability. *Advanced Functional Materials*; 25: 6029- 6040.
2. K H Choi, Sun-Young Lee, et al. (2014) Heterolayered one-dimensional nanobuilding block mat batteries. *Nano Letters*; 14(1): 5677- 5686.

References

1. Y Gogotsi, et al. (2014) Energy storage wrapped up. *Nature;* 509: 568- 570.
2. X Wang, et al. (2014) Flexible energy storage devices: Design consideration and recent progress. *Advanced Materials*; 26: 4763-4782.

Biography

Jae-Gyoung Gwon has obtained his BS and MS in Chemical Engineering from University of Seoul, South Korea. He has further completed his PhD degree in Forest Products from University of Seoul and has worked as a Post-doctorate in National Institute of Forest Science. He has worked as a Research Scientist in National Institute of Forest Science. His specialized research areas are nanocellulose applications, polymer composites and chemical analyses.

gwonjg@korea.kr