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Towards Binder-Free and Self Supporting Flexible Supercapacitor from Carbon Nano-Onions and Their Composite with CuO Nanoparticles

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Abstract : Recognizing the upcoming era of carbon nanostructures and their revolutionary applications, we investigated the formation and supercapacitor application of highly pure and hydrophilic carbon nano-onions (CNOs) by economical one-step flame-synthesis procedure. The facile and scalable method uses easily available organic carbon source such as clarified butter, restricting the use of any catalyst, sophisticated instrumentation, high vacuum and post processing purification procedure. The active material was conformally coated onto a locally available cotton wipe by “sonicating and drying” process to obtain novel, lightweight, inexpensive, flexible, binder-free electrodes with strong adhesion between nanoparticles and porous wipe. This interesting electrode with CNO as the active material delivers a specific capacitance of 102.16 F/g, the energy density of 14.18 Wh/kg and power density of 2448 W/kg which are the highest values reported so far in symmetrical two electrode cell configuration with 1M Na2SO4 as an electrolyte. Incorporation of CuO nanoparticles to these functionalized CNOs by one-step hydrothermal method add up to a significant specific capacitance of 420 F/g with deliverable energy and power density at 58.33 Wh/kg and 4228 W/kg, respectively. The free standing CNOs, as well as CNO-CuO composite electrode, showed an excellent cyclic performance and stability retaining 95 and 90% initial capacitance even after 5000 charge-discharge cycles at a current density of 5 A/g. This work presents a new platform for high performance supercapacitors for next generation wearable electronic devices.

Keywords : binder-free, flame synthesis, flexible, carbon nano-onion
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