Novel Synthesis Route to CNT Fiber Hybrid for Li-Ion Supercapacitor Applications

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We report a novel synthesis process of binder-free, nitrogen-doped carbon nanotubes (CNTs) on CNT fibers combining a modified hydrothermal process with chemical vapor deposition (CVD). $Li_4Ti_5O_{12}$ (LTO) was selected as an active material to evaluate the performance of the obtained current collector electrode, which achieved 100% capacity retention after 1000 cycles at a 15C rate and a stable specific capacity of 144mAhg^{-1} at 5C. We also present here fabrication of an asymmetrical hybrid capacitor that exhibited a maximum specific energy of 0.296 mWhcm^{-2} at 0.172 mWcm^{-2} specific power. The device maintained specific capacitance of 0.0779 mWhcm^{-2} at a high specific power of 57.05 mWcm^{-2}. Moreover, the assembled supercapacitor exhibited a very stable cycling performance, retaining 100% of its specific energy after 2000 cycles at a current density of 4 Ag^{-1}. The increase in specific power, energy and cycling performance was attributed to the porous network afforded by the nitrogen-doped CNTs and their strong binding with the active material LTO. The porous network enabled short and fast lithium ion diffusion paths while the pristine CNT allowed for fast electron transfer all in a fiber format, making it attractive as an electrode for wearable energy storage devices.