Improving flexibility and capacitive charge storability in free-standing carbon nanofiber electrodes

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ABSTRACT

Energy storage devices with higher volumetric energies and power densities are crucial in delivering high electrochemical performances without being bulky. Herein, a flexible free-standing carbon nanofiber (CNF) electrode with and without graphene is derived from electrospun polyacrylonitrile nanofiber mesh. The embedded graphene enhanced the conductivity of the polymeric solution, generating significant "whipping" motion to create better fiber cross-linking that enhances the flexibilities of CNFs. Besides, the presence of graphene reduced the population of surface oxygenated functional groups when compared to the pristine CNF. Raman spectroscopy demonstrated lower defect states in graphene-embedded CNFs, favorable for better electrical conductivity. Both the reduced surface functional group and reduced impedance (1.0 Ω compared to 1.1 Ω of pristine CNF) show that a graphene-embedded CNF recorded improved rate capability compared to a pristine CNF. When fabricated into a symmetry supercapacitor, a volumetric energy density of ∼4 mWh cm^{-3} at a power density of ∼63 mW cm^{-3} was achieved, which is one of the highest reported values based on our knowledge.

KEYWORDS

Capacitive charges; Carbon nanofibers electrodes; Electrochemical performance; Electrospuns; Free standings; Pristine carbon; Storability; Volumetric energy densities; Volumetric power density

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