

A paradigm shift: Multifunctional Energy storing smart composite systems, innovation through nanotechnology and material sciences.

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Abstract

Carbon fibre (CF) reinforced epoxy composites are playing important role in a wide variety of civil and military applications because of their outstanding properties, ease of fabrication, low shrinkage after curing, and good thermal resistance. Currently, the focus is on developing smaller, smarter, and more efficient materials. One promising route is to fabricate multifunctional composites that act as structural material and exhibit at least one additional performance-linked function. Our goal is to create a structural material that simultaneously stores electrical energy within itself, by acting as a supercapacitor. We report the fabrication and performance of multifunctional composites based on chemically activated CF grafted with graphene nanoplatelets (GNPs) and iron selenide hedgehog nanoparticles (HPs), polymer electrolyte, and reinforcing separator. Various activation methods have been used to increase the surface area of the carbon fibres, and thus the electrical performance, without compromising the mechanical properties. Electrochemical tests including charge/discharge, cyclic voltammetry, impedance spectroscopy, chronocoulometric tests, and shear mechanical tests were done on the fabricated structural supercapacitors. The specific energy of structural supercapacitors was increased with the chemical activation of CF electrodes. Further, grafting of GNPs and HPs over the surface of CF led to the improved specific capacitance of the structural supercapacitors without deteriorating the mechanical performance. This study demonstrates a multifunctional CF reinforced polymer composite that can simultaneously store electrical energy, act as a supercapacitor, and bear mechanical loads, acting as a structural component. This novel concept development could potentially have significant mass and/or volume efficiencies for applications that utilize both structural components and energy storage devices.