Freestanding Carbon Nanofiber Electrodes Derived from Electrospun Polyacrylonitrile/ZIF-8 Composite for Supercapacitors

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Supercapacitors are energy storage devices that have very long lifecycles and high power densities; however, current commercial supercapacitors, which use activated carbon electrodes, have lower energy densities compared to batteries. The energy density of supercapacitors depends on the electrostatic interaction between the electrode and the electrolyte. A larger surface area between the electrode and electrolyte results in a higher energy density. In this project, Polyacrylonitrile (PAN) was incorporated into the electrode because of PAN's high carbon yield , which increases the supercapacitor' energy density. PAN nanofibers were created via electrospinning using common organic solvents such as dimethylacetamide (DMF). However, carbon nanofibers made from PAN have low surface area . To counteract this, ZIF-8 was added to the PAN electrode. The addition of ZIF-8 improves the energy density of the supercapacitor due to its porous nature. ZIF-8 was synthesized from zinc nitrate and 2-methylimidazole, and the reaction times of the two chemicals were varied to determine the smallest particle size to achieve large surface area. The resulting PAN/ZIF-8 mixtures were prepared in DMF with different ZIF-8 loadings to create a polymer solution. This solution was electrospun to make the carbon nanofiber electrodes used to create the new supercapacitors. The supercapacitors' voltage and current were measured using an Arbin instrument. The highest energy density obtained was 51 Wh/kg at a discharge rate of 1 A/g. The PAN/ZIF-8 supercapacitors had 21% higher energy density and 8% higher power density than a PAN supercapacitor and better performance than lithium batteries, which are the most commonly used energy devices today.

Awards Won:

Arconic Foundation: First Award of $5,000