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PEDOT: PSS/GO based supercapacitor for energy storage applications

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Traditional energy storage devices like batteries and capacitors suffer from low power and poor energy densities, highlighting the need for advancements in this field. Supercapacitors offer a promising alternative as the energy and power densities of supercapacitors are comparably high. In contrast with traditional capacitors the capacitance of the supercapacitors is in the order of farad (F), higher than the electrolytic capacitors (mF) and dielectric capacitors (μF). Especially composite supercapacitors integrating carbon-based materials with pseudocapacitive components like metal oxides or conducting polymers aim to enhance energy density while preserving high power density and long cycle life. Several attempts have been made previously using different combinations of the materials mentioned above. The primary aim of this study was to fabricate a supercapacitor using electrodes made of poly(3,4-ethylenedioxythiophene) polystyrene sulfonate and graphene oxide (PEDOT: PSS/GO) to demonstrate the electrochemical properties of the nanocomposite for energy storage applications. To prepare the electrodes of the supercapacitor, first, GO was synthesized using a modified Hummer's method. The electrode fabrication process involved depositing the PEDOT: PSS/GO nanocomposite onto a graphite sheet of dimension 1 cm × 2 cm via the drop-casting method. The supercapacitor assembly was achieved by placing filter paper soaked in a 6M potassium hydroxide (KOH) solution between two electrodes made from a composite of PEDOT: PSS and GO on a graphite base. The resulting supercapacitor exhibited a specific capacitance of 18.84 F g^{-1}, with an energy density of 0.65 Wh kg^{-1} and a power density of 29.2 W kg^{-1}, as determined from the galvanostatic charge-discharge (GCD) curve data at a current of 0.5 mA. When ascorbic acid was added to the nanocomposite, the specific capacitance dropped to 13.04 F g^{-1}, with an energy density of 0.45 Wh kg^{-1} and a power density of 14.44 W kg^{-1}. This indicates that the supercapacitor without ascorbic acid achieves the highest specific capacitance. The CV results further demonstrated that despite the presence of a polymer, the absence of visible redox peaks shows that the supercapacitor operates as an electric double-layer capacitor (EDLC).

Keywords: Conducting Polymer, Graphene Oxide, Hybrid Supercapacitor, Power Density