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APROTIC ELECTROLYTE AND REDUCED GRAPHENE OXIDE ELECTRODES-BASED SUPERCAPACITORS, PERFORMANCE DEPENDENCE ON CURRENT COLLECTORS

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Supercapacitors (SCs) offer rapid charging and discharging capabilities, making them ideal for applications requiring frequent, high-power bursts of energy. Compared to batteries, their relatively low energy density (E_g) limits the suitability of SCs for long-term energy storage. Reduced graphene oxide (rGO) serves as a promising electrode material for SCs due to its high surface area, excellent electrical conductivity and chemical stability. The choice of current collector material significantly influences the performance of rGO-based SCs. The present study investigated the performance of SCs with current collector materials, fluorine-doped tin oxide (FTO) and Copper (Cu). However, since Cu current collectors are difficult to use along with protic solvent electrolytes due to their high reactivity, aprotic solvent electrolytes were used. The synthesis of rGO from natural graphite was achieved through the modified Hummers method, starting with the oxidation of graphite powder using a mixture of 98% concentrated sulfuric acid, potassium permanganate and sodium nitrate. The subsequent reduction of graphene oxide (GO) was obtained by adding hydrogen peroxide. To fabricate the electrodes for the SC, rGO was dispersed in dimethylformamide together with titanium dioxide (TiO_2), which acts as the binder. The resulting rGO/TiO_2 suspension was coated onto conductive substrates, FTO and Cu, followed by solvent evaporation to obtain an rGO layer on each substrate and compare the electrode performance. Synthesised Graphite Powder, GO, rGo and rGO/TiO_2 electrodes were analysed using XRD spectra. The SCs were prepared using the electrolyte based on the saturated solution of Lithium trifluoromethanesulfonate dissolved in an ethylene carbonate and propylene carbonate mixture at a 1:1 molar weight ratio along with the two electrodes. The specific capacitance (C_{sp}) of rGO-based SCs was higher with the Cu current collector compared to that of FTO at all scan rates. The highest C_{sp} values were observed at a scan rate of 2 mV/s, with Cu reaching 65.70 F/g and FTO at 59.04 F/g. The E_g and power density (P_g) of rGO-based SCs were also higher with Cu current collectors compared to FTO at all current densities. The highest E_g value was 3.36 Wh/kg with Cu at 0.5 mA/cm^2, while the highest P_g value was 20,001.79 W/kg with Cu at 5.0 mA/cm^2. These results demonstrated that Cu current collectors with aprotic solvent electrolytes are more suitable for SC applications compared to FTO current collectors.

Keywords: Current collector, Energy density, Power density, Reduced graphene oxide, Specific capacitance