PEDOT: PSS/GO based Three Electrode Photo Supercapacitor to Harness Light Energy and Storage

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The potential use of photo-powered energy storage devices in smart electronics has attracted a lot of attention due to the emerging power crisis in the world. Therefore, a device capable of simultaneous energy harvesting and storage is crucial. This effort involved the fabrication of a photo-supercapacitor comprising three electrodes. A dye-sensitized photoanode and two graphite electrodes coated with poly(3,4-ethylenedioxythiophene) polystyrene sulfonate and graphene oxide (PEDOT: PSS/GO) were utilized as the three electrodes. In the fabrication process of the device, a gel polymer electrolyte was integrated between a five-layer TiO_2-based photoanode and the middle electrode, as the dye-sensitized solar cell (DSSC). The middle and counter electrodes of the supercapacitor were separated by a filter paper soaked with KOH. The bifunctional middle electrode, which serves as both an electrode for the supercapacitor and a counter electrode for the DSSC to allow electrolyte regeneration, was a double-sided coated electrode based on PEDOT: PSS/GO. Also, a comparison was conducted between PEDOT: PSS/GO and PEDOT: PSS/GO/Ascorbic acid-based photo supercapacitors. Ascorbic acid was added as a dispersing as well as GO-reducing agent. Before the assembly of the hybrid device, the DSSC, and the supercapacitor were analyzed separately. The performance of the fabricated photo supercapacitor was then evaluated under a light intensity of 1000 W m^{-2}. The photo supercapacitor utilizing PEDOT: PSS/GO-based middle and counter electrode was able to achieve a power conversion efficiency of 1.14%, open circuit voltage (V_{oc}) of 0.66 mV, current density (J_{sc}) of 4.35 mA cm^{-2}, a fill factor (*FF*) of 0.40 and a specific capacitance of 3.22 F g^{-1}. The PEDOT: PSS/GO nanocomposite optimized the electrical double layer capacitance provided by individual GO sheets and the photo capacitive contribution of redox-active PEDOT: PSS. The results show that the photo convertibility, *FF*, and V_{oc} are higher in PEDOT: PSS/GO system compared to the ascorbic acid-based system.

Keywords: Photo-Supercapacitor, Dye-Sensitized Solar Cells, Symmetric Supercapacitor, PEDOT: PSS/GO Nanocomposite