Performance stability of solid-state polypyrrole-reduced graphene oxide-modified carbon bundle fiber for supercapacitor application

ABSTRACT

The stability performance of a solid-state polypyrrole-reduced graphene oxide (PPy-rGO) supercapacitor electrode after a series of charging-discharging cycles is investigated. The electrochemical performances show that the capacity retention, specific capacitance, equivalent series resistance, and charge transfer resistance all decrease after charging-discharging cycles. Thermogravimetric analysis shows the degradation of electroactive materials, causing decreased electrochemical performance of PPy-rGO. The morphology changes reveal that the pore size is reduced by ∼12 μm at the 1000th charge-discharge cycle, which limits the diffusion of electrolyte ions into the electrode. The positive shifts in the binding energy of the N1s spectra at the 500th and 1000th charge-discharge cycles indicate the formation of a hydrogen-bridge bond, affecting the electron transfer in the PPy-rGO composite as observed through X-ray photoelectron spectroscopy. Moreover, the structural properties of rGO change from amorphous to graphitic after a series of charging-discharging processes, as shown by the Raman spectra. Furthermore, the peak of the NH bending vibration is red-shifted by approximately 108 cm−1, indicating the changes in the chemical environment after a series of charging-discharging cycles, as shown by Fourier transform infrared spectroscopy.

Keyword: Graphene; Polypyrrole; Supercapacitor; Stability