Graphene-Nickel Cobaltite Nanocomposite Asymmetrical Supercapacitor with Commercial Level Mass Loading

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Abstract

A high performance asymmetric electrochemical supercapacitor with a mass loading of 10 mg cm^{-2} on each planar electrode is fabricated by using graphene-nickel cobaltite nanocomposite (GNCC) as a positive electrode and commercial activated carbon (AC) as a negative electrode. Due to the rich number of faradaic reactions on the nickel cobaltite, the GNCC positive electrode shows significantly higher capacitance (618 F g^{-1}) than graphene-Co_3O_4 (340 F g^{-1}) and graphene-NiO (375 F g^{-1}) nanocomposites synthesized under identical conditions. More importantly, graphene greatly enhances the conductivity of nickel cobaltite and allows the positive electrode to charge/discharge at scan rates similar to commercial AC negative electrode. This improves both the energy density and power density of the asymmetric cell. The asymmetric cell composed of 10 mg GNCC and 30 mg AC displayed an energy density in the range of 19.5 Wh kg^{-1} with an operational voltage of 1.4 V. At high sweep rate, the system is capable of delivering an energy density of 7.6 Wh kg^{-1} at a power density of about 5,600 W kg^{-1}. Cycling results demonstrate that the capacitance of the cell increases to 116% of the original value after the first 1,600 cycles due to a progressive activation of the electrode, and maintains 102% of the initial value after 10,000 cycles.