Abstract

In this research work, we synthesized Carbon-based Transition Metal Oxide nanocomposites for energy storage applications, which consist of two parts:
In the 1st part of research work, we examined the electrochemical characteristics of asymmetric supercapacitors, consisting of a positive electrode material made of CoMoO4/rGO/PANI (CMORP) and a negative electrode material made of activated carbon (AC). The CMORP nanocomposite was prepared via a simple hydrothermal approach. The prepared CMORP nanocomposite was tested using several physicochemical techniques such as Raman spectroscopy, field emission scanning electron microscopy (FESEM), X-ray photoelectron spectroscopy (XPS), and X-ray diffractometer (XRD). The CMORP demonstrated a remarkable specific capacity of 630 C g-1 in a 3-electrode arrangement carried out in a 3M KOH aqueous media. The constructed CMORP //AC asymmetric supercapacitor exhibited a specific capacity of 350 C g-1, an energy density of 96 W h kg-1, with a current density of 1.4 A g-1. The device exhibited exceptional cyclic stability, maintaining over 97% of its initial capacitance after 10,000 cycles at 6 A g-1 current density. This composite electrode has the potential to dramatically enhance the capabilities of flexible electronics, wearable tech, and electronic products.
2nd part of this research work employed the formation of NiMoO4 (NMO), NiMoO4/ rGO (NMOR) and NiMoO4/rGO/PANI nanocomposite known as NMORP. The NMORP nanocomposite has a maximum specific capacity of 1150 C g-1 at 1 A g-1. The actual capacity retention percentage was found to be 97.5% after 5,000 cycles at a high current density of 10 A g-1. The investigated characteristics was attained due to the combined action of the structural and material properties of the NMORP nanocomposite. The improved structural stability and long cyclability of the NMORP nanocomposite electrode can be attributed to the 2D-2D coupling occurring at the interface between rGO and NMO nanosheets and the stable 3D architecture resembling hydrangea flowers. Moreover, the NMORP composite greatly affects the other samples concerning charge transfer and ion diffusion due to an increased level of conductivity and of the pores, which varies between 10 and 20 nm. The NMORP//AC supercapacitor thus has an energy density of 82.43 Wh kg-1 , which is quite impressive for a battery of 850 W k. In addition, it offers excellent cyclic stability, measured at 94.5% of its original capacity, if it was charged/discharged at the current density of 10 A g-1 for a total of 10,000 cycles.