Three dimensional graphene composite electrodes for electrochemical applications

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Abstract

In the emerging field of energy storage technology, the development of efficient energy storage devices with both high energy and power densities is highly desirable. The performance of these devices is closely related to material properties used for the fabrication of the device[1–3]. In our work few-layers graphene was synthesized on a nickel foam template by chemical vapour deposition (CVD). The resulting three-dimensional (3D) graphene was loaded with metal oxides (MnO_2) nanostructures using hydrothermal techniques coupled with microwave irradiation. The composites were characterized and investigated as electrode material for electrochemical capacitors. Raman spectroscopy measurements performed on both 3D graphene and the composite material show that the 3D graphene network consisted of mostly few layers, while structural and morphological characterization, performed with X-ray diffractometry (XRD) and scanning electron microscopy (SEM), respectively, reveal the presence of the MnO_2 in the 3D architecture. The electrochemical characterizations including cyclic voltammetry (CV), constant current experiment (charge-discharge) and long term cycling (stability) using a 6 M KOH aqueous electrolyte show that the composite electrodes materials exhibit excellent properties as a pseudocapacitive material with a high specific capacitances value of 305 Fg^{-1} at a current density of 1 Ag^{-1}, with 84% retention of the initial capacitance after 1000 cycles in a three electrode configuration, while a symmetric coin cell devices exhibited a specific capacitance of 240 Fg^{-1}, maximum energy and power densities of 8.3 $Whkg^{-1}$ and 20 Wkg^{-1} with no capacitance loss after 1000 galvanostatic discharge cycles. These results demonstrate that composites made using 3D graphene are versatile and show considerable promise as electrode materials for electrochemical applications.

References

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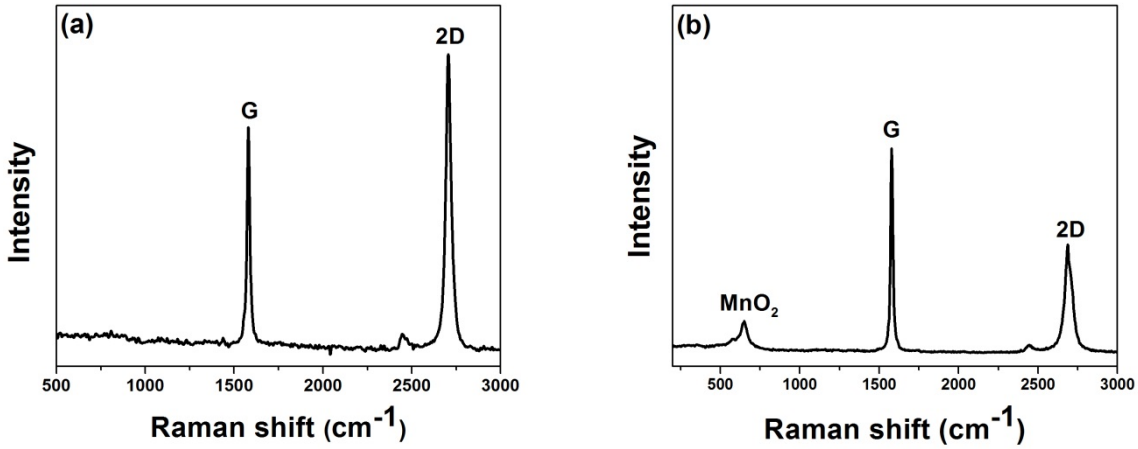
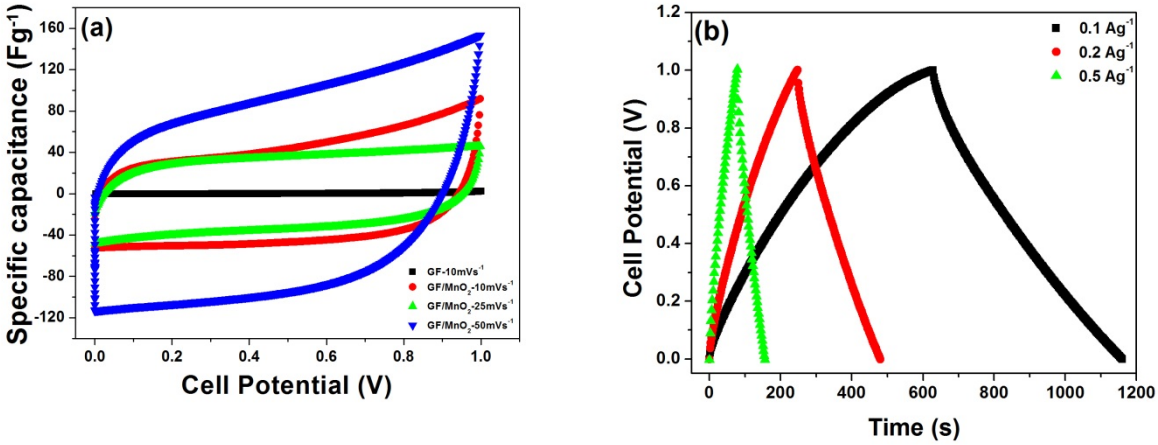
Figures



Raman spectra of (a) the 3D graphene and (b) composite of 3D graphene and MnO_2



Electrochemical performance of the composite electrode material (a) CV and (b) CD