Highly Nanoporous Graphene-Based Composites for the Next Generation Energy Storage/Conversion Devices

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Abstract

Because of the rapid fossil fuel consumption along with the environmental issues, there is an urgent exploration for high-performance and affordable clean energy devices. It is of a great interest to synthesize nano-structural materials of high gravimetric energy density and low energy depletion at high current for applications in modern energy devices. Although intensive researches have been set forth to study the electrochemical properties of the materials, their favourable structures are less studied in terms of energy delivery and repetitive use. Owning to their large specific surface areas, high electrical conductivities and stable thermal, chemical and mechanical properties, nanocarbons such as carbon nanotubes and graphene have been studied as a backbone for *in situ* nano-architecture development of the active materials in recent years. In this work, the hierarchically nano-porous graphene-based composites were prepared by a novel method of two-step hydrothermal annealing. The morphological and porous structures of the samples were characterized with field emission scanning electron microscopy, transmission electron microscopy and nitrogen adsorption/desorption at 77 K. The electrochemical properties of the materials were studied with cyclic voltammetry and galvanostatic charge–discharge measurements. Due to the large specific surface area, morphologically favorable nanostructures for mass storage and transfer and the interconnected electrical conduction pathways of graphene network, the nanocomposites exhibited extraordinary energy density as well as high-performance of oxygen evolution reaction. The results demonstrate the significance of structural innovations in graphene-based materials for the next generation energy storage/conversion devices.