One-step synthesis of $Co(OH)_2$/graphene nanocomposites from graphite for electrochemical supercapacitors

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Electrochemical supercapacitors (ESs) are attractive energy storage devices because of their high power density, long cycle life (>100,000 cycles), and rapid charging-discharging rates. ESs can be applied in various applications, including consumer electronics, memory back-up systems, industrial power, energy management, public transportation, military devices, and so on. There is increasing interest in the development of advanced electrode materials having high specific surface areas and conductivity. Various materials have been investigated as an electrode in ESs, including carbon materials, conducting polymers, and transition metal oxides.

Among these materials, metal oxides typically have several redox states or structures and contribute to the charge storage in pseudocapacitors via fast redox reactions. But single metal oxides usually have some limitations such as poor electrical conductivity, insufficient electrochemical cycling stability, limited voltage operating window and low specific capacitance. It has been reported that compounds of carbon materials such as carbon nanotube, graphene, graphite materials, and metal oxide composites such as $Ni(OH)_2$ nanoplates grown on graphene sheets, Co_3O_4/graphene, and MnO_2/graphene composite, have superior capacitive performance to single transition metal oxides. However, most graphenes have been synthesized by reducing chemically exfoliated graphene oxide (GO) using a reducing agent. Due to the loss in oxygen-containing groups of GO after chemical reduction, the reduced GO leads to aggregate between GO layers. This re-stacking disturbs the access of electrolyte ions to the surface of the reduced GO as well as the decrease in surface area. To resolve the restacking problem of the graphene, it has also been reported on graphene-based composites with various structures such as $Ni(OH)_2$, Mn_3O_4, MnO_2 and Co_3O_4 nanoparticles.

In this work, a direct and simple method to fabricate graphene-based nanocomposites from graphite in water for precluding the re-stacking of GO reduction was developed. The shape of the synthesized $Co(OH)_2$ on the graphene surface have very thin nanosheets. The synthesized samples were characterized by transmission elec-tron microscopy (TEM), powder X-ray diffraction (XRD), and BET. In addition, the electrochemical analyses were made using cyclic voltammetry and galvanostatic charge-discharge tests.

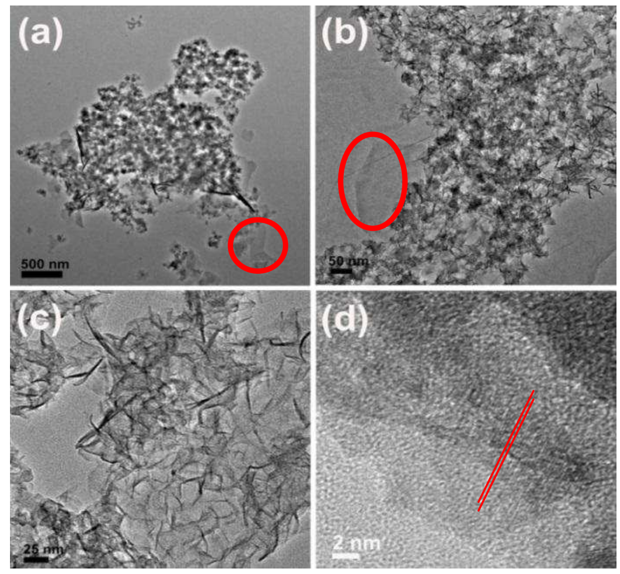

Figure 1. TEM images of $Co(OH)_2$/graphene nanocomposites. Red circles show graphene. High- resolution TEM image in (d) represents that the lattice distance is 0.236 nm.

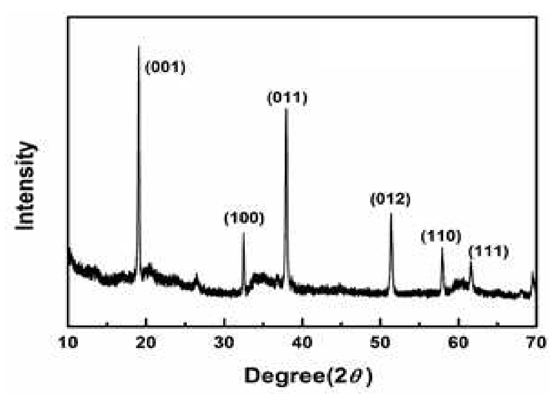

Figure 2. XRD pattern of $Co(OH)_2$/graphene nanocomposites.