Preparation of graphene and its composites with MnO$_2$ for supercapacitors by Thermal Reduction

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Supercapacitors, the promising energy-storage devices with high power densities, environment-protection and long cyclic lives, have drew considerable attention and develop rapidly. But it has relatively low energy density which is affected by electrode material. Graphene (GN) which has advantages of high specific surface area and conductivity, manganese dioxide which has advantages of high specific capacity, low price and is environmental friendly, make themselves the ideal supercapacitor electrode materials. In this paper, graphene and its composites will be prepared by thermal reduction and the electrochemical performance of them on different temperature will be studied. In 1 mol/L sodium sulfate, the specific capacity of the thermal reduced graphene at 300 $^\circ$C in air atmosphere can be up to 54 F/g. At 150 $^\circ$C, the specific capacity of GN/MnO$_2$ which prepared by thermal reduction can be up to 175 F/g.

1. Experiments
1.1 Preparation of graphene (GN)
Preparate graphite oxide (GO) by modified Hummers $^{[1, 2]}$, and then prepare GN by heating GO at 300 $^\circ$C for 2 h.

1.2 Preparation of GN/MnO$_2$ composites
Firstly prepare graphene oxide by ultrasonicing GO solution for 1 h. Secondly add MnSO$_4$·H$_2$O solution into the graphene oxide solution, and stir it well. Thirtly, pour KMnO$_4$ solution into the solution above, stir it well too, keeping MnSO$_4$·H$_2$O and KMnO$_4$ mole ratio of 3:2. Finally heat the compositis at 200 $^\circ$C for 1 h after washing and drying.

2. CV curve of GN and GN/MnO$_2$
The cyclic voltammograms test curve of GN and the composites is shown in figure 1 (a) (b) respectively. The scanning speed were 10 mV · s$^{-1}$, 20 mV · s$^{-1}$, and 50mV · s$^{-1}$, its potential window is 0 ~ 0.8 V. They are approximate rectangular in 1 mol · L$^{-1}$ sodium sulfate solution, demonstrating that the material has good electrochemical performance. GN specific capacity is 54 F/g, the compound specific capacity is 175 F/g when the current density is 100 mA/g.

3. Micrograph of GN and GN/MnO$_2$
We can see that the thermal reduced graphene has a very thin layer structure from Fig2(a), in Fig(b) manganese dioxide evenly distributed on the surface of graphene, and present as a bar.

Reference: