Incorporation of Manganese Dioxide within few-layer graphene from expandable graphite for supercapacity

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1. Introduction

Supercapacity, also known as ultracapacitors or electrochemistry capacity, is of practical interest due to their high power electrical energy storage and exceptionally long cycle life; Manganese Dioxide as a kind of pseudocapacitors, which depends on the fast and reversible redox reactions at the electrode surface for charge storage, is a promising materials for supercapacity for usage of electric vehicles (EV) and hybrid-electric vehicles (HEV). Despite its properties of the low-cost, relatively environmentally benign properties, and high theoretical specific capacitance (~1380 F/g)[1] have attracted much attention, the problems of poor electrical conductivity and low mass surface-loading in a planar ultrathin configuration[2-4] are to be solved, which limit large-scale commercialization of MnO_2.

2. Method

Expandable graphite is a mature product, which is much cheaper than graphene from chemical deposition vapor (CVD) method or reduction of graphene oxide. In this report, we adopted a facile method to produce few-layer grapheme (FLG) from expandable graphite with sonication in the isopropyl alcohol, then followed by acid-treatment and washed several times with ethanol. With the oxidation reduction between potassium permanganate and ethanol[5] , Manganese Dioxide was rapidly deposited on the few-layer graphene for Supercapacity. As a comparsion, the bare MnO_2 was synthesized without FLG added.

3. Results

The test result of MnO_2/FLG composite was illustrated in Figure 1. In comparison, the performance of bare MnO_2 without FLG was exhibited as reference.

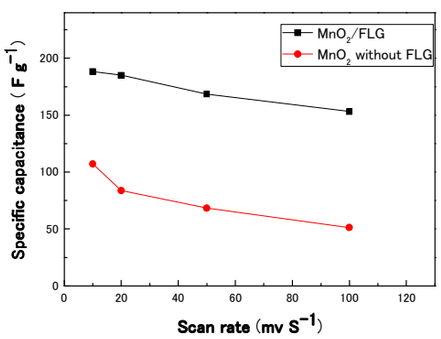

Figure1. Specific capacitance (based on the composite) at different scan rates in 1 M Na_2SO_4solution.

As shown in the Figure 1, the composite of MnO_2/FLG yielded much higher specific capacitance than that was achieved by the bare MnO_2 without FLG at different scan rate. Due to the FLG added provides large surface for the deposition of MnO_2, the phenomenon of agglomeration of MnO_2 was avoided and the interfacial contact between the active particles of MnO_2 and the surrounding electrolyte was enhanced.

The MnO_2/FLG composites exhibited a specific capacitance of 188 F g^{-1} at 10 mv s^{-1} in 1 M Na_2SO_4 electrolyte, whereas, the specific capacitance value by using bare MnO_2 without FLG only reached to 107 F g^{-1}. Furthermore, when both electrodes show gradually decreased capacitance with the increase of the scan rate, the specific capacitances by utilizing MnO_2/FLG composite were 185 F g^{-1}, 168 F g^{-1},153 F g^{-1} at 20 mv s^{-1}, 50 mv s^{-1}, and 100 mv s^{-1}, respectively, proving increasing electrochemically active surface area accessed by electrolyte. As a comparsion, specific capacitance of bare MnO_2 reduced to 83.9 F g^{-1},68.4 F g^{-1},51.3 F g^{-1}, respectively.

Reference

[1]. M. Toupin, T. Brousse and D. Bélanger, *Chemistry of Materials*, 2004, **16**, 3184-3190.
[2]. T. M. McEvoy, J. W. Long, T. J. Smith and K. J. Stevenson, *Langmuir*, 2006, **22**, 4462-4466.
[3]. N. Nagarajan, H. Humadi and I. Zhitomirsky, *Electrochimica Acta*, 2006, **51**, 3039-3045.
[4]. K.-W. Nam and K.-B. Kim, *Journal of the Electrochemical Society*, 2006, **153**, A81-A88.
[5]. C.-Y. Chen, C.-Y. Fan, M.-T. Lee and J.-K. Chang, *Journal of Materials Chemistry*, 2012, **22**, 7697-7700.