

## **Supplemental Information**

### **The assembly of aqueous rechargeable magnesium ions battery capacitor: the nanowire Mg-OMS-2/Graphene as cathode and activated carbon as anode**

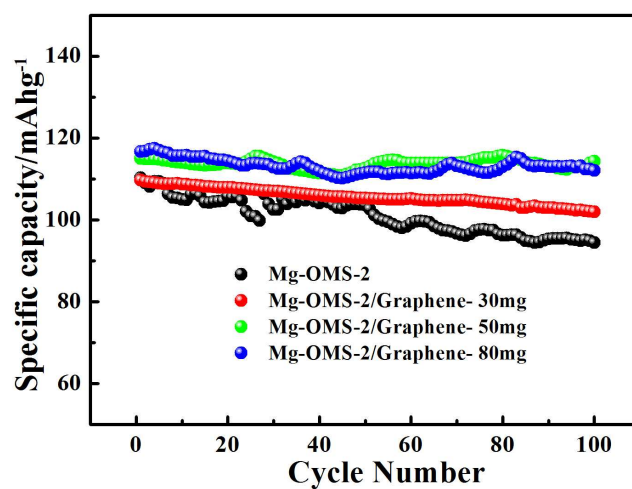
Hongyu Zhang, Ke Ye\*, Kai Zhu, Ruibai Cang, Xin Wang, Guiling Wang, Dianxue  
Cao\*

*Key Laboratory of Superlight Materials and Surface Technology of Ministry of  
Education, College of Materials Science and Chemical Engineering, Harbin  
Engineering University, Harbin, 150001, P.R. China*

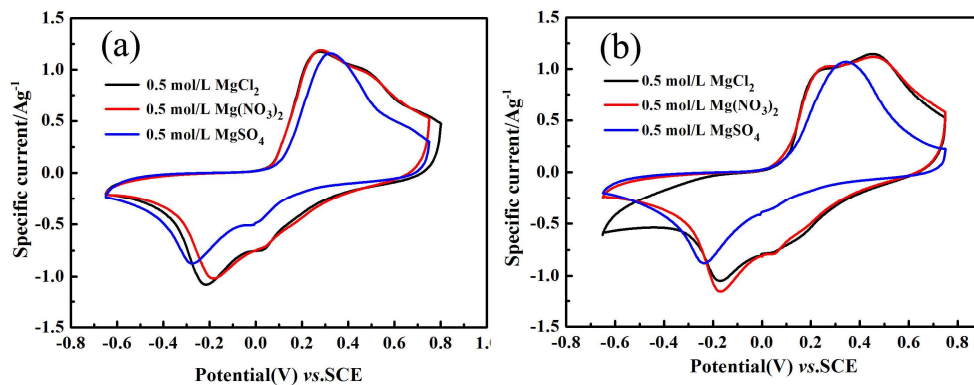
#### **Corresponding Authors:**

E-mail addresses: yeke@hrbeu.edu.cn (K. Ye); caodianxue@hrbeu.edu.cn (D. Cao)

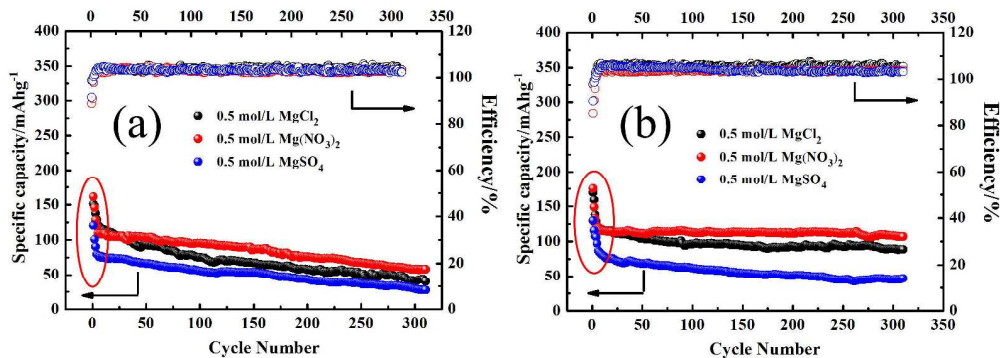
Supplemental Information consists of four figures over five pages.



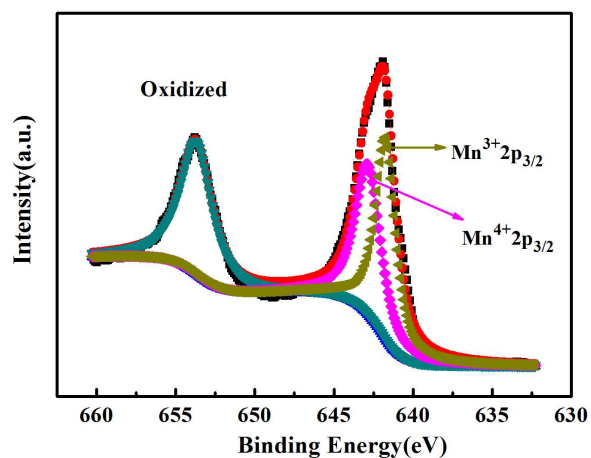
**Figure S1** The cycle performance of different amount of graphene in composites at  $100 \text{ mA g}^{-1}$  in  $0.5 \text{ mol dm}^{-3} \text{ Mg}(\text{NO}_3)_2$ . It is obvious that Mg-OMS-2/Graphene-30mg has little effect for improving the electrochemical performance, the Mg-OMS-2/Graphene-50mg and Mg-OMS-2/Graphene-80mg both have a better improvement in electrochemical performance. So, the optimum amount of Graphene is 50 mg, which uses to prepare the Mg-OMS-2/Graphene composite in this work.



**Figure S2** The cyclic voltammograms (CVs) of Mg-OMS-2 (a) and Mg-OMS-2/Graphene (b) electrodes at  $1 \text{ mV s}^{-1}$  in  $0.5 \text{ mol dm}^{-3}$   $\text{MgCl}_2$ ,  $\text{Mg}(\text{NO}_3)_2$  and  $\text{MgSO}_4$ . At the lower scan rate, these two electrodes show two couples of redox peaks distinctly, which are in good line with the changed valence of Mn.



**Figure S3** Cycle performance of Mg-OMS-2 (a) and Mg-OMS-2/Graphene (b) electrodes at  $100 \text{ mA g}^{-1}$  in  $0.5 \text{ mol dm}^{-3}$   $\text{MgCl}_2$ ,  $\text{Mg}(\text{NO}_3)_2$  and  $\text{MgSO}_4$ . This is the original file for cycle performance of these two electrodes. The Figure S3 shows the activation data for the first 10 cycles (in red oval) in cycling performance. The tunnel structures of Mg-OMS-2 and Mg-OMS-2/Graphene as we prepared need activation step. It is clearly seen that after the first 10 cycle tests, the electrodes reach a relatively stable process. It can also comprehend that after 10 cycles measurements, the stable, closed to straight line is the really battery performance of Mg-OMS-2 and Mg-OMS-2/Graphene. And the first 10 cycles exhibit the performance of capacitor, namely, the Mg-OMS-2 or Mg-OMS-2/Graphene firstly adsorbs the magnesium ions at the surface which reach the saturation state, and then, the magnesium ions begin to insert into the body phase. So, the first 10 cycles are not the battery performance, which should be cut off.



**Figure S4** XPS patterns of Mn 2p core level spectra of oxidized electrode. This result shows that the percentage of  $\text{Mn}^{3+}$  and  $\text{Mn}^{4+}$  are calculated to be 48.1% and 51.9% by fitting this XPS data. Comparing with the fresh electrode with percentage of 54.6%  $\text{Mn}^{3+}$  and 45.4%  $\text{Mn}^{4+}$ , a part of  $\text{Mn}^{3+}$  transforms to  $\text{Mn}^{4+}$  after the charged process.