

## Supporting Information

**Na-Mn-O@C yolk-shell nanorods with ultrahigh electrochemical performance for lithium ion batteries**

*Jiannian Li, Jun Yu, Ibrahim Saana Amiin, Jie Zhang, Jinzhi Sheng, Zongkui Kou, Zhe Wang, Qiang Yu, Liqiang Mai, and Shichun Mu\**

J. Li, Prof. J. Yu, I. S. Amiin, J. Zhang, Z. Kou, Z. Wang, Prof. S. Mu

State Key Laboratory of Advanced Technology for Materials Synthesis and Processing,  
Wuhan University of Technology, Wuhan 430070, China

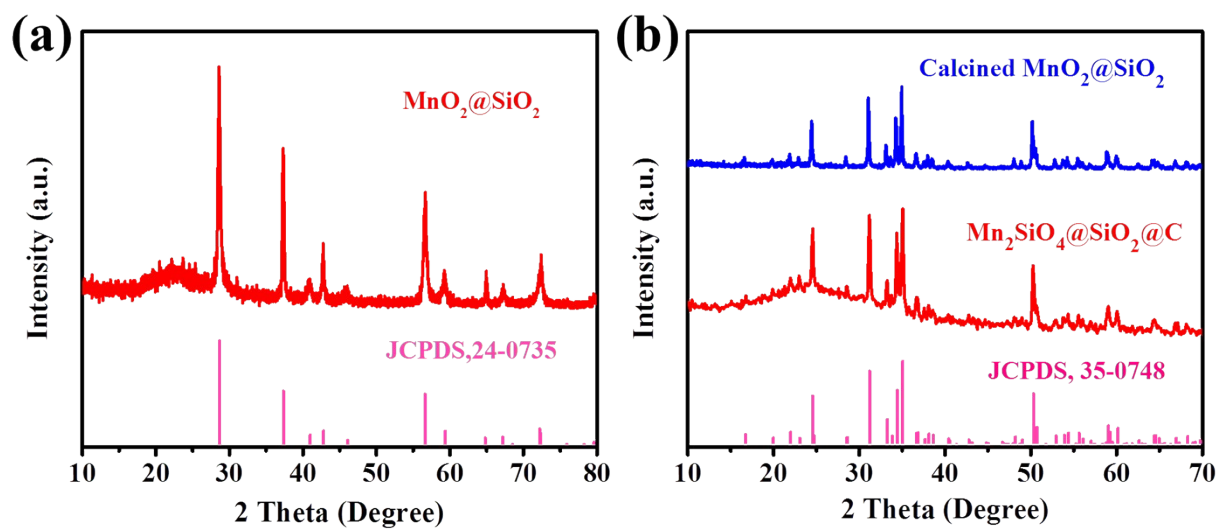
\*E-mail: [msc@whut.edu.cn](mailto:msc@whut.edu.cn).

Q. Yu, J. Sheng, Prof. L. Mai

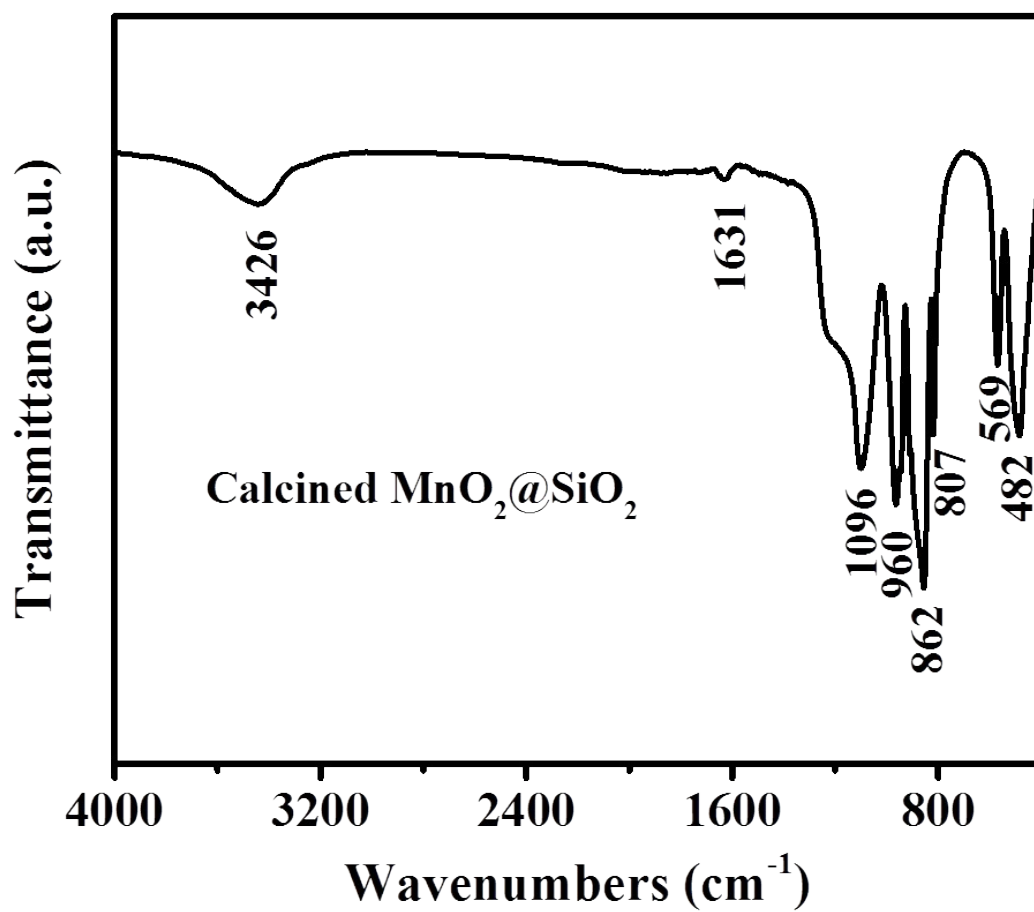
WUT-Harvard Nano Key Laboratory, Wuhan University of Technology, Wuhan 430070,  
China

**Preparation of MnO<sub>2</sub> nanorods:**

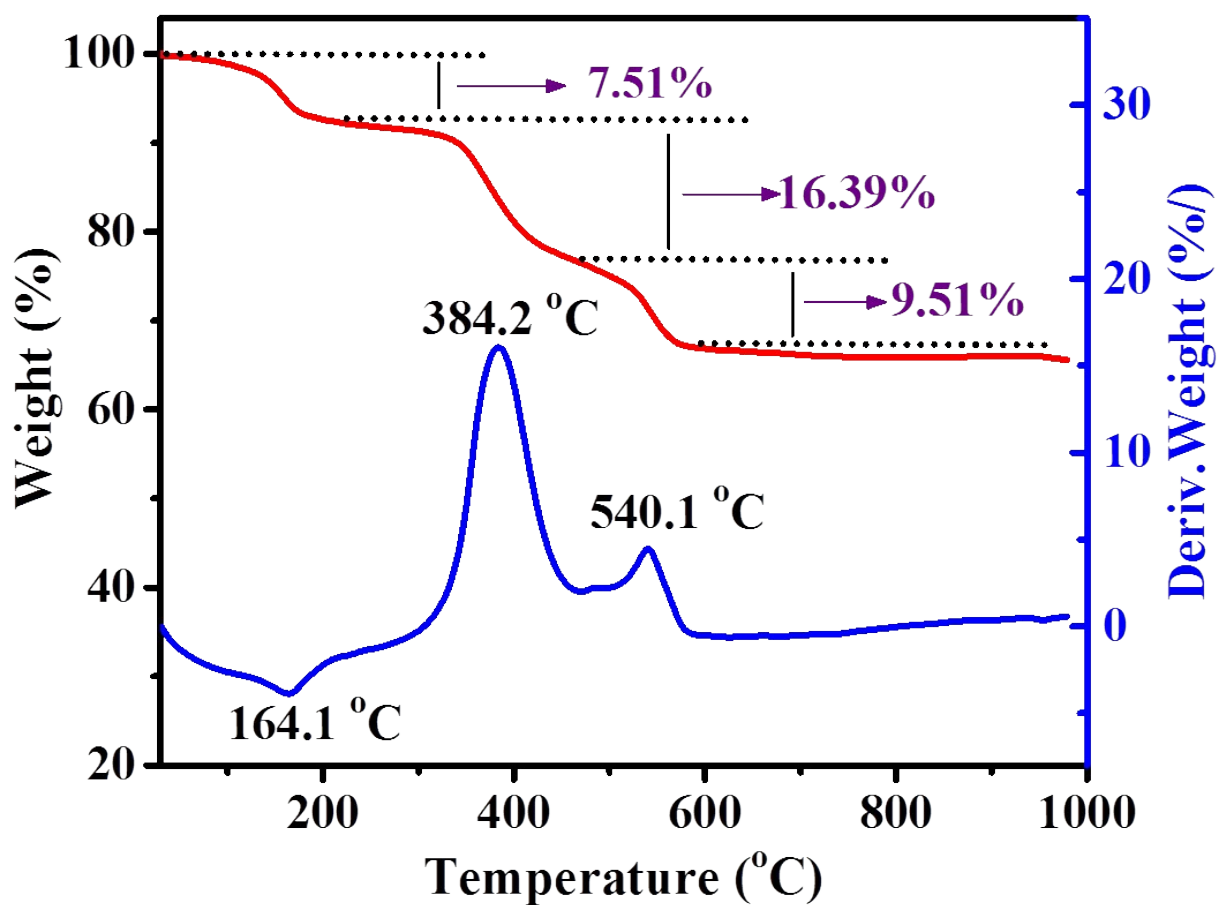
MnO<sub>2</sub> nanorods were prepared by a simple hydrothermal method. In a typical procedure, 8 mmol MnSO<sub>4</sub>·H<sub>2</sub>O and 8 mmol (NH<sub>4</sub>)<sub>2</sub>S<sub>2</sub>O<sub>8</sub> were dissolved in 70 mL deionized water under continuous stirring for 30 min. And then transferred into a 100 mL Teflon-lined stainless steel autoclave and maintains at 140 °C for 12 h. Finally, the sample was collected after centrifugation with deionized water and ethanol, and then dried in vacuum oven with 60 °C for 12 h.



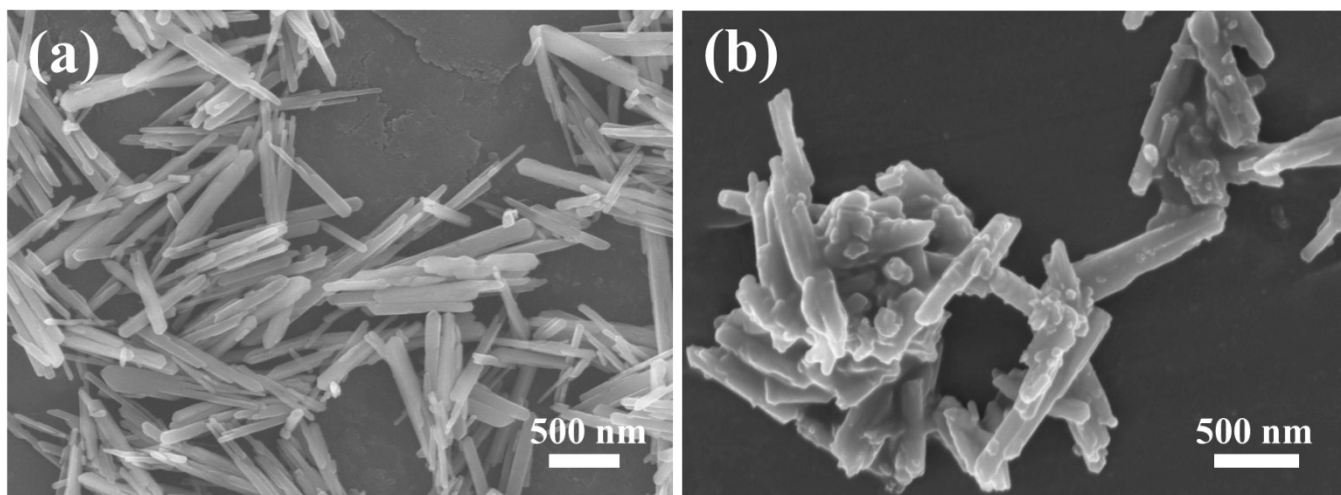
**Figure S1.** XRD patterns of (a) precursor  $\text{MnO}_2@\text{SiO}_2$  nanorods and (b) the calcined intermediate sample  $\text{Mn}_2\text{SiO}_4@\text{SiO}_2@\text{C}$  before silica removal (red line), the calcined  $\text{MnO}_2@\text{SiO}_2$  (blue line)



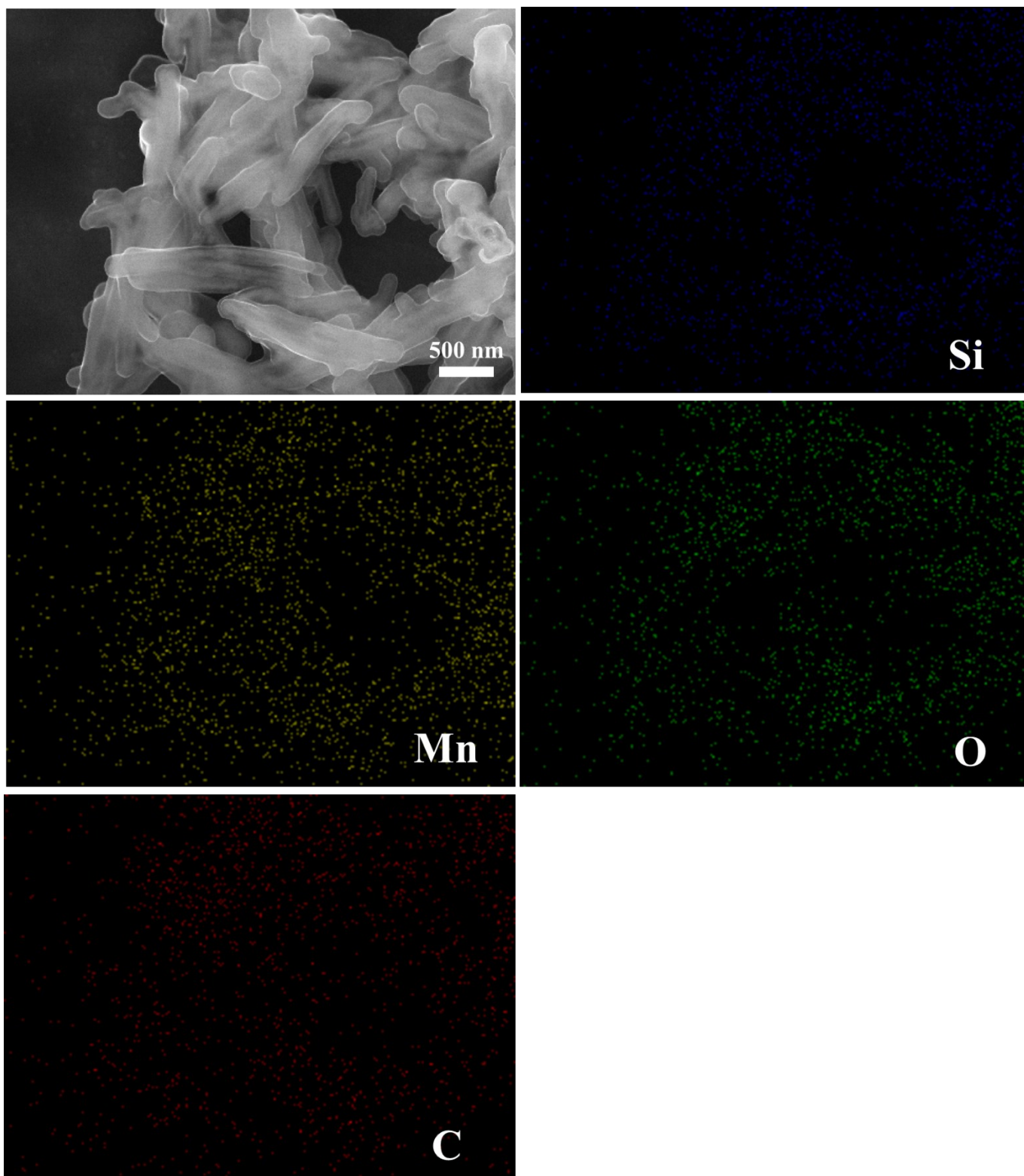
**Figure S2.** FTIR spectrum of the calcined MnO<sub>2</sub>@SiO<sub>2</sub> crystalline powders.



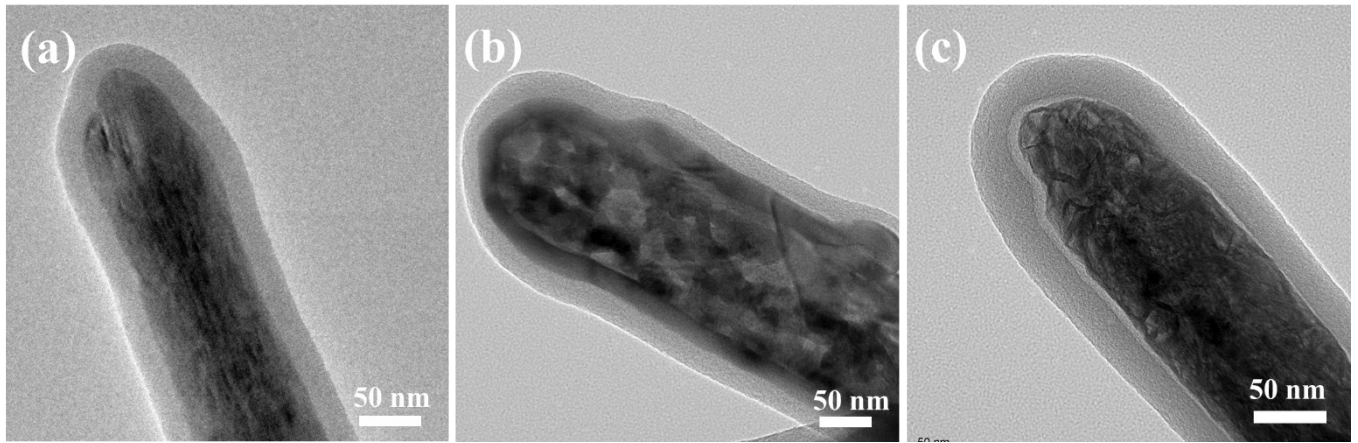
**Figure S3.** TGA-DSC curves of SMOH@C. A mass weight loss of ~7.51% can be observed from onset temperature to 200 °C, which can be assigned to the removal of water as well as volatile residue. Subsequently, two obvious exothermic peaks can be observed and the total weight loss of ~25.9 % between 200 °C and 600 °C, indicate the combustion of carbon shell.<sup>1,2</sup>



**Figure S4.** FESEM images of as-prepared precursors (a) MnO<sub>2</sub> nanorods, (b) core-shell MnO<sub>2</sub>@SiO<sub>2</sub> nanorods.



**Figure S5.** FESEM image and corresponding EDS elemental mapping of Si, Mn, O, and C for  $\text{Mn}_2\text{SiO}_4@\text{SiO}_2@\text{C}$  nanorods before silica removal.



**Figure S6.** TEM images of (a) MnO<sub>2</sub>@SiO<sub>2</sub> core-shell nanorods, (b) Calcined Mn<sub>2</sub>SiO<sub>4</sub>@SiO<sub>2</sub>@C nanorod, (c) SMOH@C yolk-shell nanorods.



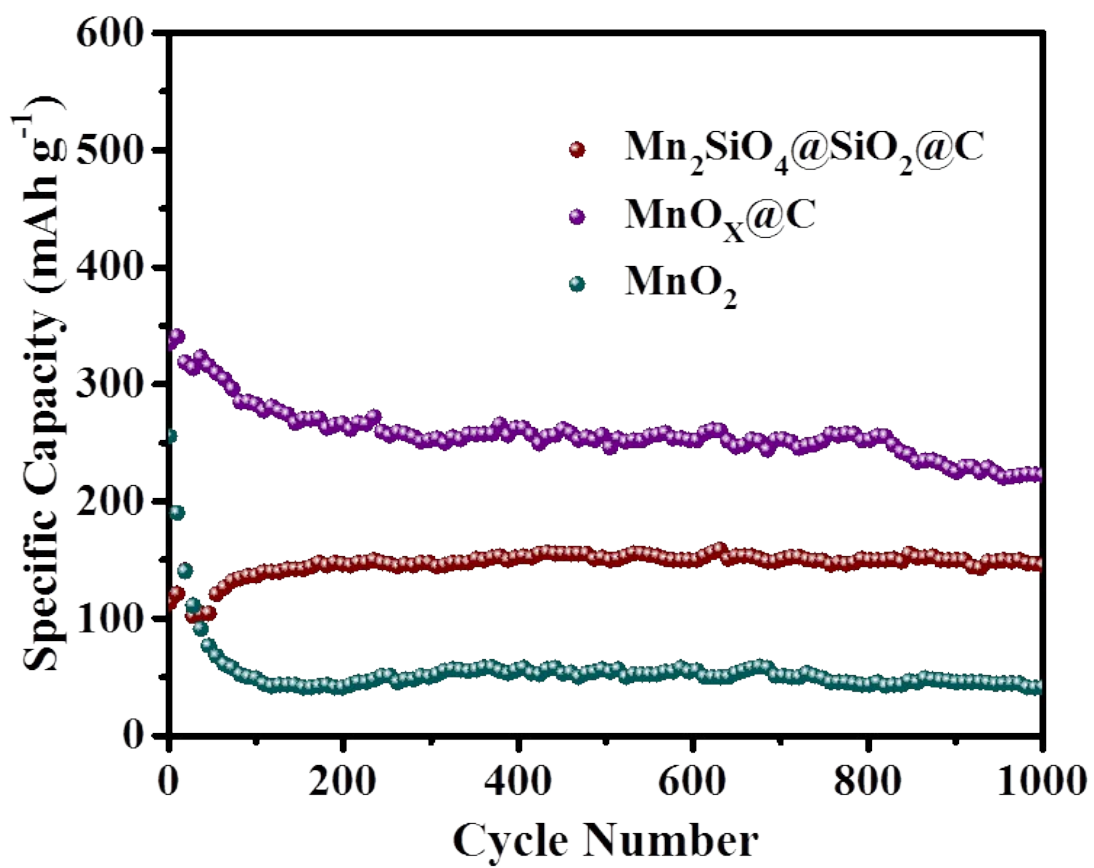
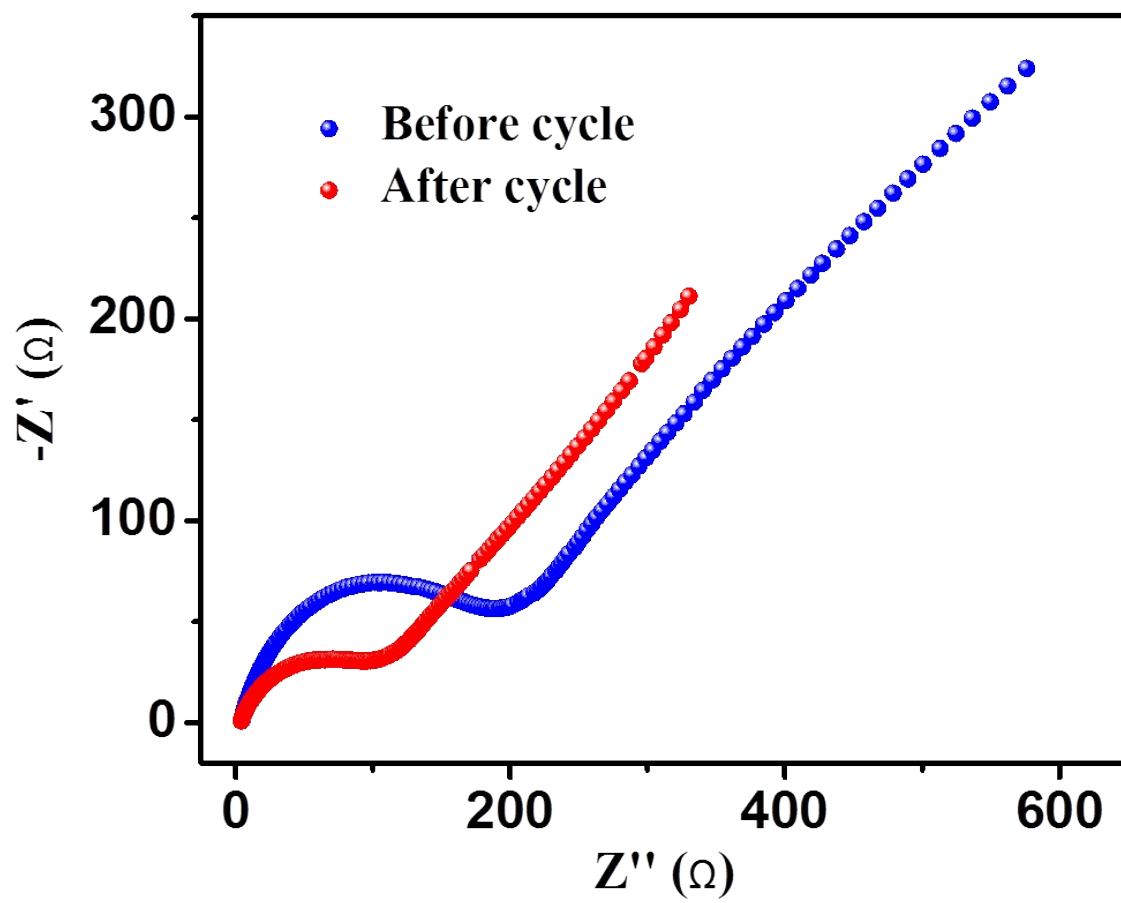


Figure S7. Long cycling life of MnO<sub>2</sub>, MnO<sub>x</sub>@C, and Mn<sub>2</sub>SiO<sub>4</sub>@SiO<sub>2</sub>@C at 4.0 A g<sup>-1</sup>.



**Figure S8.** Nyquist plots for SMOH@C before and after 300 cycles.

## Supplementary References

1. N. Zhang, Q. Zhao, X. Han, J. Yang, J. Chen, *Nanoscale*, 2014, **6**, 2827.
2. W. Luo, D. Shen, R. Zhang, B. Zhang, Y. Wang, S. X. Dou, H. K. Liu, Yang, J. *Adv. Funct. Mater.*, 2016, **26**, 7800.