Supplementary Information

Maize-like $FePO_4$@MCNT nanowire composite for sodium-ion batteries via a microemulsion technique

Shuojiong Xu,[a] Shiming Zhang,[ab] Junxi Zhang,*[a] Tian Tan,[a] Yao Liu[a]

[a]*Electrochemical Research Group, Shanghai University of Electric Power, Shanghai, 200090, People's Republic of China.*

[b]*State Key Laboratory of Silicon Materials, Key Laboratory of Advanced Materials and Applications for Batteries of Zhejiang Province & Department of Materials Science and Engineering, Zhejiang University, Hangzhou 310027, People's Republic of China.*

* Corresponding author. Tel. /Fax. : +86-21-65700719.

E-mail address: zhangjunxi@shiep.edu.cn.

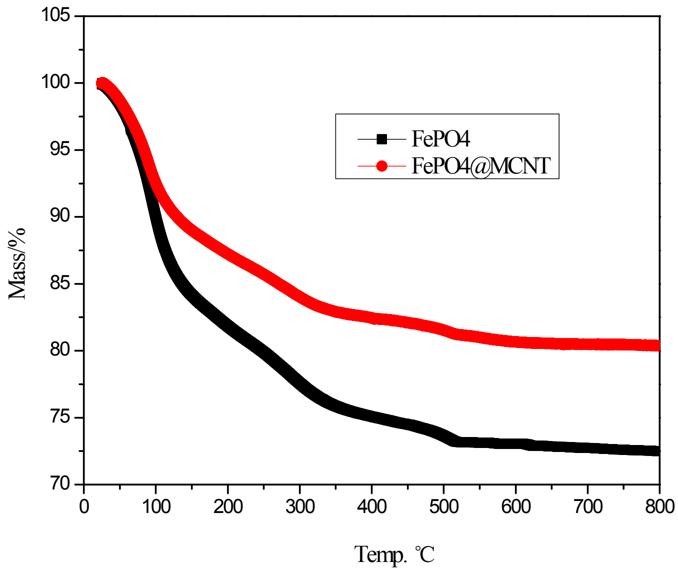

Fig. S1 TGA curves of $FePO_4$ and the $FePO_4$@MCNT. The samples were tested by TA Q500 Thermogravimetric Analysis. The remaining weight of $FePO_4$ is 72%, the first weight loss observed below 100℃ is about 5~10%, which could be ascribed to the release of adsorbed water on the surface of the sample. The next weight loss from 100℃ to 450℃ is approximate 20%, which corresponds to the elimination of crystal water. The remaining weight of $FePO_4$@MCNT is 80%, which is consistent with the presence of 70% $FePO_4$ in $FePO_4$@MCNT.

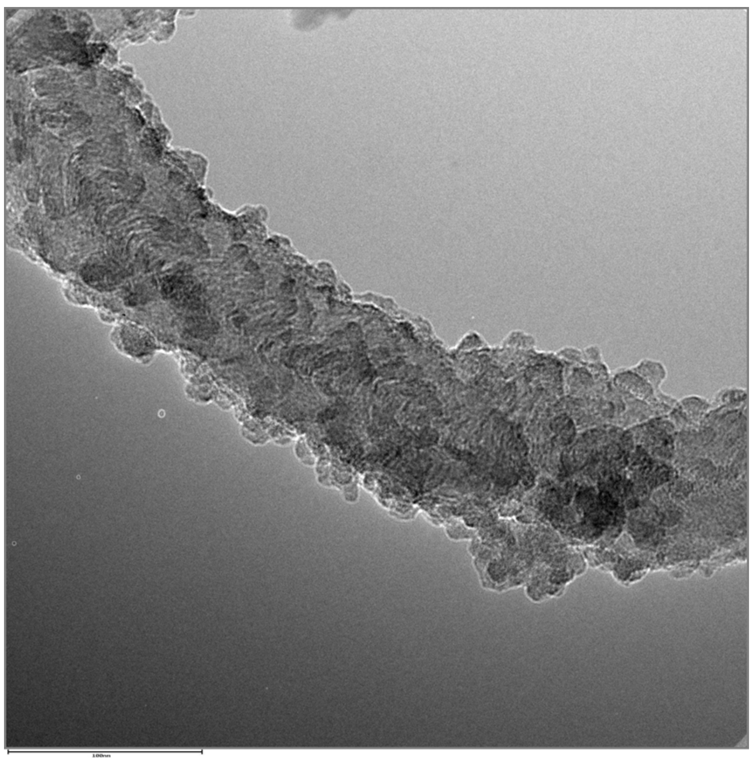

Fig. S2 TEM image of $FePO_4$ @ MCNT were acquired on a Philips CM200 FEG transmission electron microscope operated at 200 KV, showing the MCNT was covered with amorphous spherical $FePO_4$ nanoparticles.

The BET surface areas of samples were measured using Quantachorome Nova Station A by nitrogen sorption at 77K. The surface areas of $FePO_4$ and $FePO_4$@MCNT are 117.691 m^2/g and 114.927 m^2/g, respectively. The lower value of $FePO_4$@MCNT should be ascribed to one side of amorphous $FePO_4$ nanopartice loaded on the MCNT.

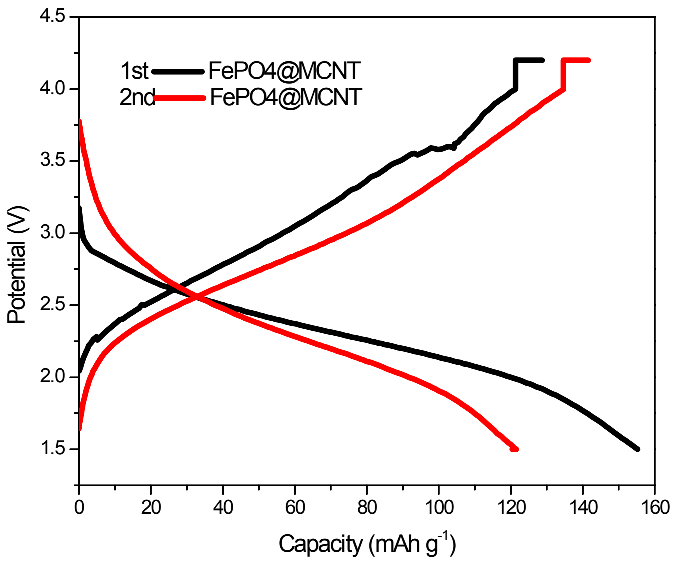

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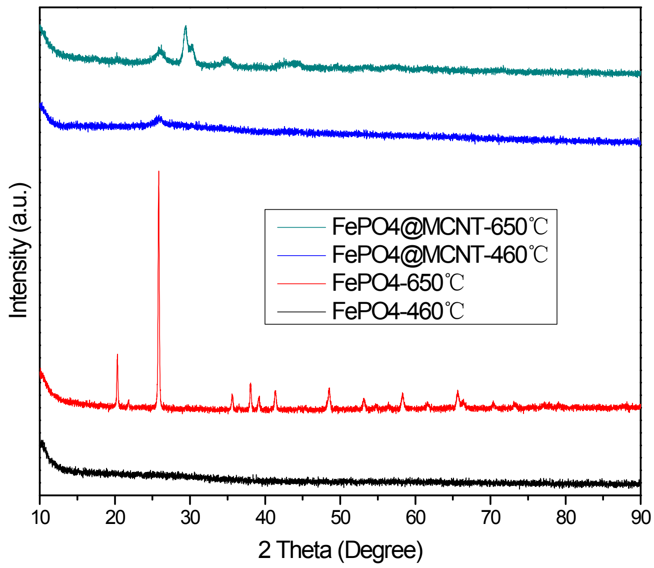
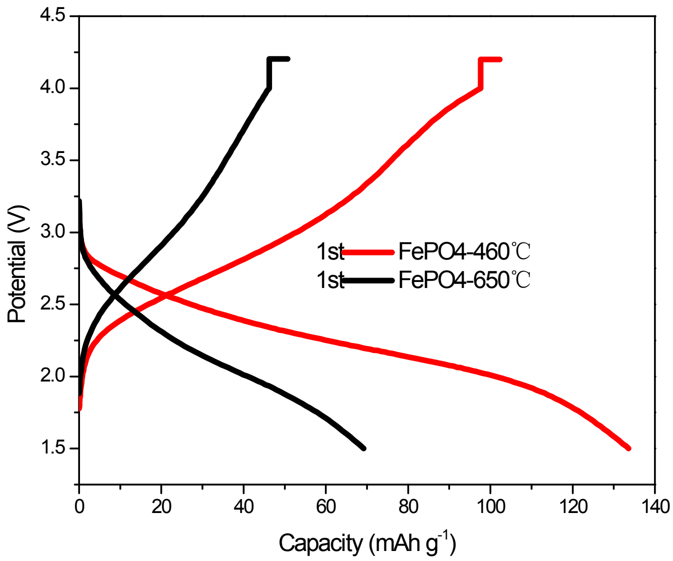
Fig. S3 The charge and discharge Curves of the initial two cycles of $FePO_4$@MCNT at 0.1 C. The composite delivered discharge and charge capacities of 155.2 mAh g^{-1} and 128.7 mAh g^{-1} in the first cycle; 120.4 mAh $g-^{1}$ and 141.5 mAh g^{-1} in the second cycle.

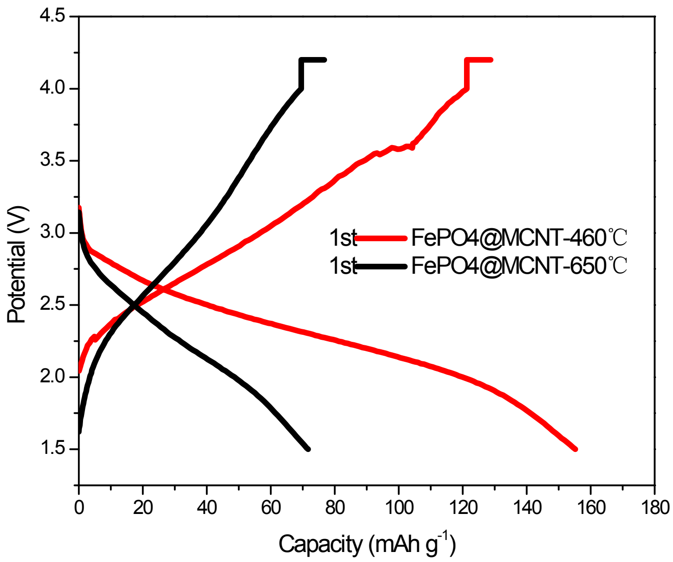


Intensity (a.u.)
FePO4@MCNT-650℃
FePO4@MCNT-460℃
FePO4-650℃
FePO4-460℃
10
20
30
40
50
60
70
80
90
2 Theta (Degree)

(a)



(b)



(c)

Fig. S4 (a) XRD patterns of $FePO_4$ and the $FePO_4$@MCNT composite at different calcination temperatures (460℃, 650℃). (b) The charge-discharge Curves of $FePO_4$ at different calcination temperatures. (c) The charge-discharge Curves of the $FePO_4$@MCNT composite at different calcination temperatures.

As shown in Fig. S4 (a), amorphous $FePO_4$ completely changes to crystalline trigonal $FePO_4$ at 650℃ in air. From Fig. S4 (b), the amorphous $FePO_4$ delivered discharge and charge capacities of 133.6 mAh g^{-1} and 102.3 mAh g^{-1} in the first cycle, but the trigonal $FePO_4$ just delivered discharge and charge capacities of

69.2 mAh g^{-1} and 50.7 mAh g^{-1}, which is consistent with the poor electrochemical behavior in Li-ion batteries.[28]

It can be seen from Fig. S4 (a) that the $FePO_4$@MCNT composite also shows the 26.8° diffraction peak of the MCNTs at 650℃ in N_2. But the other peaks should be ascribed to the carbon thermal reduction of Fe^{3+} to Fe^{2+}, owing to the MCNTs and organic residues calcined at high temperature in N_2. As shown in Fig. S4 (c), the $FePO_4$@MCNT (650℃) composite only delivered discharge and charge capacities of 71.7 mAh g^{-1} and 76.7 mAh g^{-1} in the first cycle. It is demonstrated that $FePO_4$@MCNT (460℃) composite has better electrochemical performance than $FePO_4$@MCNT (650℃).