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Supplementary Information

$LiFePO_4/Li_2S_n$ hybrid system with enhanced Li-ion storage performance

Ye Yuan,[a] Bo Wang,*[ab] Rensheng Song,[a] Fei Wang,[a] Hao Luo,[a] Tiantian Gao[a] and Dianlong Wang*[a]

[a] *MIIT Key Laboratory of Critical Materials Technology for New Energy Conversion and Storage, School of Chemistry and Chemical Engineering, Harbin Institute of Technology, 150001 Harbin, China. E-mail: wangbo19880804@163.com; wangdianlonghit@163.com*

[b] *School of Materials Science and Engineering, Harbin Institute of Technology, 150001 Harbin, China. E-mail: wangbo19880804@163.com*

Figures

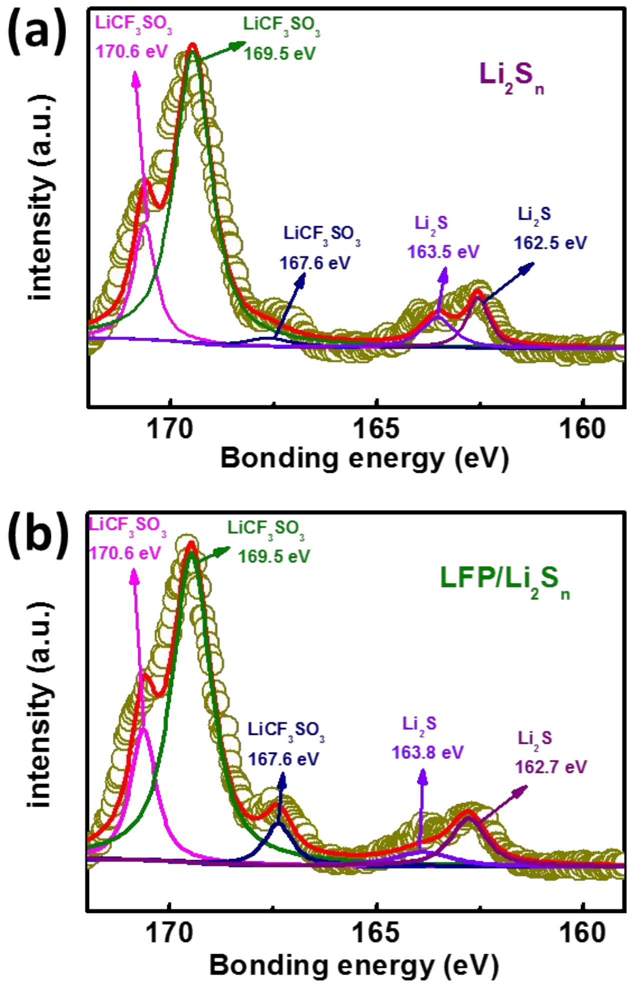

Fig. S1† High resolution XPS spectrum of S 2p for Li_2S_n (a) and LFP/Li_2S_n hybrid system (b) after the cycling test (at fully discharged state). It can be seen the obvious shifts of the peak positions of Li_2S between LFP/Li_2S_n hybrid system and Li_2S_n system, indicative of the interaction between LFP and Li_2S_n.[1,2]

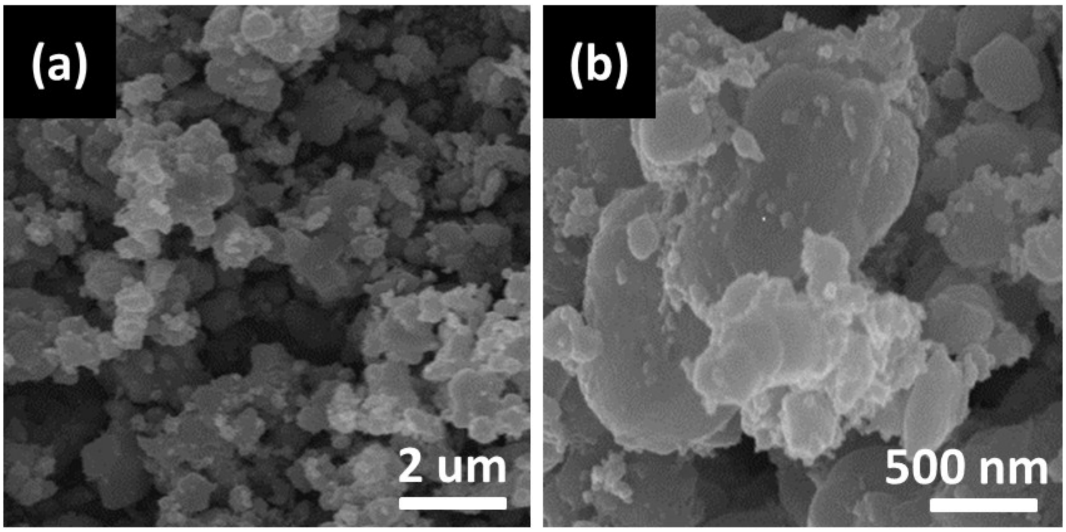

Fig. S2† (a) Low- and (b) high-magnification SEM images of commercial LFP powder, revealing that the particles are in irregular shape with particle size ranging from tens of nanometer to micrometer. Severe particle agglomeration can also be seen. The BET surface area of the commercial LFP powder was measured to be 9.3 $m^2 \cdot g^{-1}$ without pores existence.[3]

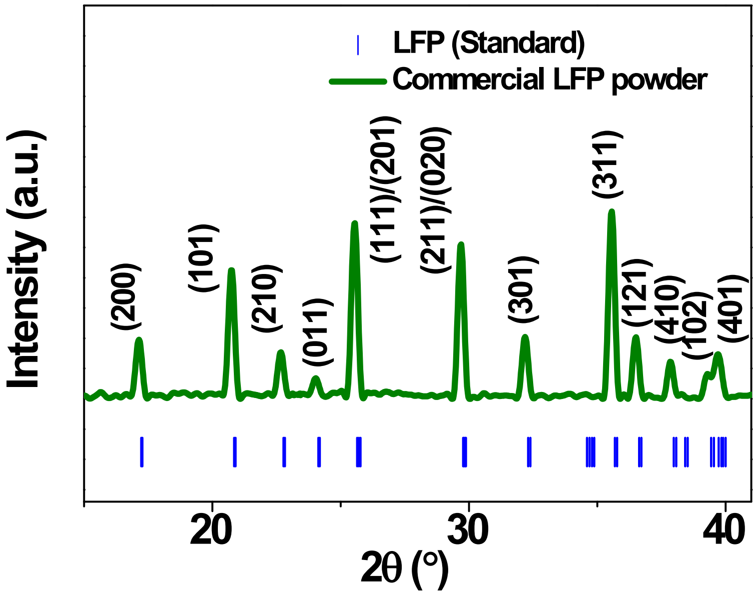

Fig. S3† XRD pattern of the commercial LFP powder and the standard for LFP (JCPDS card no. 81–1173).

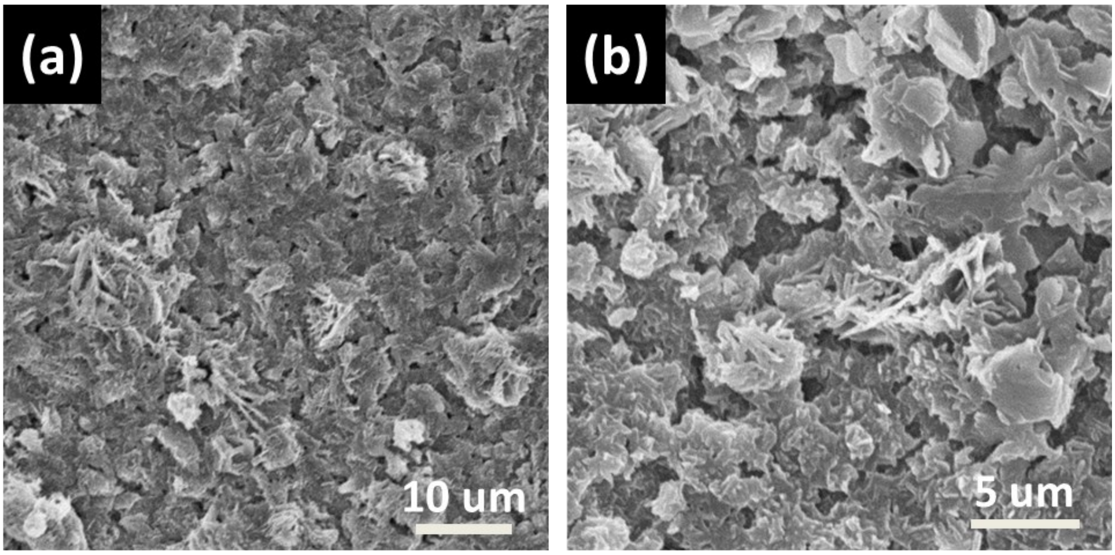

Fig. S4† (a) and (b) SEM images of LFP electrode in LFP/Li_2S_n hybrid system after the cycling test (at fully discharged state) with different magnification. It can be seen that the integrality of the electrode was kept well and a Li_2S layer was uniformly deposited on the surface of LFP electrode, suggested a good structural stability of the electrode during the cycling process.

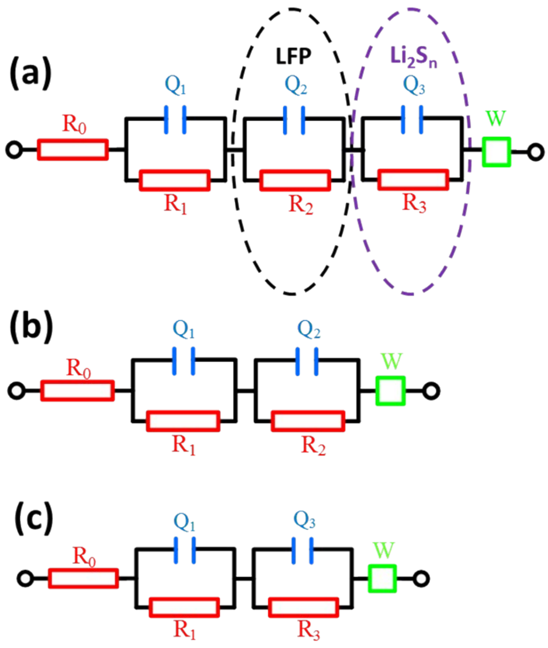

Fig. S5† The equivalent circuits for the Nyquist plots of LFP/Li_2S_n hybrid system (a), LFP system (b) and Li_2S_n system (c). In the equivalent circuit, R_0 represents the ohmic resistance corresponding to the intersection with the Z_{re} axis at the high frequency region of the Nyquist plot, R_1 and Q_1 represent the resistance of the solid electrolyte interphase (SEI) film and the relax capacitance corresponding to the high-frequency region in the semicircle of the Nyquist plot, R_2 and Q_2 represented the charge transfer resistance and double-layer capacitance corresponding to the electrochemical reaction of LFP (the 1st semicircle of the Nyquist plots), R_3 and Q_3 represented the charge transfer resistance and double-layer capacitance corresponding to the electrochemical reaction of Li_2S_n (the 2nd semicircle of the Nyquist plots), and W represents the Warburg resistance related to the lithium ion diffusion process corresponding to the straight line in the low-frequency region of the Nyquist plot.[4-6] Here, a constant phase element Q is employed taking into account the non-ideal frequency response of the displayed data.

Table S1† The fitting values of the resistance components in the equivalent circuits. Based on the fitting data, the higher conductivity ($1/R_{sum}$) and lower charge-transfer resistance corresponding to each electrochemical process of LFP/Li_2S_n hybrid system were confirmed, beneficial from the synergistic effect for energy-storage between LFP component and Li_2S_n component.

	R_0 (Ω)	R_1 (Ω)	R_2 (Ω)	R_3 (Ω)	R_{sum}^a (Ω)
LFP	4.23	96.64	63.34	-	164.21
Li_2S_n	4.09	154.20	-	47.19	205.48
LFP- Li_2S_n	9.60	70.77	31.98	10.70	123.05

[a] $R_{sum} = R_0 + R_1 + R_2 + R_3$

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