Supporting information

Synthesis of $LiMnPO_4$/C with superior performance as Li-ion battery cathode by a two-stage microwave solvothermal process

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Table S1. Synthesized samples used in this study.

Sample	Synthesis temp. / °C	Synthesis time / min
MW-160-03	160	3
MW-160-10	160	10
MW-160-30	160	30
MW-180-10	180	10
MW-200-10	200	10
LMP/NC	C-coated MW-160-10 using dopamine as carbon source	
LMP/C	C-coated MW-160-10 using glucose as carbon source	
Pure-LMP	Pure MW-160-10 without a carbon coating	

Table S2. Elemental analysis results.

Sample	Element content		
	N (wt%)	C (wt%)	H (wt%)
LMP/C	0.05	7.98	0.33
LMP/NC	1.18	5.97	0.40
MW-160-03/C	1.12	6.18	0.22
MW-160-30/C	1.07	5.37	0.19
MW-180-10/C	1.10	5.45	0.20
MW-200-10/C	1.08	5.97	0.23

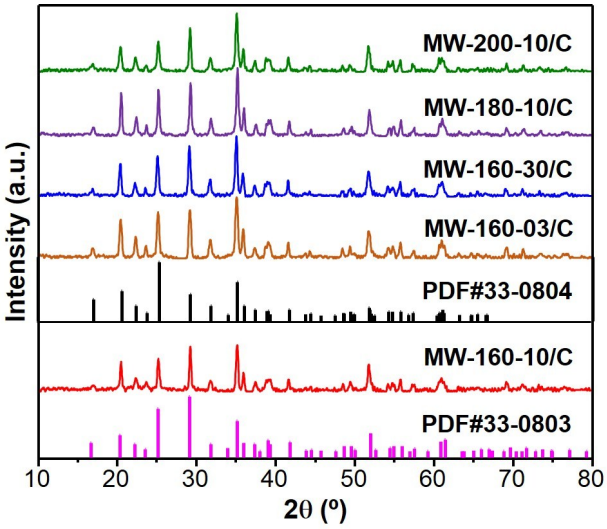

Fig. S1. Powder X-ray diffraction patterns of the carbon-coated $LiMnPO_4$ obtained under different conditions.

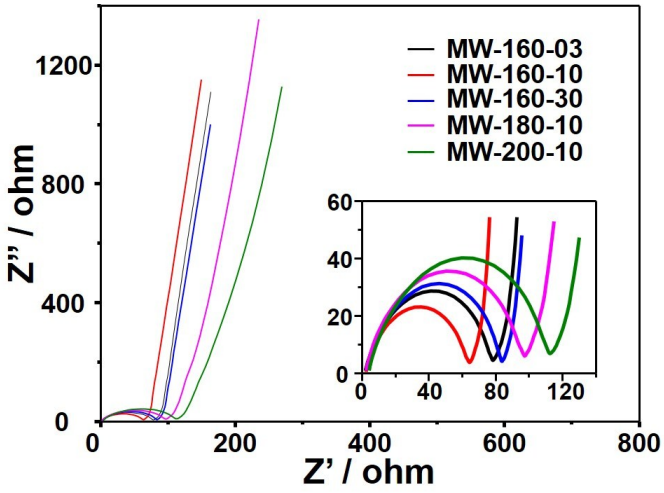

Fig. S2 The impedance spectra for samples under different condition assembled in coin cell.

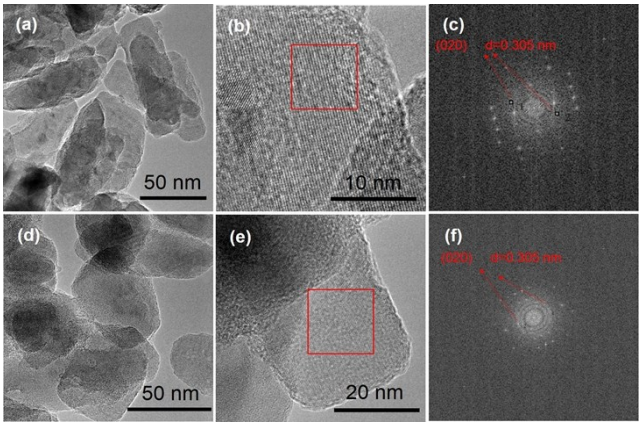

Fig. S3 (a-c) the TEM and FFT of sample MW-160-03/C, (d-e) the TEM and FFT of sample MW-160-30/C.

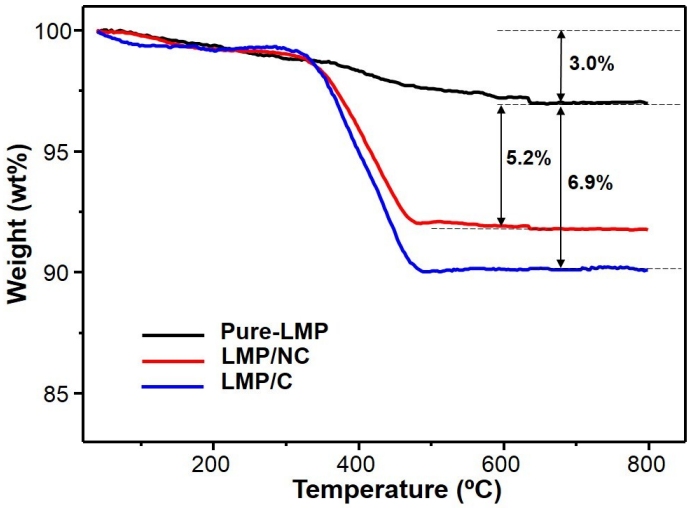

Fig. S4. The TG analysis results.

Calculation of the carbon content

For the sample of LMP/NC, there is 91.8 wt% of residue after pyrolysis at 800 ºC in air, and for the pure LMP, it is 97 wt%.

By assuming that the carbon content is x.

(1-x)*0.97+x*0=0.918 Thus, x=5.4%.

So the carbon content of the three samples are separately 5.4 wt% (LMP/NC), 7.1 wt% (LMP/C), and 3 wt% (Pure-LMP).

Lithium ion diffusion coefficient:

$$D_{Li^+} = \frac{R^2T^2}{2A^2n^4F^4C^2\sigma^2} \qquad \textbf{(Eq. S1)}$$

The lithium ion diffusion coefficient (D_{Li+}) has been calculated for all samples using the **Eq. S1**, where R is the gas constant, T is the absolute temperature, A is the contact area of the electrode (2.01 cm^2), n is the number of electrons per molecule, F is the Faraday constant, C is the concentration of Li^+ ions (6.38×10^{-3} mol cm^{-3}, ratio between the tap density of the prepared material and molecular weight) and σ is the Warburg coefficient associated with the slope of the linear fits between Z_{re} and the reciprocal square root of the angular frequency in the low frequency region.

Table S3. Comparison of the electrochemical data of LMP in literature

Synthesis process	Cycle performance	Rate performance	Reference
Solvothermal method	Charge 0.5 C Discharge 0.5 C 134 mA h g^{-1} after 100 cycles	Charge 10 C Discharge 10 C 108 mA h g^{-1}	Journal of Materials Chemistry A [16]
Solid state reaction	Charge 0.02 C Discharge 0.2 C 130 mA h g^{-1} after 50 cycles	Charge 0.02 C Discharge 10 C 35 mA h g^{-1}	Nano Letters [33]
Impregnation	Charge 0.1 C Discharge 1 C 155 mA h g^{-1} after 50 cycles	Charge 0.1 C Discharge 10 C 110 mA h g^{-1}	Advanced Energy Material [40]
Ultrasonic spray pyrolysis	Charge 0.05 C Discharge 0.5 C 130 mA h g^{-1} after 50 cycles	Charge 0.1 C Discharge 10 C 58 mA h g^{-1}	Advanced Functional Material [41]
Microwave solvothermal method	Charge 0.5 C Discharge 0.5 C 154 mA h g^{-1} after 100 cycles	Charge 10 C Discharge 10 C 118 mA h g^{-1}	This work

References:

40. H. Yoo, M. Jo, B.-S. Jin, H.-S. Kim and J. Cho, *Adv. Energy Mater.*, **2011**, 1, 347–351.

41. S.-M. Oh, S.-W. Oh, C.-S. Yoon, B. Scrosati, K. Amine and Y.-K. Sun, *Adv. Funct. Mater.*, **2010**, 20, 3260–3265.