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Supporting information for

Synergistic Effect for the Preparation of $LiMn_2O_4$ Microspheres with High Electrochemical Performance

Pengli Zhu,*[a,b]‖ Xiangli Chu,[a]‖ Fengrui Zhou,[a] Rong Sun*[a] and Chingping Wong*[b,c]
[a]*Shenzhen Institutes of Advanced Technology, Chinese Academy of Science, 1068 Xueyuan Avenue, Shenzhen University Town, Shenzhen, 518055, China. E-mail: pl.zhu@siat.ac.cn or rong.sun@siat.ac.cn*
[b]*School of Materials Science and Engineering, Georgia Institute of Technology,771 Ferst Drive, Atlanta, GA, 30332, USA*
[c]*Department of Electronic Engineering, The Chinese University of Hong Kong, Shatin NT, Hong Kong SAR, China, E-mail: cpwong@cuhk.edu.hk*

Fig. S1. Photographs of (a) the reaction bottle after adding HCl with 2 min for routine method (left) and 60 min (right), (b,c) below filtrate of the routine method and synergistic method, respectively.

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Calculation of the yield of MnO_2

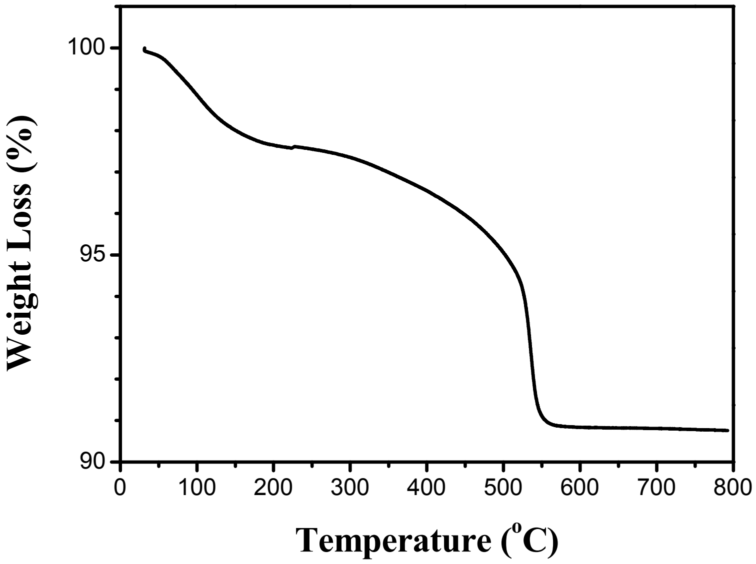

Fig. S2. Thermo gravimetric analysis (TGA) curve of MnO_2 microspheres recorded from ambient to 800 °C with a heating rate of 10 $°C\cdot min^{-1}$ under air flow.

Theoretical total weight of MnO_2 is calculated based on the chemical reaction equation (1) in the main body of this article. The stoichiometric relationship between $MnCO_3$ and MnO_2 are as follows:

$MnCO_3$	~	$KMnO_4$	~	MnO_2
3 mol		2 mol		5 mol
1.15 g / M[$MnCO_3$]				x / M[MnO_2]

Where M[$MnCO_3$] and M[MnO_2] is the molecular weight of $MnCO_3$ (114.95 g mol^{-1}) and MnO_2 (86.94 g mol^{-1}).

In the TGA curve of MnO_2 microspheres, as shown in Fig. S2, we observed a weight loss of 9.2 wt% upon heating, which involves the volatilization of free or crystal water (normally below 200 °C) and the decomposition and release of O_2 from MnO_2: $4MnO_2 \rightarrow 2Mn_2O_3 + O_2$. So when using 1.15 g of $MnCO_3$, the theoretical weight of MnO_2 is x = 1.45 g. If further minus the water (2~3 wt%) part, the experimental weight of MnO_2 would approximately equal to 1.49 g. The yield of the obtained MnO_2 powders prepared via the routine method and our method is calculated in Table S1, it can be seen that the yield in our experiment is nearly 99%, indicating the completely conversion of $MnCO_3$ and $KMnO_4$.

Table S1 The weight and yield of obtained MnO_2 powders.

Reaction time after adding HCl	Routine method	synergistic method
Experimental weight (g)	1.25 g	1.47 g
Yield	~ 84 %	~ 99 %

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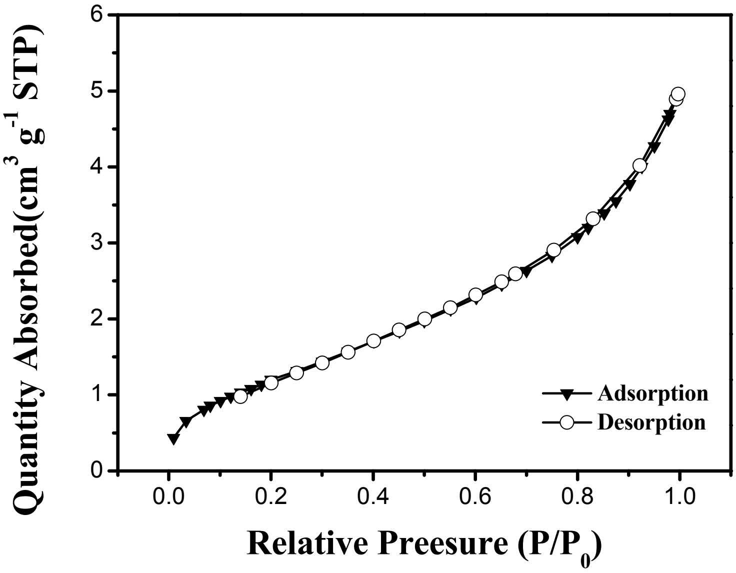

Fig. S3 N_2 adsorption/desorption isotherms plots of the $LiMn_2O_4$ microspheres.

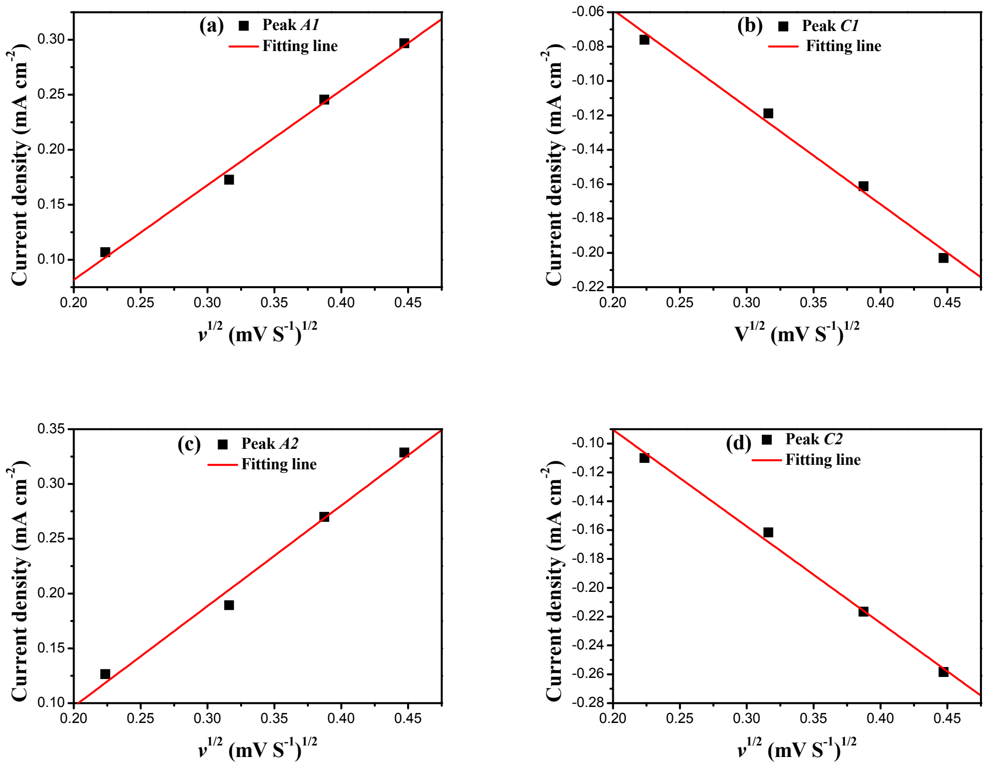

Fig. S4 Plots of the peak current density versus the square root of potential scan rate derived from the CV curves of $LiMn_2O_4$ microspheres. (a) Peak *A1*, (b) Peak *C1*, (c) Peak *A2* and (d) Peak *C2*, respectively.

Table S2 Summary of Li^+ diffusion coefficient determined by CV method.

	Peak A1			*Peak C1*		
v (mV/s)	E (V)	I_p (mA/cm^2)	D_{Li} (cm^2 s^{-1})	E (V)	I_p (mA/cm^2)	D_{Li} (cm^2 s^{-1})
0.05	4.067	1.07E-01	5.56E-09	3.95	-7.60E-02	8.04E-10
0.10	4.090	1.73E-01	7.30E-09	3.932	-1.19E-01	2.06E-09
0.15	4.109	2.45E-01	9.81E-09	3.914	-1.61E-01	3.41E-09
0.20	4.119	2.97E-01	1.08E-08	3.908	-2.03E-01	4.81E-09
	Peak A2			*Peak C2*		
v (mV/s)	E (V)	I_p (mA/cm^2)	D_{Li} (cm^2 s^{-1})	E (V)	I_p (mA/cm^2)	D_{Li} (cm^2 s^{-1})
0.05	4.187	1.26E-01	4.83E-10	4.072	-1.10E-01	5.55E-10
0.10	4.208	1.89E-01	1.29E-09	4.055	-1.62E-01	1.51E-09
0.15	4.224	2.70E-01	2.04E-09	4.042	-2.17E-01	2.54E-09
0.20	4.231	3.29E-01	2.97E-09	4.035	-2.58E-01	3.78E-09

Table S3 Summary of the Lithium ion diffusion coefficient in references

Morphology	Measurement method	Lithium ion diffusion coefficient (D cm^2 S^{-1})	References
Porous nanorods	CV	1.74×10^{-9}~ 1.30×10^{-8}	[23]
Spherical	CITT	0.9×10^{-10} ~ 16.3×10^{-10}	[29]
	PITT	$10^{-9.5}$~ $10^{-11.5}$	
Porous spheres	CV	4.61×10^{-10}	[30]
Porous nanoscaled	CV	1.40×10^{-8} ~ 3.6×10^{-10}	[31]

CV: cycling voltammetry

CITT: capacity intermittent titration technique

PITT: potential intermittent titration technique