Supporting Information

In-Situ Formed Amorphous Carbon-Coated $LiMn_2O_4$ Cathode with Long-Term Stability for Lithium-Ion Batteries

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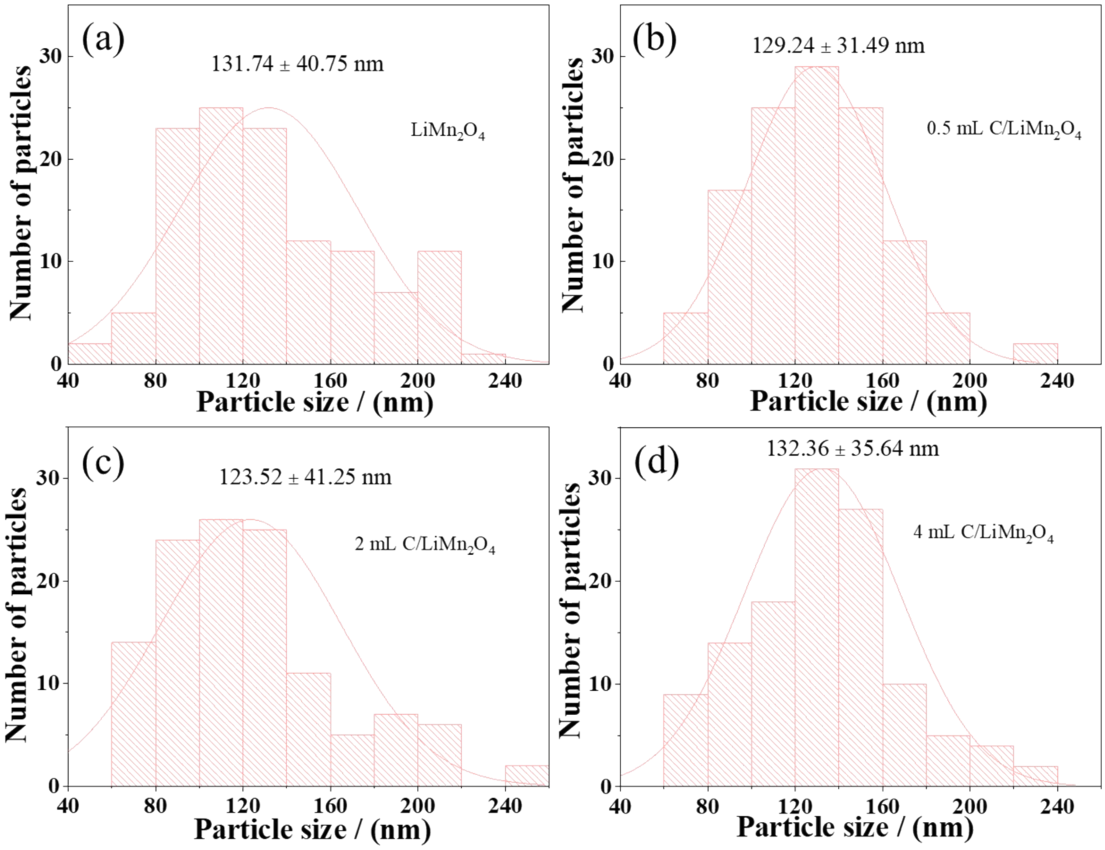

Fig. S1. (a-d) Particle size distribution of $LiMn_2O_4$ and carbon-coated $LiMn_2O_4$ with different NMP contents.

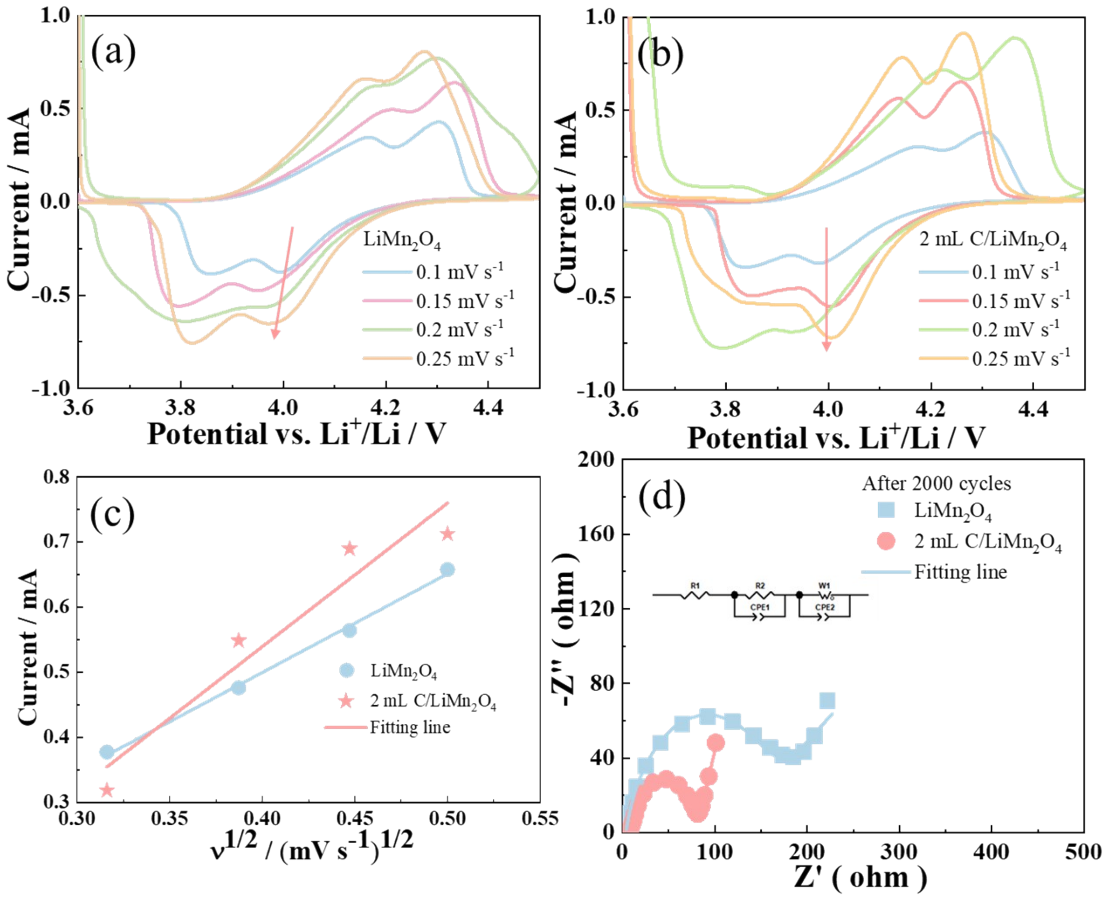

Fig. S2. CV curves of the (a) bare $LiMn_2O_4$ and (b) 2 mL C/$LiMn_2O_4$ with different scan rates from 0.1 to 0.25 mV s^{-1}; (c) The relationship of the reduction peak current at bare $LiMn_2O_4$ and 2 mL C/$LiMn_2O_4$ with the square root of scan rate. (d) EIS plots of bare $LiMn_2O_4$ and 2 mL C/$LiMn_2O_4$ after 2000 cycles, and the inset shows the equivalent circuits.

Table S1 Mn $2p_{3/2}$ peak parameters for Mn in the $LiMn_2O_4$ sample.

Peak	B.E. (eV)	FWHM (eV)	Percent (%)
Mn^{4+} (total)=48.50			
Mn^{4+}	642.06	0.93	19.58
Mn^{4+}	642.74	0.96	14.36
Mn^{4+}	643.84	1.00	9.54
Mn^{4+}	645.20	1.00	3.38
Mn^{4+}	646.17	1.00	1.64
Mn^{3+} (total)=51.50			
Mn^{3+}	640.50	1.00	14.24
Mn^{3+}	641.30	0.98	18.84
Mn^{3+}	642.45	0.94	5.49
Mn^{3+}	643.31	0.90	8.99
Mn^{3+}	644.51	0.90	3.94

Table S2 Mn 2p$_{3/2}$ peak parameters for Mn in the 2 mL C/LiMn$_2$O$_4$ sample.

Peak	B.E. (eV)	FWHM (eV)	Percent (%)
Mn^{4+} (total)=47.47			
Mn^{4+}	642.12	0.94	18.36
Mn^{4+}	642.65	0.92	15.51
Mn^{4+}	643.90	0.98	8.61
Mn^{4+}	645.20	1.00	3.34
Mn^{4+}	646.10	1.00	1.65
Mn^{3+} (total)=52.54			
Mn^{3+}	640.83	0.92	13.31
Mn^{3+}	641.47	1.00	15.95
Mn^{3+}	640.00	1.00	5.64
Mn^{3+}	643.28	0.99	13.68
Mn^{3+}	644.54	0.90	3.96

Table S3 Impedance data of $LiMn_2O_4$ and 2 mL C/$LiMn_2O_4$.

Sample	R_1 (Ω)	R_2 (Ω)
$LiMn_2O_4$ before cycle	2.02	375.93
2 mL C/$LiMn_2O_4$ before cycle	2.46	145.92
$LiMn_2O_4$ after 2000 cycles	3.57	191.92
2 mL C/$LiMn_2O_4$ after 2000 cycles	8.61	81.80

The lithium-ion diffusion coefficient (D_{Li+}) of the $LiMn_2O_4$ and 2 mL C/$LiMn_2O_4$ were calculated using the Randles-Sevick equation: [1, 2]

$$I_p = 2.69 \times 10^5 n^{3/2} A D_{Li^+}^{1/2} C v^{1/2}$$

where I_p is the peak current in voltametric scan, n is the number of electrons transferred in a single reaction (1 for $LiMn_2O_4$ and $LiMn_2O_4$ based materials), A is the electrode area (1.26 cm^2), D_{Li}^+ is the Li^+ diffusion coefficients ($cm^2\ s^{-1}$), C is the bulk concentration of Li^+ ions (0.0237 mol cm^{-3}) and v represents the scan rate.

The Li^+ diffusion coefficient (D_{Li^+}) can be calculated by the following equation: [3]

$$D_{Li^+} = R^2T^2/2A^2n^4F^4C^2\sigma^2$$

Where D_{Li^+} is the diffusion coefficient of Li^+ (cm^2 s^{-1}), R is the gas constant (8.314 J $mol^{-1}K^{-1}$), T is the absolute temperature (298.15 K), A is the surface area of electrode (1.26 cm^2), n refers to the number of electrons involved in redox reaction, F is the Faraday constant (9.65×10^4 C mol^{-1}), C is the concentration of Li^+ in active material (0.0238 mol cm^{-3}), and σ is the Warburg coefficient obtained from the slope. By linear fitting of the relationship plot Z' and the square root of the angular frequency ω (Fig. 6d), the Warburg coefficient σ was obtained.

References

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