Supporting Information

High-Performance Amorphous Carbon Coated $LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$ Cathode Material with Improved Capacity Retention for Lithium-Ion Batteries

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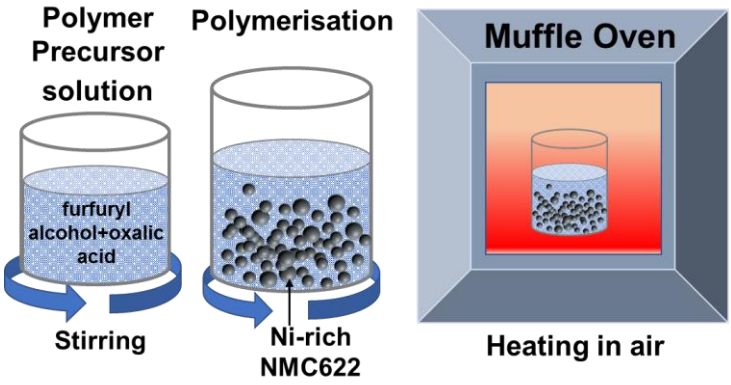

Figure S 1: Schematic of synthesis process.

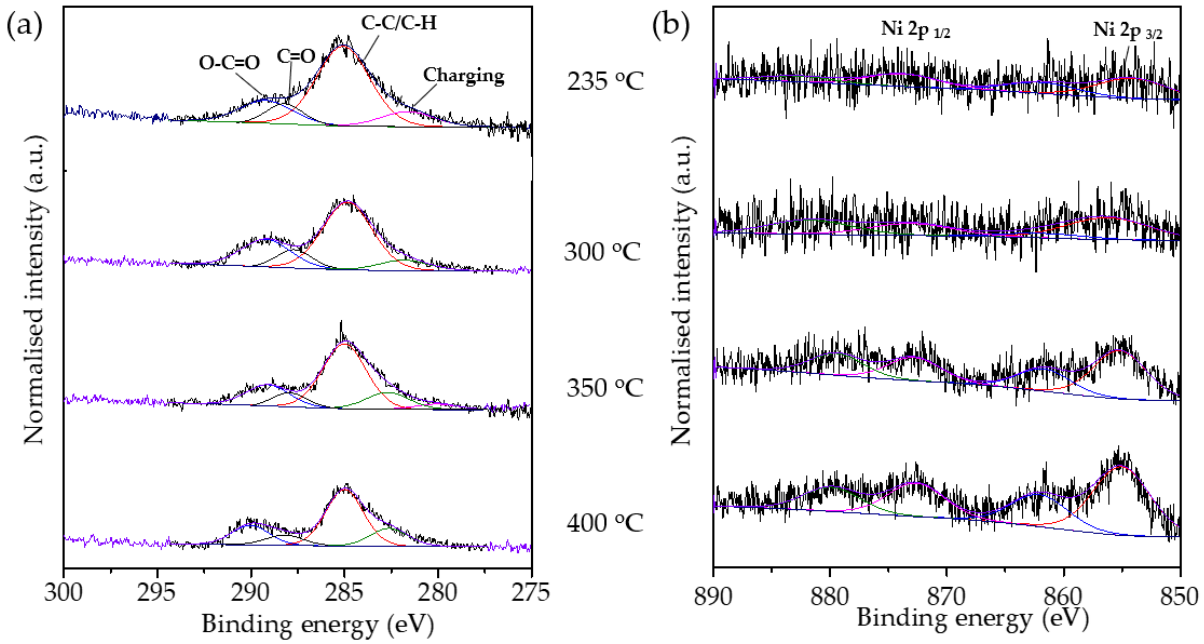

Figure S 2: XPS detail spectra for (a) C 1s and (b) Ni 2p regions.

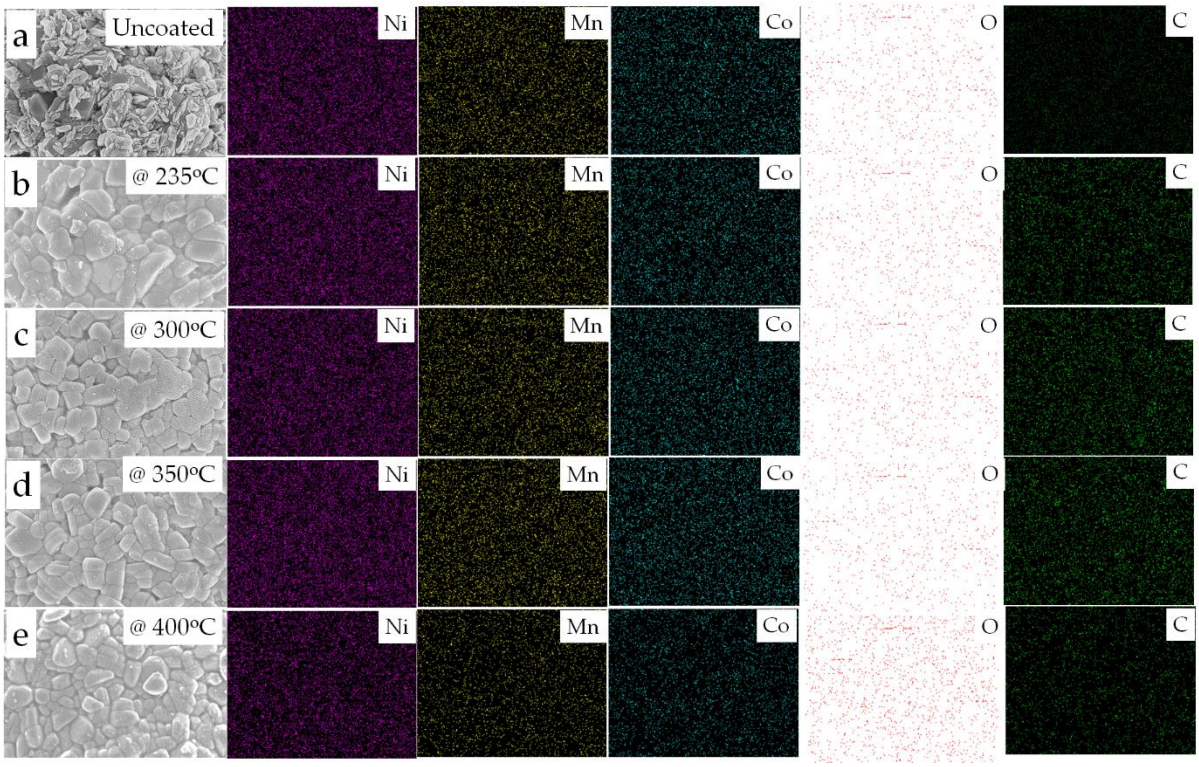

Figure S 3: EDAX analysis of (a) Uncoated pristine NMC622, (b) Coated calcined at 235 °C, (c) Coated calcined at 300 °C, (d) Coated calcined at 350 °C, (e) Coated calcined at 400 °C.

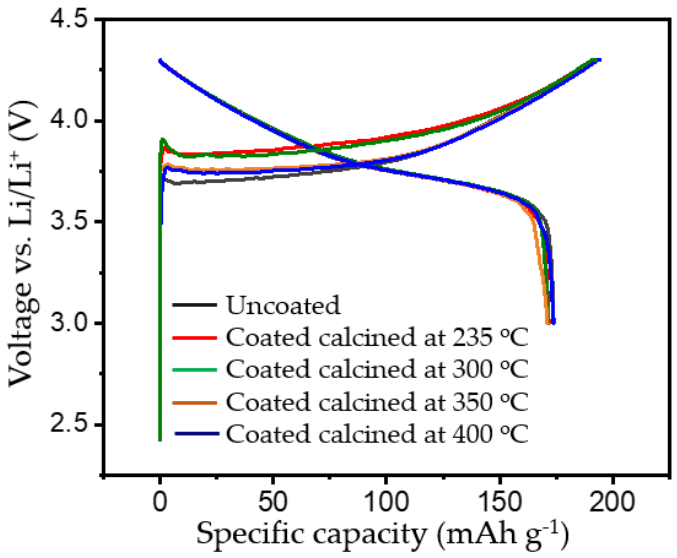

Figure S 4: Formation cycle profile of uncoated and coated calcined NMC622 sample carried at 0.1C current rate.

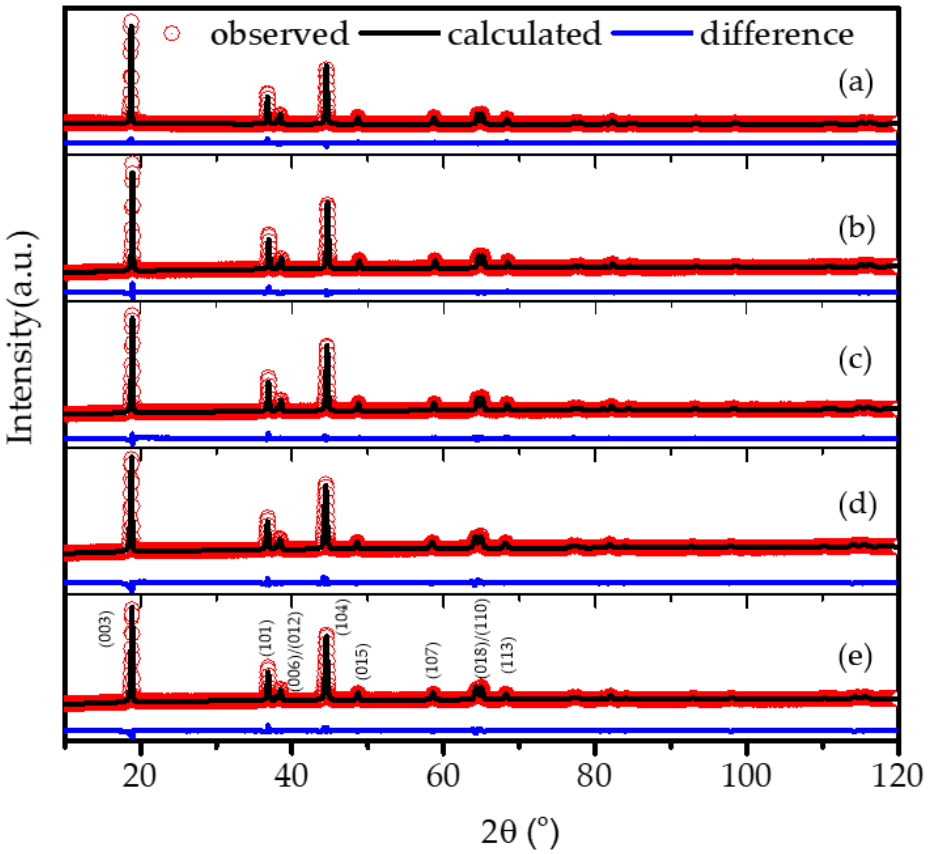

Figure S 5: XRD patterns of (a) Uncoated pristine NMC622, (b) Uncoated calcined at 235 °C, (c) Uncoated calcined at 300 °C, (d) Uncoated calcined at 350 °C, (e) Uncoated calcined at 400 °C.

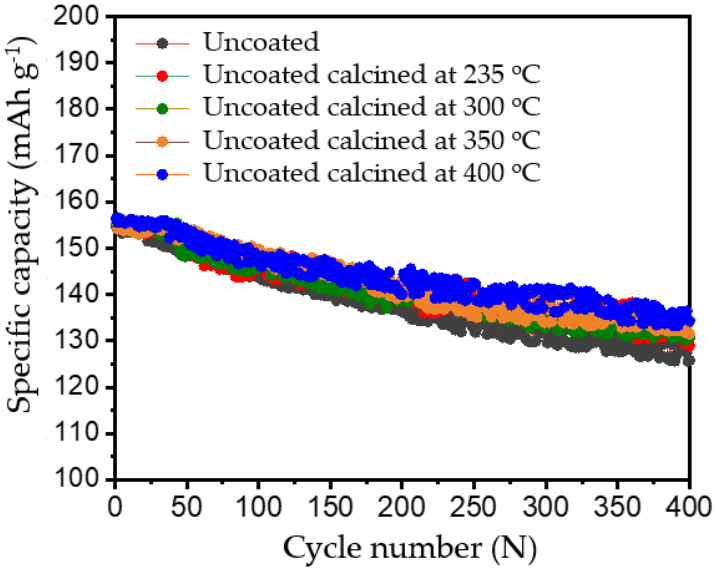

Figure S 6: Cycling performance of the uncoated pristine NMC622 and uncoated calcined at 235 °C, 300 °C, 350 °C and 400 °C.

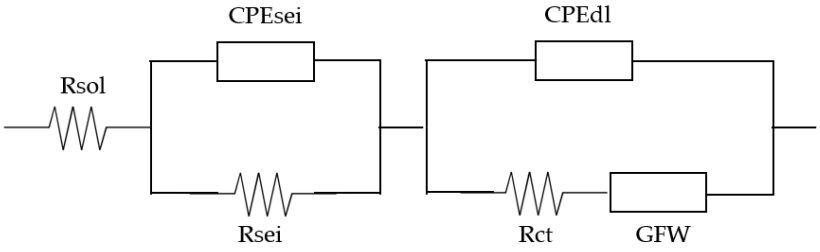

Figure S 7: Equivalent electrical circuit for the impedance analysis of the uncoated and coated samples.

Table S 1: The lattice parameters of uncoated pristine and the uncoated heated NMC622 samples.

Sample/ Calcination temperature	**a**	**c**	**c/a**	**I(003)/I(104)**	**Rwp**	**Goodness-of-fit (χ^2)**
(°C)	**(Å)**	**(Å)**				
Uncoated pristine	2.8681(4)	14.2230(7)	4.95	1.62	0.99	2.04
Uncoated calcined at 235°C	2.8680(3)	14.2241(5)	4.95	1.61	0.95	1.91
Uncoated calcined at 300°C	2.8679(7)	14.2244(2)	4.95	1.62	0.97	1.96
Uncoated calcined at 350°C	2.8673(4)	14.2174(8)	4.95	1.61	0.96	1.91
Uncoated calcined at 400°C	2.8680(2)	14.2223(5)	4.95	1.62	0.97	1.93

Table S 2: Comparison of previously reported different surface coating material to improve their long-term electrochemical cycling performance.

Coating material	Cathode material	Voltage window	Current rate	Capacity retention without coating (%)	Capacity retention with surface coating (%)	No. of cycles
TiO_2[1]	$LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$	2.5-4.3 V	1C	67.5	85.9	100
Nitrogen-doped carbon[2]	$LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$	3.0–4.5 V	1C	76.4	92.0	100
SiO_2[3]	$LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$	3.0–4.3 V	2C	74.0	80.0	700
Al_2O_3[4]	$LiNi_{0.5}Mn_{0.3}Co_{0.2}O_2$	3.0-4.3 V	1C	70.0	90.0	180
Polypyrrole[5]	$LiNi_{0.8}0Co_{0.15}Al_{0.05}O_2$	2.75-4.3 V	1C	71.6	88.9	100
ZrO_2[6]	$LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$	2.8-4.5 V	1C	82.7	93.8	150
Al_2O_3[7]	$LiNi_{0.7}Mn_{0.15}Co_{0.15}O_2$	3.0-4.3 V	0.5C	67.0	92.0	100
Li_2SiO_3[8]	$LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$	2.8-4.6 V	1C	61.5	73.6	100
Li_3PO_4[9]	$LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$	2.7–4.5 V	2C	59.4	82.8	200
WO_3 membrane[10]	$LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$	2.8-4.3 V	1C	75.0	84.9	200
Prussian blue[11]	$LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$	2.8-4.3 V	1C	83.5	89.0	350
Amorphous carbon (This work)	**$LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$**	**3.0-4.3 V**	**2C**	**81.3**	**89.4**	**400**

Table S 3: Comparison of previously reported different surface coating material to improve their high current electrochemical performances.

Coating material	Cathode material	Voltage window	Highest discharge current rate	Discharge capacity without coating (mAh g^{-1})	Discharge capacity with surface coating (mAh g^{-1})	Capacity improvement (%)
Reduced Graphene Oxide[12]	$LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$	3.0-4.5 V	10C	104.9	132.6	26.4
Nitrogen-doped carbon[2]	$LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$	3.0-4.5 V	5C	130.0	156.0	20.0
Prussian blue[11]	$LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$	2.8-4.3 V	5C	129.0	133.9	3.8
Al_2O_3[4]	$LiNi_{0.5}Mn_{0.3}Co_{0.2}O_2$	3.0-4.3 V	10C	30.0	45.0	50.0
Polypyrrole[5]	$LiNi_{0.8}0Co_{0.15}Al_{0.05}O_2$	2.75-4.3 V	5C	146.2	163.5	11.8

ZrO_2[6]	$LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$	2.8-4.5 V	5C	120.0	140.0	16.7
Al_2O_3[7]	$LiNi_{0.7}Mn_{0.15}Co_{0.15}O_2$	3.0-4.3 V	4C	90.0	134.0	48.9
SiO_2[13]	$LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$	3.0–4.3 V	8C	138.0	157.0	13.8
$Li_4Ti_5O_{12}$ [14]	$LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$	2.7-4.3 V	10C	59.1	106.4	80.0
Li_3PO_4[9]	$LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$	2.7–4.5 V	10C	82.7	126.6	53.1
rGO@TiO_2[15]	$LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$	3.0-4.5 V	10C	137.3	156.5	14.0
TiO_2[1]	$LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$	2.5-4.3 V	10C	84.0	95.0	13.1
Li_2SiO_3[8]	$LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$	2.8-4.6 V	10C	110.0	159.0	44.5
Amorphous carbon (This work)	**$LiNi_{0.6}Mn_{0.2}Co_{0.2}O_2$**	**3.0-4.3 V**	**10C**	**63.4**	**94.7**	**49.4**

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