Supplementary Material

A 3D multifunctional host anode from commercial carbon cloth for lithium metal batteries

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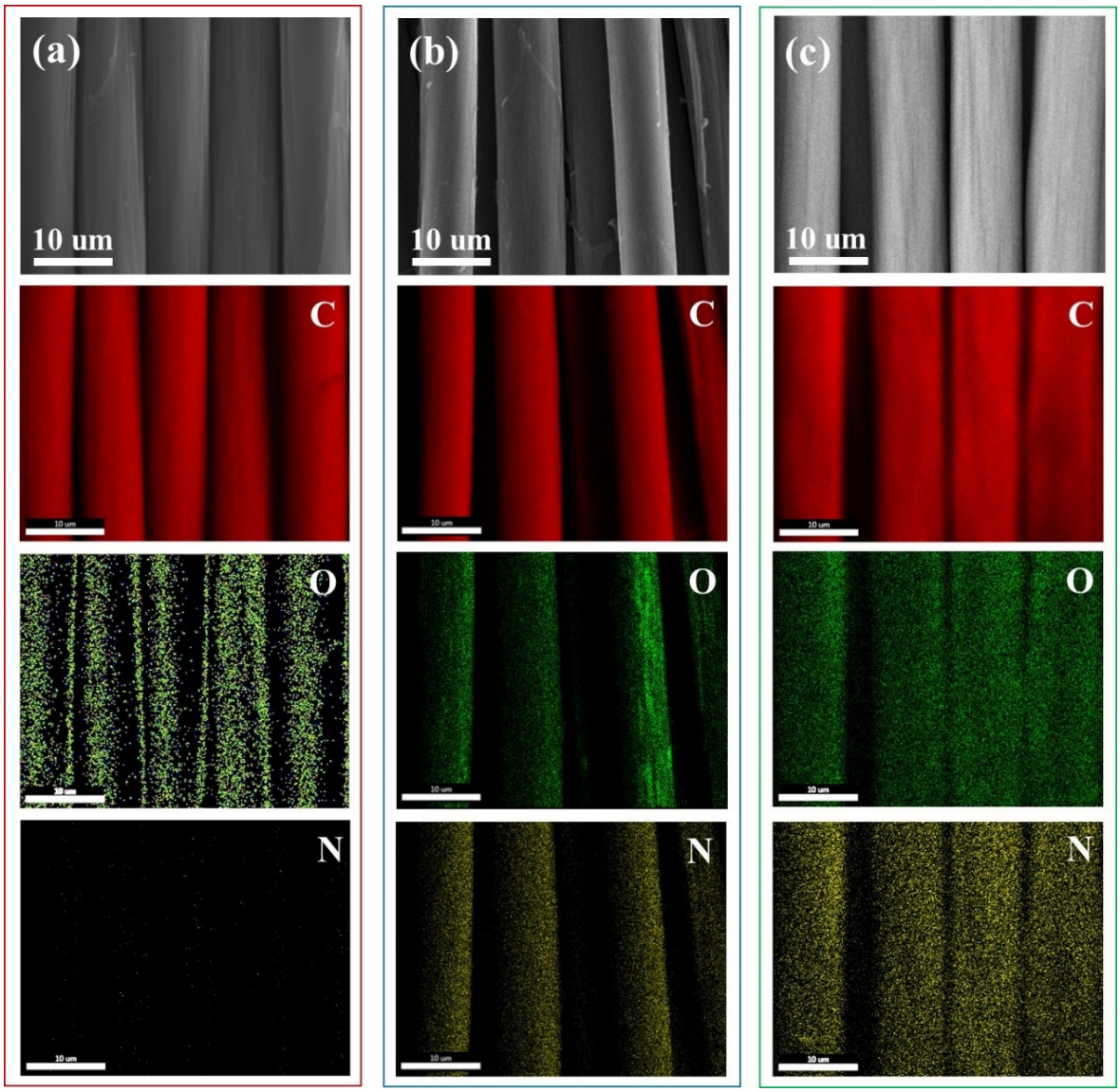

Figure S1. EDS mapping images of (a) CC, (b) NCC, and (c) KNCC.

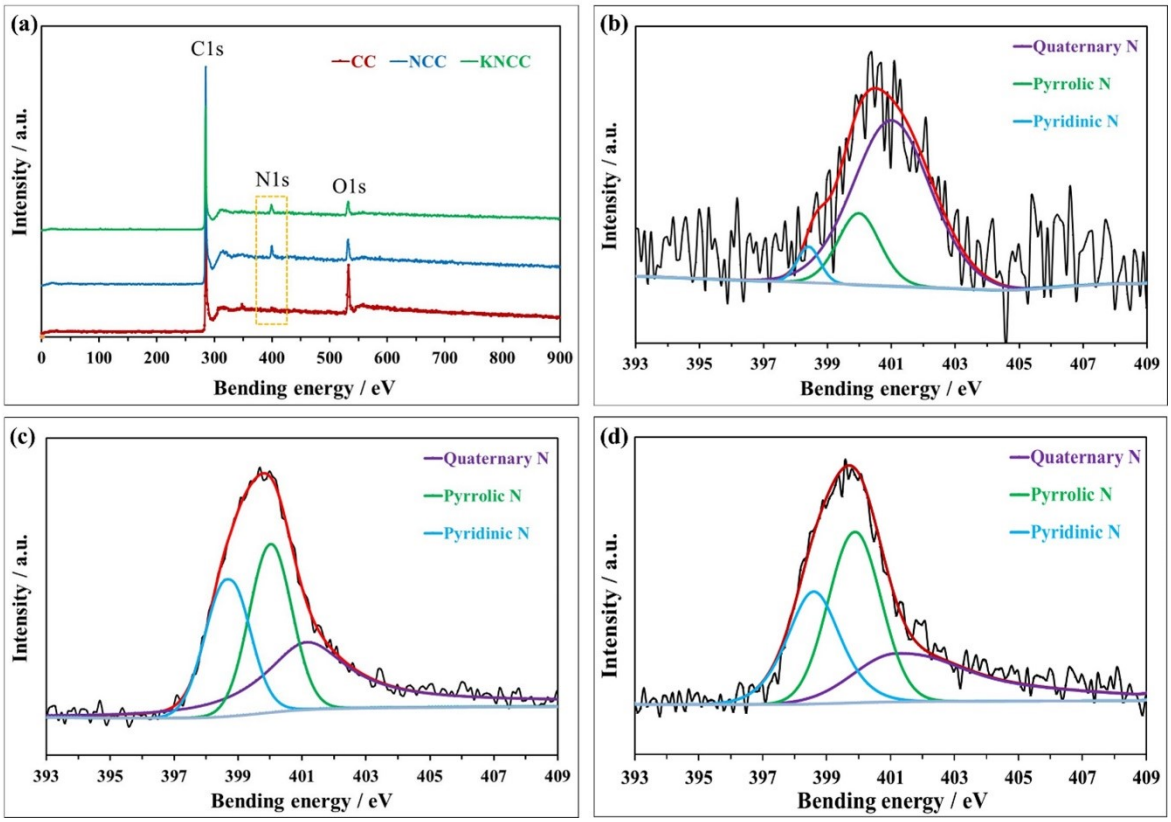

Figure S2. (a) Original XPS survey spectra of various materials. N 1s XPS spectra of (b) CC, (c) NCC, and (d) KNCC.

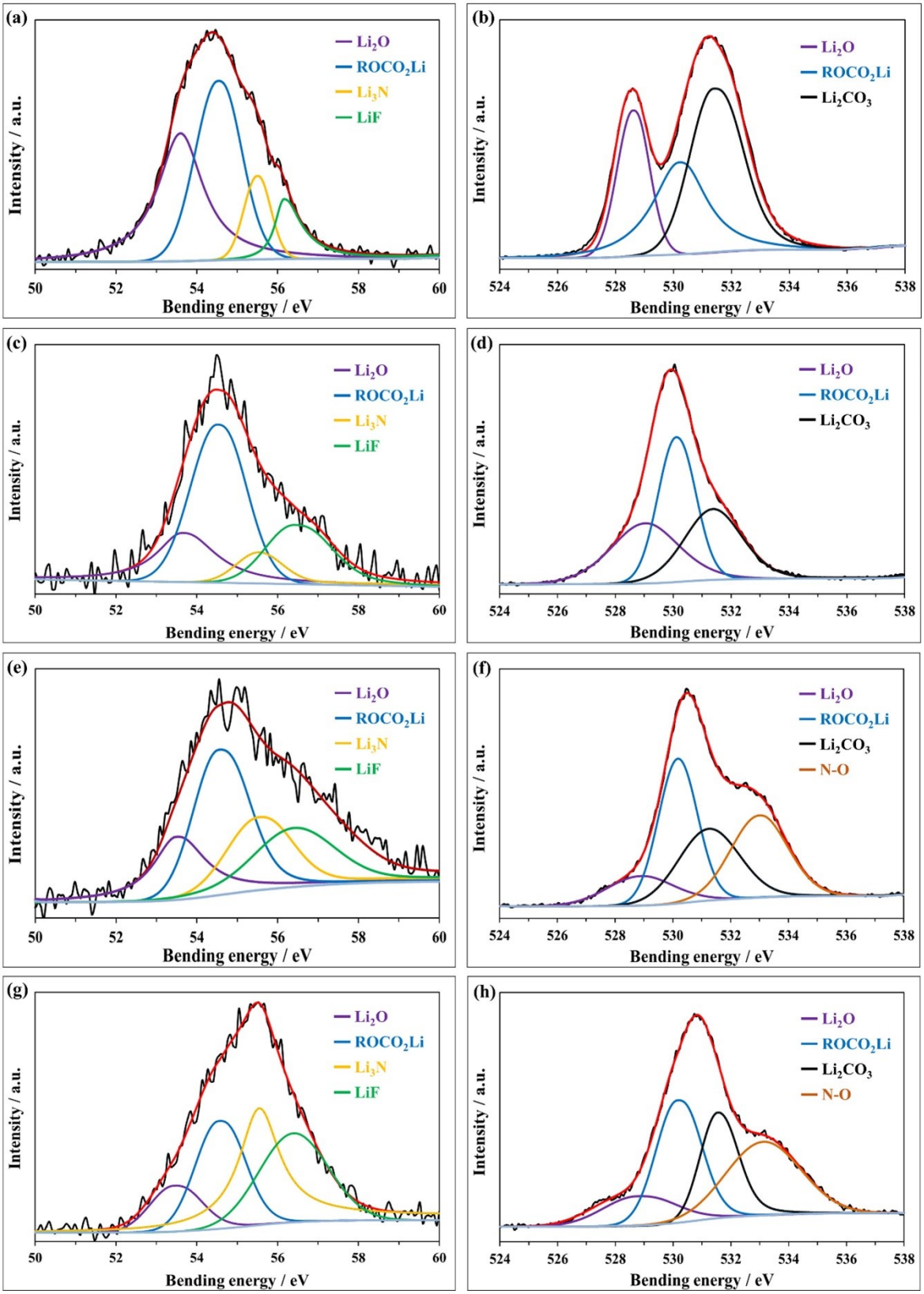

Figure S3. (a, c, e, g) Li 1s and (b, d, f, h) O 1s XPS spectra of various anodes retrieved from their corresponding half cells after one initial discharge/charge cycle at a current density of 2

mA cm^{-2} with a discharge capacity of 2 mAh cm^{-2}. (a, b) Cu. (c, d) CC. (e, f) NCC. (g, h) KNCC.

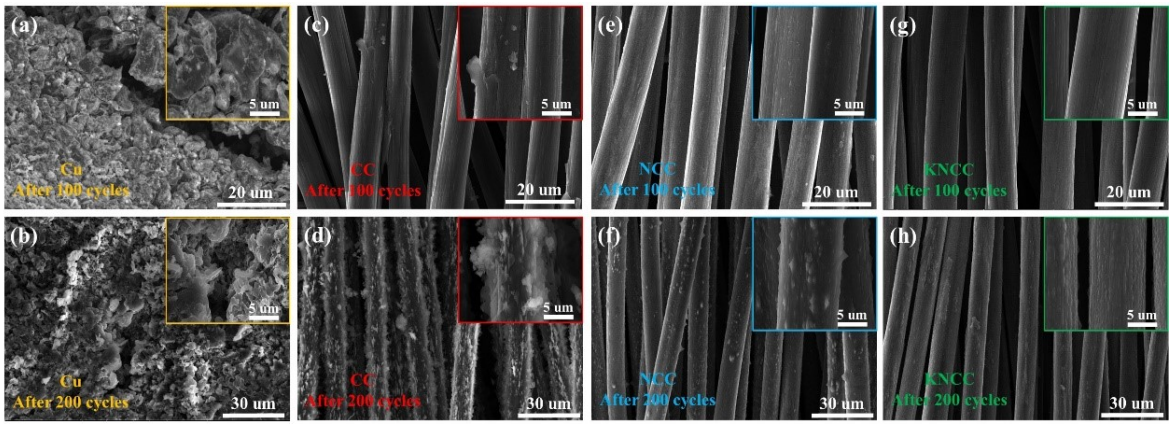

Figure S4. SEM images of various anodes retrieved from their corresponding half cells after cycled at a current density of 2 mA cm^{-2} with a discharge capacity of 2 mAh cm^{-2} for (a, c, e, g) 100 cycles and (b, d, f, h) 200 cycles. (a, b) Cu. (c, d) CC. (e, f) NCC. (g, h) KNCC.

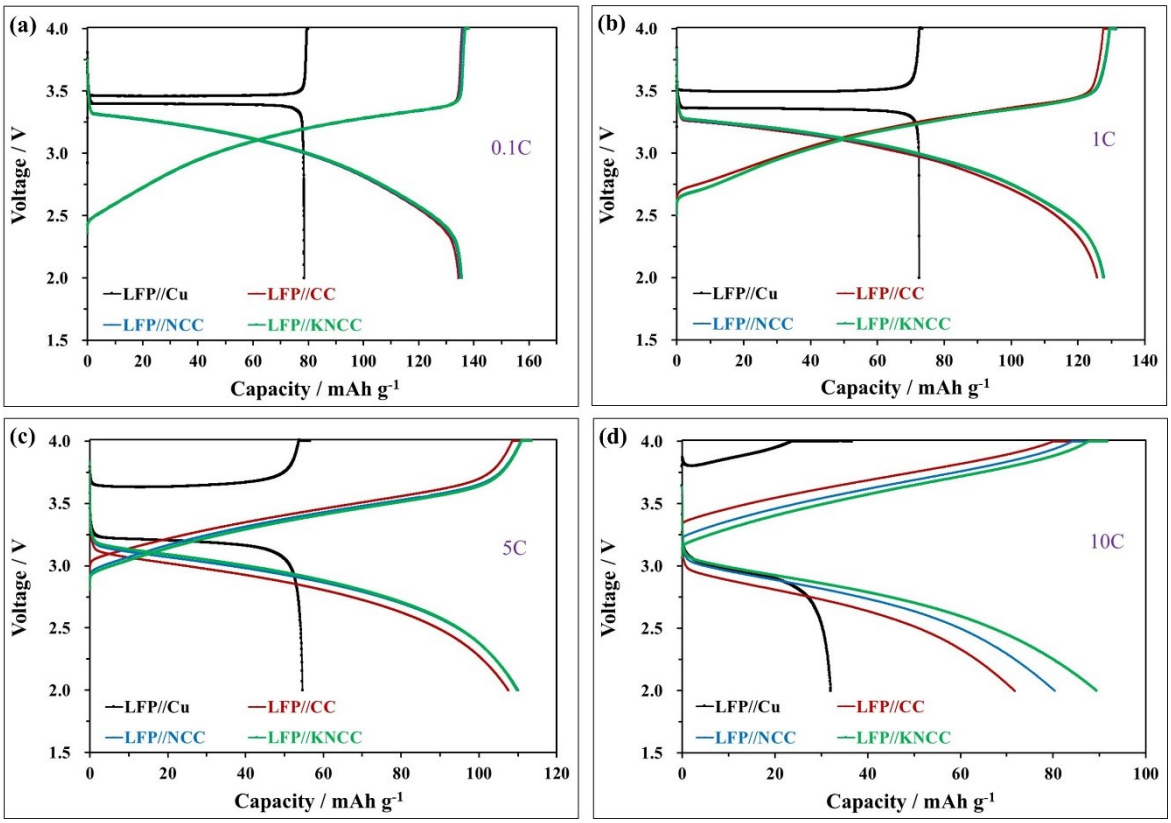

Figure S5. Charge/discharge profiles of full cells with various anodes at different currents of (a) 0.1 C, (b) 1 C, (c) 5 C, and (d) 10 C.

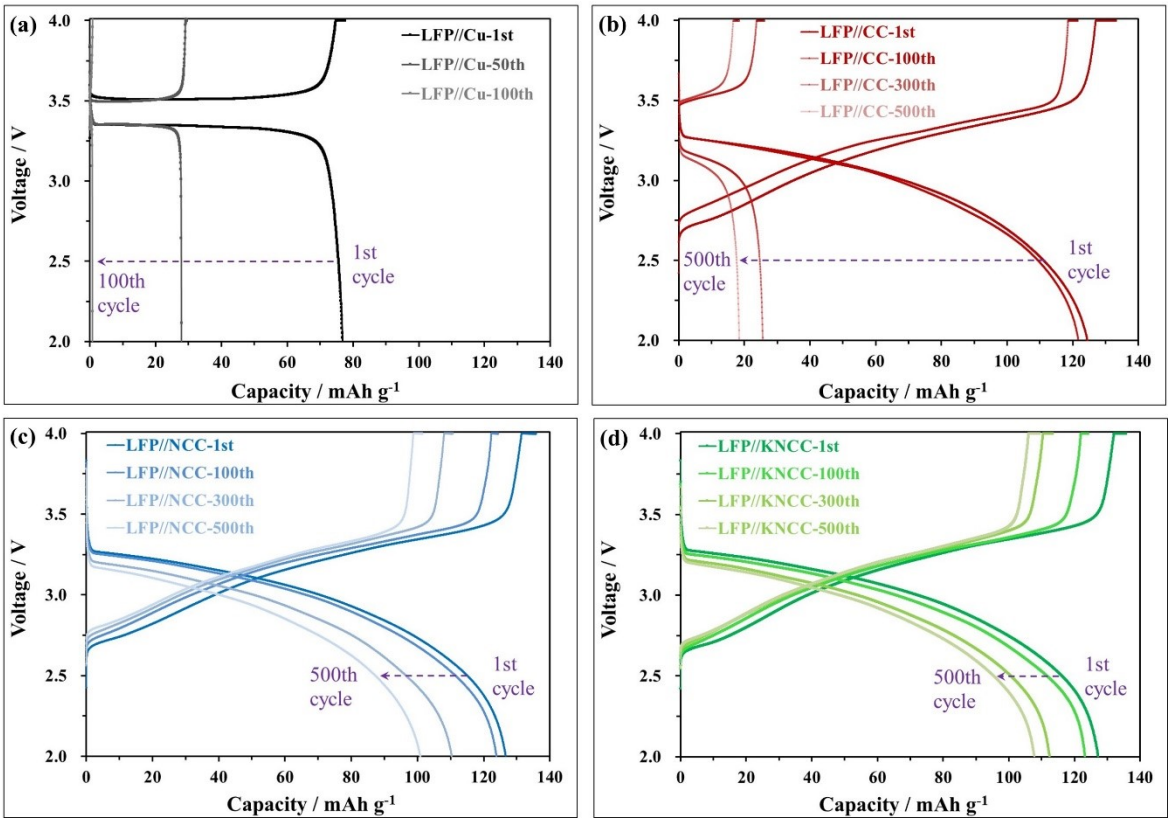

Figure S6. Charge/discharge profiles upon cycling at 1 C of full cells with various anodes of (a) Cu, (b) CC, (c) NCC, and (d) KNCC.

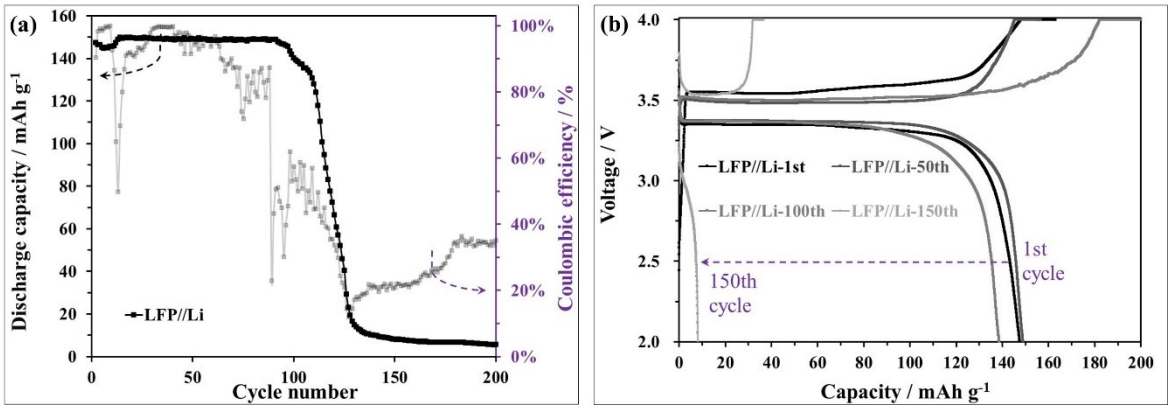

Figure S7. (a) Cycling performance and (b) charge/discharge profiles upon cycling at 1 C of a full cell incorporating a conventional Li metal anode.

Table S1. BET specific surface areas and DFT pore volumes of various materials.

Material	Specific surface area ($m^2\ g^{-1}$)	Total pore volume ($cm^3\ g^{-1}$)	Micropore volume ($cm^3\ g^{-1}$)	Mesopore volume ($cm^3\ g^{-1}$)	Macropore volume ($cm^3\ g^{-1}$)
CC	10.48	0.0130	0	0.0113	0.0017
NCC	10.81	0.0177	0	0.0157	0.0020
KNCC	18.71	0.0335	0	0.0310	0.0024

Table S2. Contents of different elements of various materials.

Material	C (atom.%)	O (atom.%)	N (atom.%)
CC	83.59	16.12	0.29
NCC	87.93	6.46	5.61
KNCC	87.86	6.82	5.32

Table S3. Distributions of different types of doped nitrogen of various materials.

Material	Pyridinic N (atom.%)	Pyrrolic N (atom.%)	Quaternary N (atom.%)
CC	4.96	17.95	77.09
NCC	28.50	33.42	38.08
KNCC	27.53	42.22	30.25

Table S4. Overall Li binding energies of various materials.

Material	Overall Li binding energy (eV)
CC	-48.53
NCC	-55.49
KNCC	-55.73

Overall Li binding energy of a material is defined as the sum of the binding energies of its 100 atoms with Li according to:

$$E_O = \sum C_x * A_x * E_x$$

where E_O is overall Li binding energy per 100 atoms of the material, C_x is the content of a specific element, A_x is the atomic ratio of a specific type of an element (for carbon, A_x = 100%; for nitrogen, A_x refers to the atomic ratios of pyridinic N, pyrrolic N, and quaternary N, respectively, in Table S3), E_x is binding energy of Li with a specific element. According to a previous report [1], the binding energies of Li with carbon, quaternary N, pyridinic N, and pyrrolic N were -0.579 eV, -0.183 eV, -1.003 eV, and -1.379 eV, respectively, which were used for the calculation of E_O values of various materials in the present work.

Table S5. Potential plateaus during the SEI formation of various anodes in half cells.

Anode	First plateau		Second plateau	
	Potential (V, vs. Li/Li^+)	Length (mAh cm^{-2})	Potential (V, vs. Li/Li^+)	Length (mAh cm^{-2})
Cu	0.9551	0.0022	0.0827	0.0061
CC	1.3136	0.0240	0.7433	0.1313
NCC	1.4840	0.0400	0.7507	0.2010
KNCC	1.4950	0.0416	0.7697	0.2521

Current density: 2 mA cm^{-2}.

Table S6. Initial charge/discharge performances of full cells with various anodes.

Full cell	Charge capacity (mAh g^{-1})	Discharge capacity (mAh g^{-1})	ICE (%)
LFP||Cu	163.4	85.3	52.2
LFP||CC	166.9	135.5	81.2
LFP||NCC	166.0	136.3	82.1
LFP||KNCC	165.7	136.9	82.6

Current: 0.1 C. Cut-off voltage: 2.0 ~ 4.0 V.

References

[1]. Kim, M. S.; Ryu, J.-H.; Deepika; Lim, Y. R.; Nah, I. W.; Lee, K.-R.; Archer, L. A.; Il Cho, W. Langmuir–Blodgett artificial solid-electrolyte interphases for practical lithium metal batteries. *Nat Energy* **2018**, 3, 889-898.