Electronic Supplementary Information

Facile synthesis of cobalt fluoride (CoF_2)/multi-walled carbon nanotubes (MWCNTs) nanocomposites and improvement of their electrochemical performance as cathode materials for Li-ion batteries

Hayoung Park,[ab] Il-Seop Jang,[ab] Bo-Ye Song,[ab] Yun Chan Kang,[b] Seongseop Kim*[c] and Jinyoung Chun*[a]

[a] Emerging Materials R&D Division, Korea Institute of Ceramic Engineering and Technology (KICET), Jinju 52851, Republic of Korea. E-mail: jchun@kicet.re.kr

[b] Department of Materials Science and Engineering, Korea University, Seoul 02841, Republic of Korea.

[c] School of Chemical Engineering, Clean Energy Research Center, Jeonbuk National University, Jeonju 54896, Republic of Korea. E-mail: seongseopkim@jbnu.ac.kr

***Corresponding authors.**

E-mail addresses: seongseopkim@jbnu.ac.kr (S. Kim), jchun@kicet.re.kr (J. Chun).

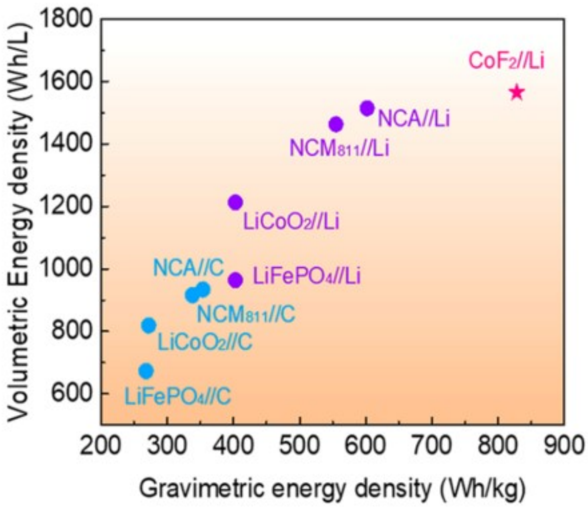

Fig. S1 Comparison of theoretically achievable energy densities (maximal values) for CoF_2-Li battery, commercial Li-ion batteries, and Li-metal batteries using commercial cathodes. Reproduced with permission from Ref. 23. Copyright (2021) ACS Nano.

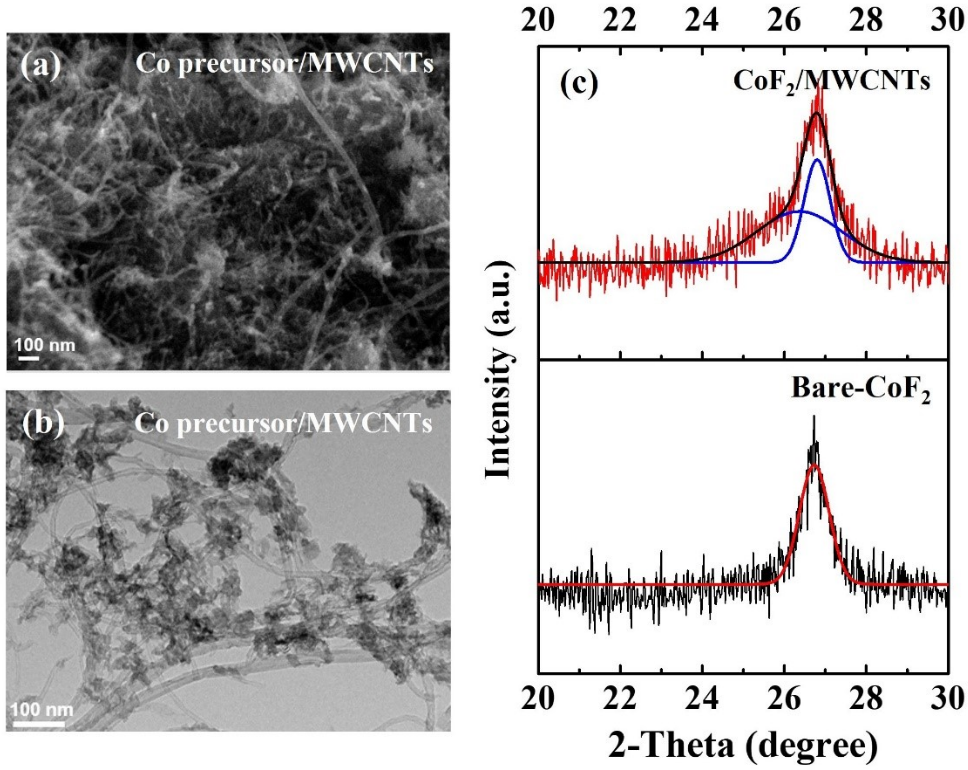

Fig. S2 (a) SEM and (b) TEM image of Co precursor/MWCNTs. (c) A partial magnification of XRD patterns of CoF_2/MWCNTs and bare-CoF_2.

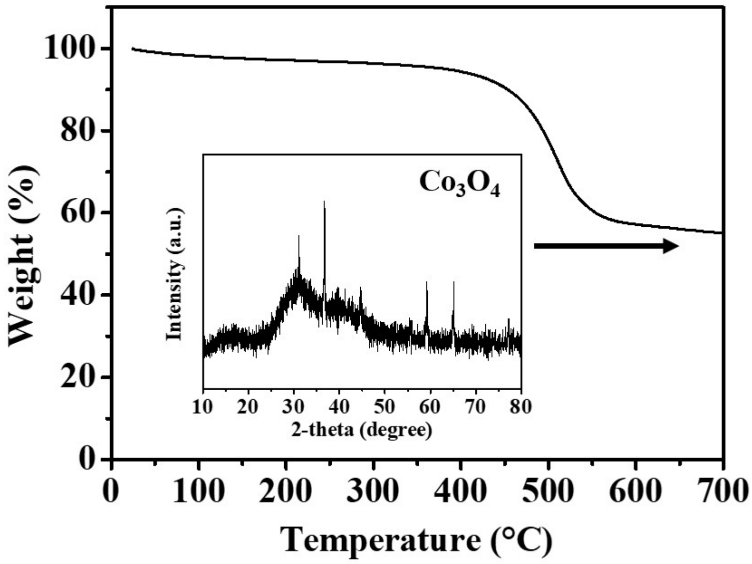

Fig. S3 TGA curve of CoF_2/MWCNTs nanocomposites.

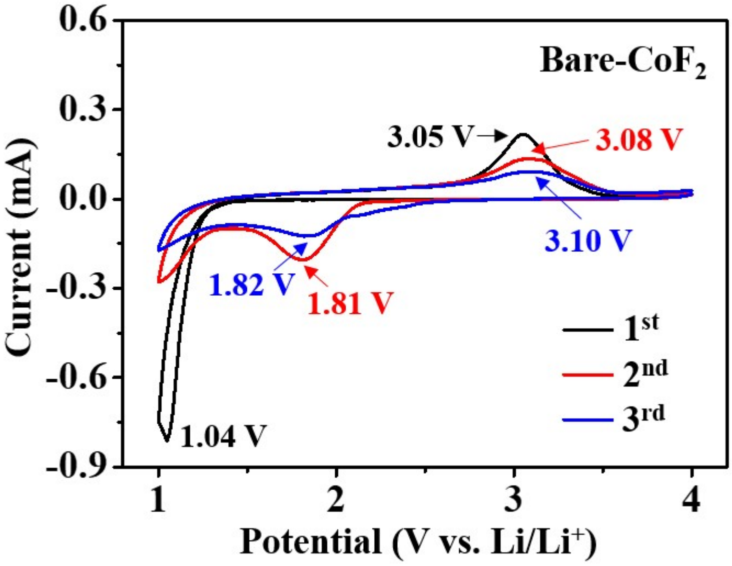

Fig. S4 CV curves of bare-CoF_2 measured at a scan rate of 0.1 mV s^{-1}.

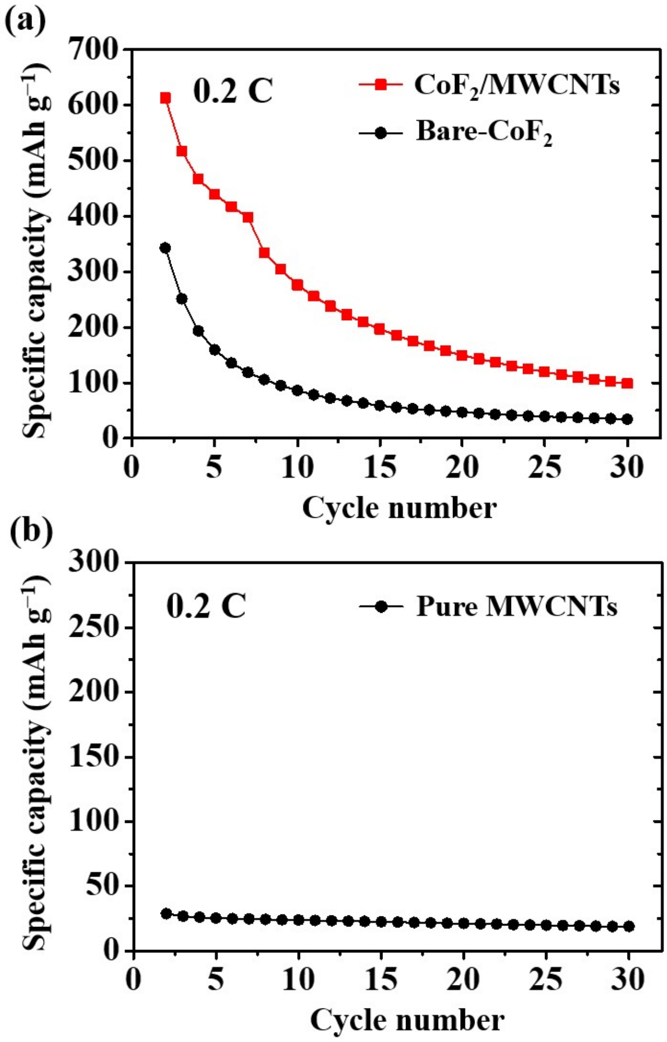

Fig. S5 Cycle properties of (a) CoF_2/MWCNTs and bare-CoF_2 and (b) pure MWCNTs. The specific capacities of pure MWCNTs are calculated based on the target mass of MWCNTs (30 wt%).

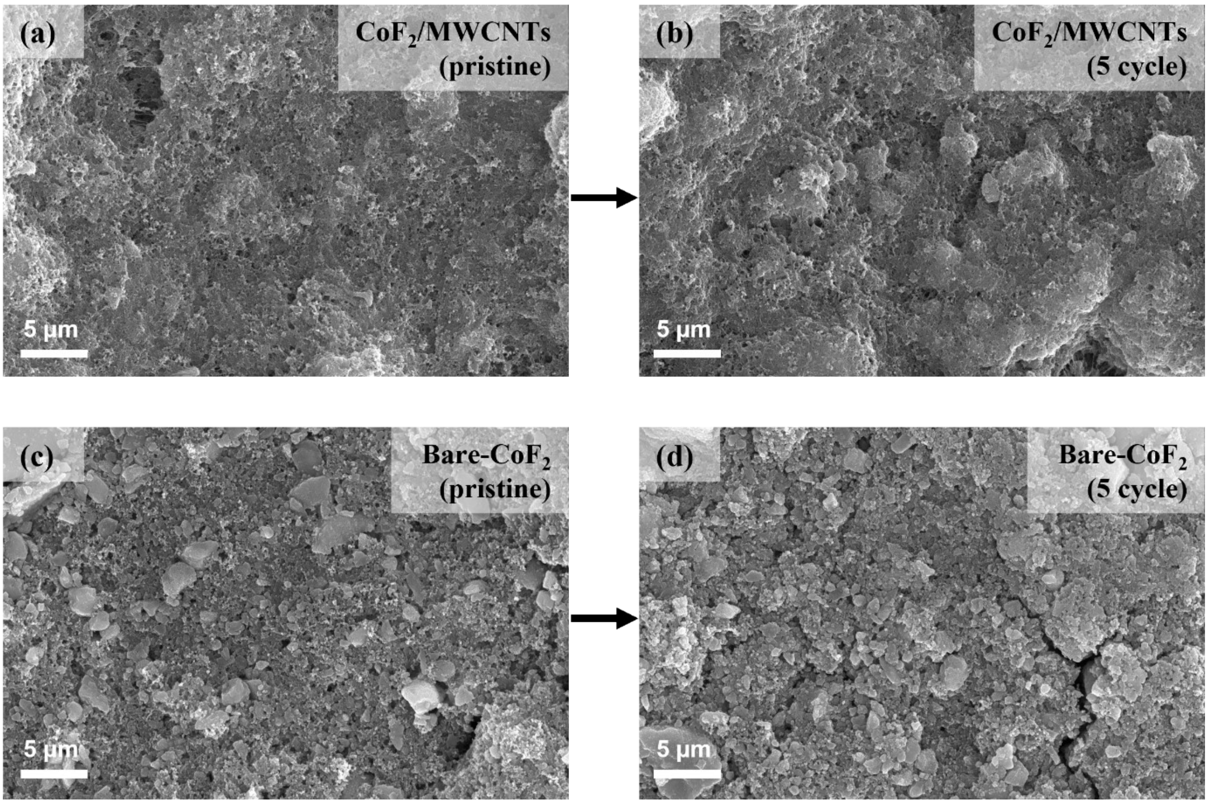

Fig. S6 SEM images of (a, b) CoF_2/MWCNTs and (c, d) bare-CoF_2 electrodes: (a, c) Before cycling (pristine) and (b, d) after the 5th cycle at 0.5 C.

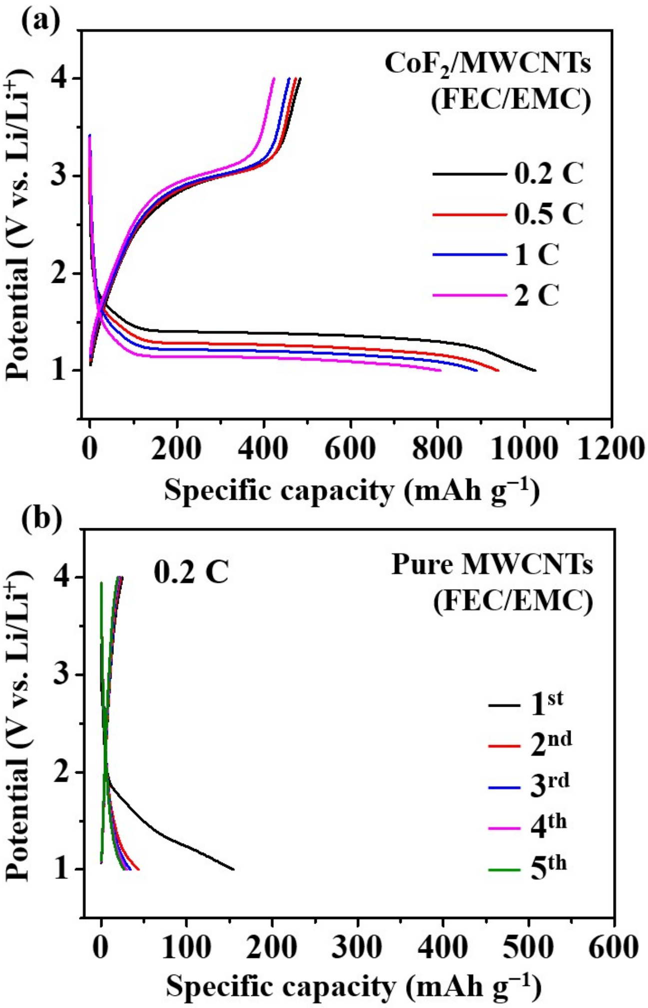

Fig. S7 Voltage profiles of (a) CoF_2/MWCNTs with FEC/EMC at the first cycle with various C-rates (0.2, 0.5, 1, and 2 C) and (b) pure MWCNTs. The specific capacities of pure MWCNTs are calculated based on the target mass of MWCNTs (30 wt%).

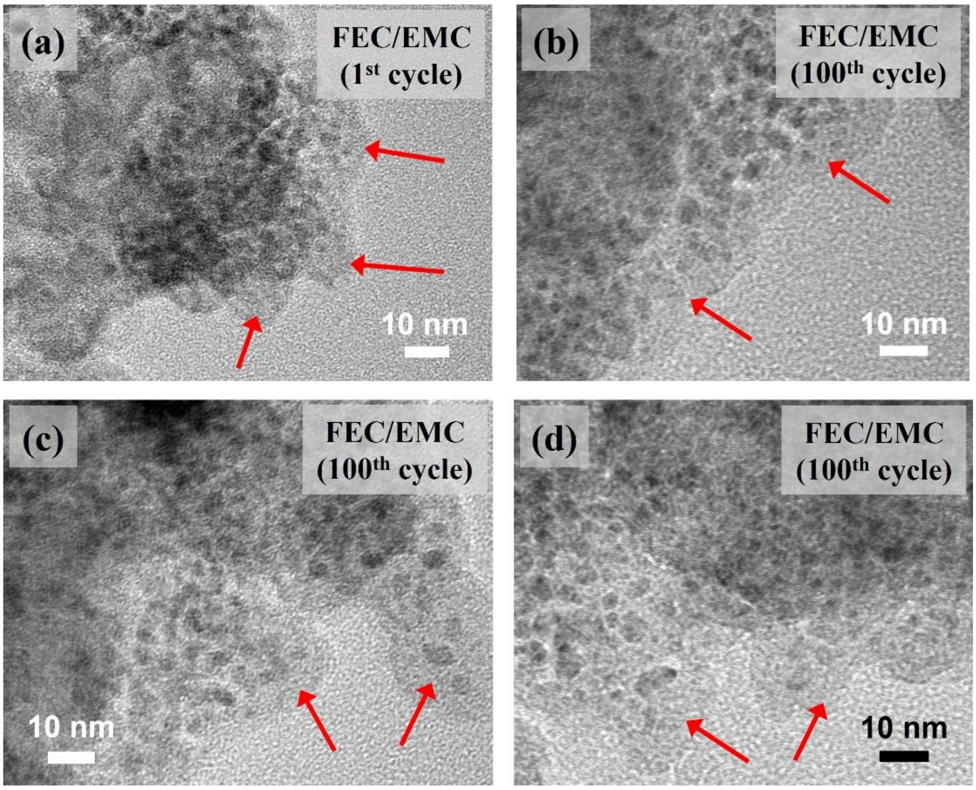

Fig. S8 TEM images of CoF_2/MWCNTs cycled in FEC/EMC electrolyte: (a) After the 1st cycle and (b–d) after the 100th cycle at 0.5 C.

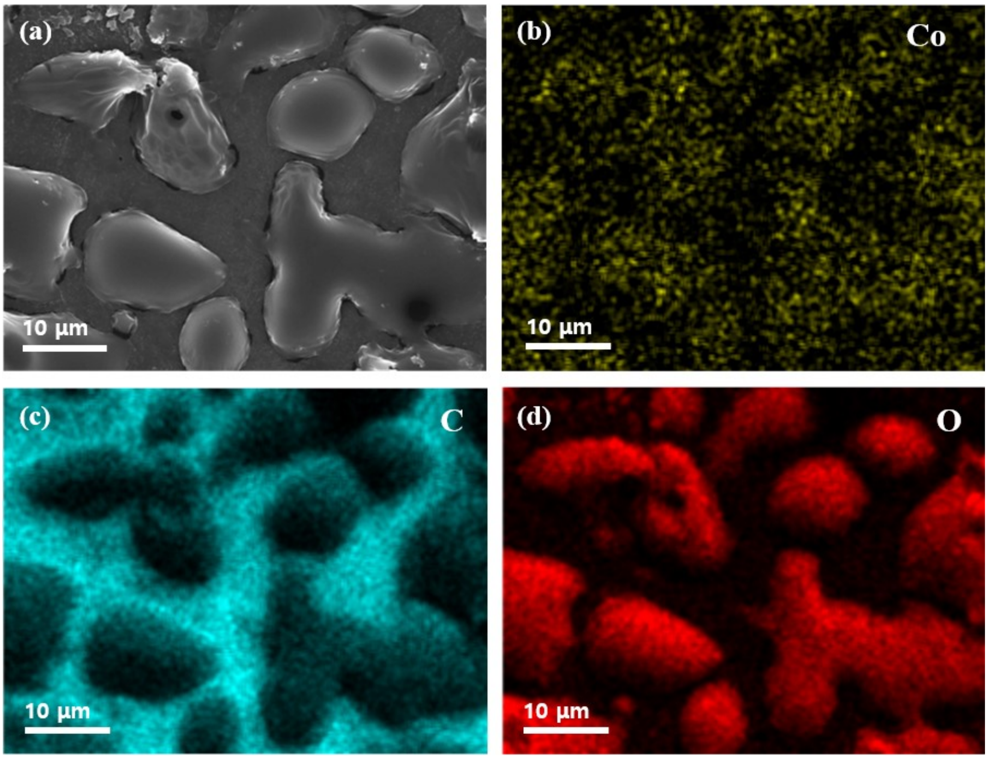

Fig. S9 Post-mortem analysis of clogged parts of the separator after the 100th cycle (electrode: CoF_2/MWCNTs) in EC/DMC electrolyte: (a) SEM image and EDS elemental mapping of (b) cobalt, (c) carbon, and (d) oxygen.

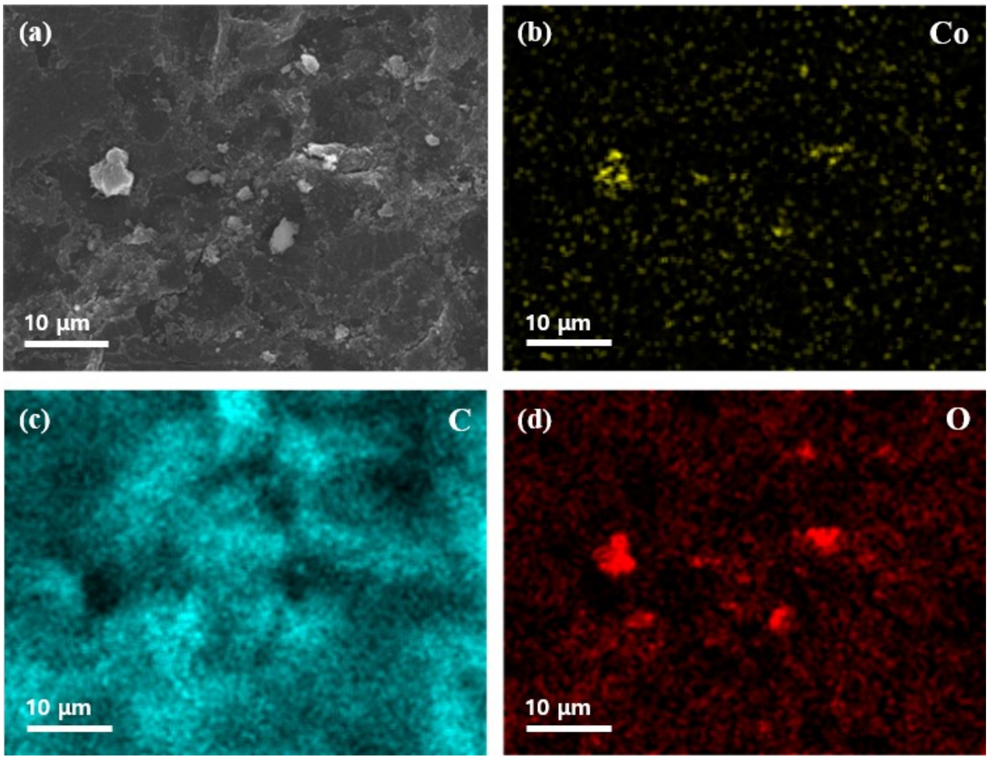

Fig. S10 Post-mortem analysis of clogged parts of the separator after the 100th cycle (electrode: CoF_2/MWCNTs) in FEC/EMC electrolyte: (a) SEM image and EDS elemental mapping of (b) cobalt, (c) carbon, and (d) oxygen.

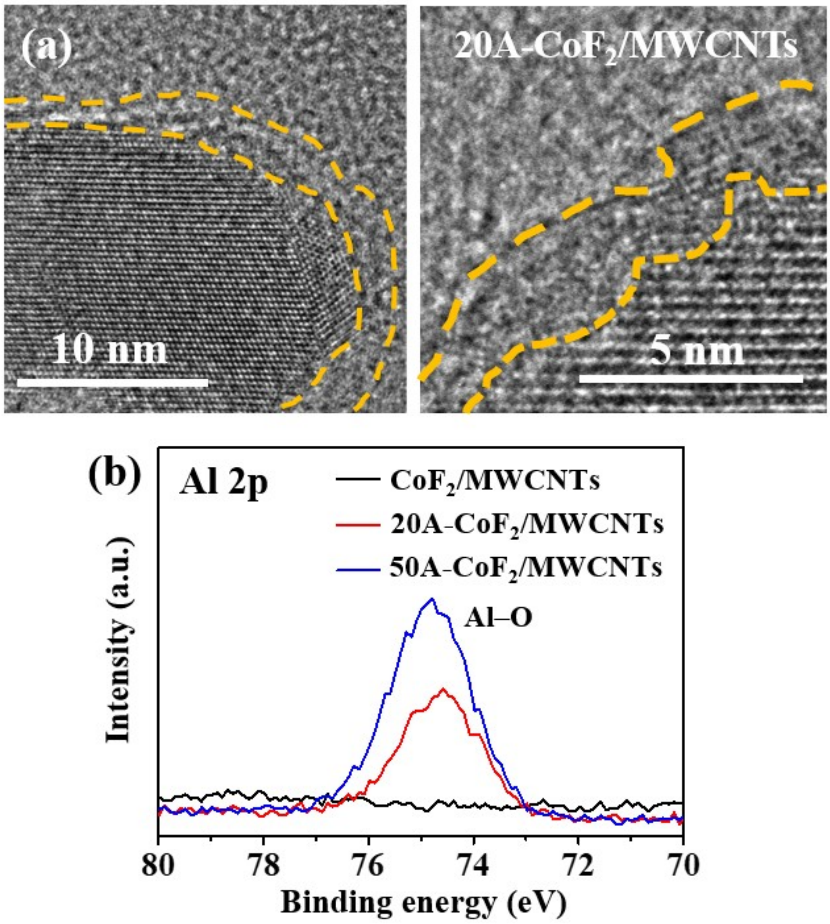

Fig. S11 (a) HR-TEM images of 20A-CoF_2/MWCNTs. (b) XPS spectrum of Al 2p of 20A- and 50A-CoF_2/MWCNTs.

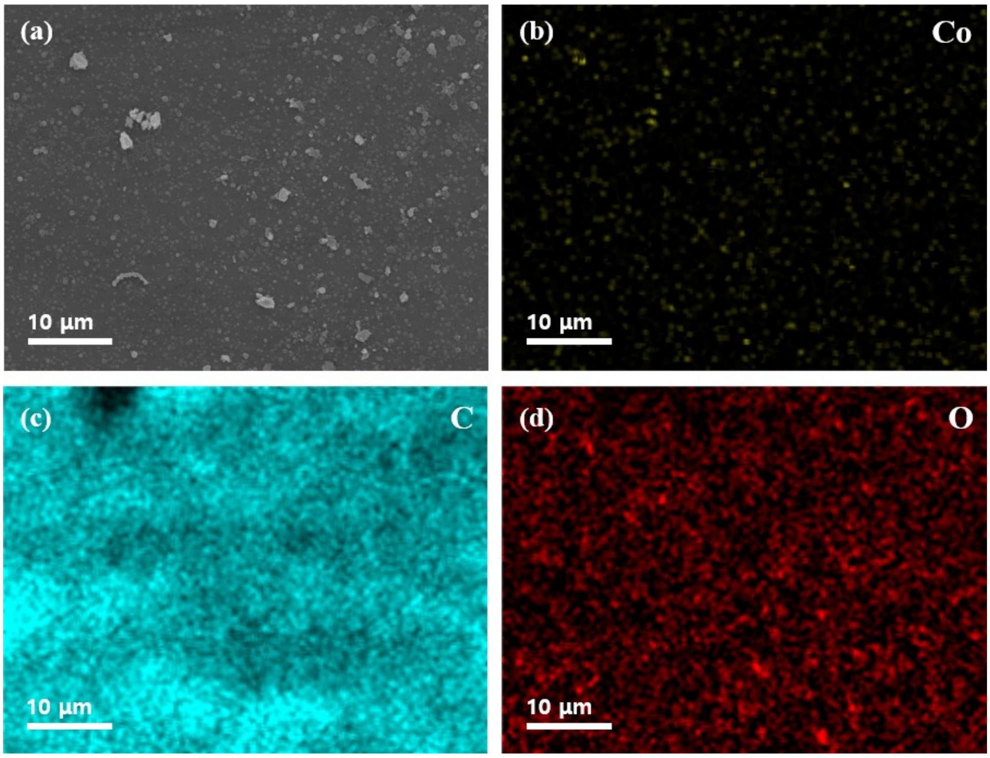

Fig. S12 Post-mortem analysis of clogged parts of the separator after the 500th cycle (electrode: 50A-CoF_2/MWCNTs) in FEC/EMC electrolyte: (a) SEM image and EDS elemental mapping of (b) cobalt, (c) carbon, and (d) oxygen.

Table S1 Comparison of electrochemical performance of cobalt fluorides as cathode materials for LIBs.

Cathode material	Reversible capacity (@ high current density)	Ref.
CoF_2/MWCNTs	**469 mAh g^{-1} (@ 2 C)**	**This work**
Honeycombed CoF_2@C	205 mAh g^{-1} (@ 2 C)	[19]
CoF_2@C (MOF)	195 mAh g^{-1} (@ 2 C)	[23]
CoF_2/Fe_2O_3	90 mAh g^{-1} (@ 1 A g^{-1})	[31]
CoF_2@carbon fiber cloth	~150 mAh g^{-1} (@ 1 A g^{-1})	[35]
CoF_2/mesoporous carbon	432 mAh g^{-1} (@ 2 C)	[28]
CoF_2/CNT	~150 mAh g^{-1} (@ 1 A g^{-1})	[21]
Co/LiF/C	~25 mAh g^{-1} (@ 1.25 C)	[22]

* The discharge capacities in Ref. 22, 28, 31, and 35 are considered as the reversible capacities because the coulombic efficiencies of each data are close to 100%.