Electronic Supplementary Information

Design of an ultralong-life Li-CO_2 batteries with IrO_2 nanoparticles highly dispersed onto nitrogen-doped carbon nanotubes

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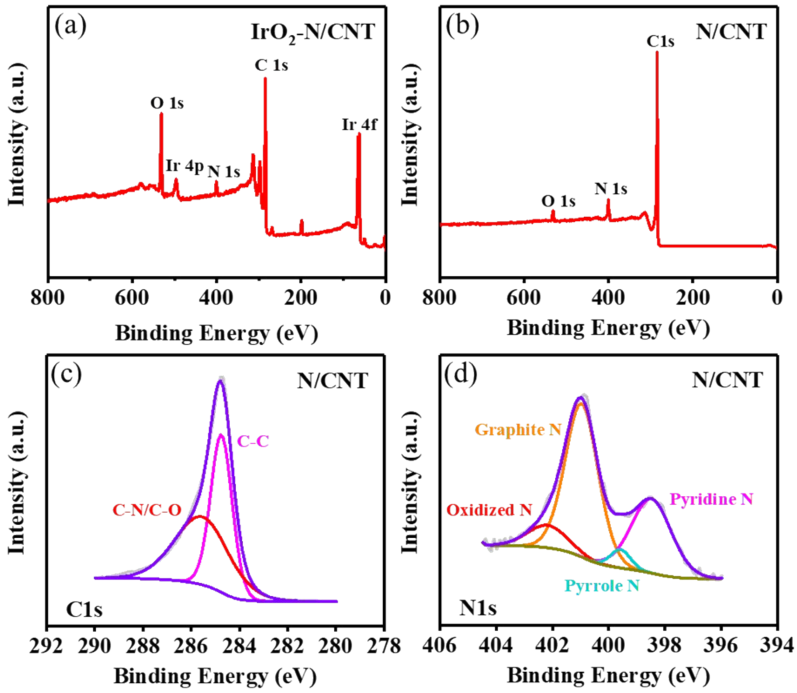

Figure S1. The full XPS spectrum of (a) IrO_2-N/CNT and (b) N/CNT; the high-resolution XPS spectra of (c) C1s and (d) N1s for N/CNT.

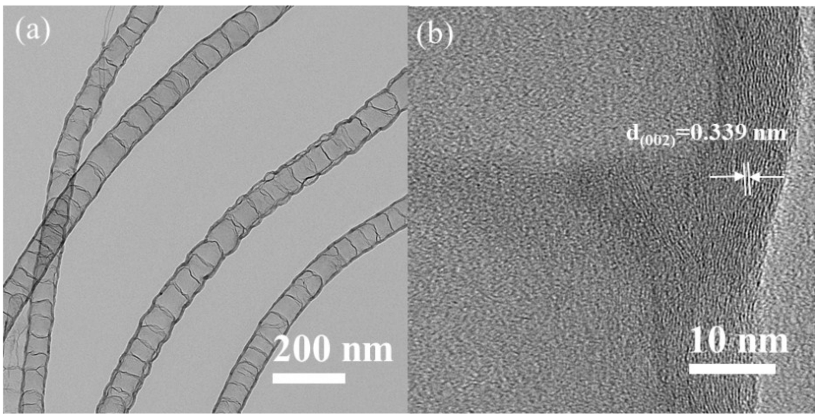

Figure S2. (a) TEM and (b) HRTEM images of N/CNT.

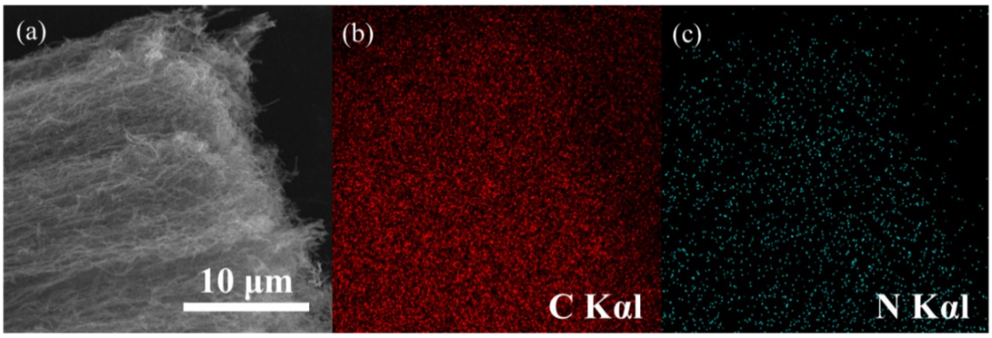

Figure S3. The EDS mapping of C and N in N/CNT.

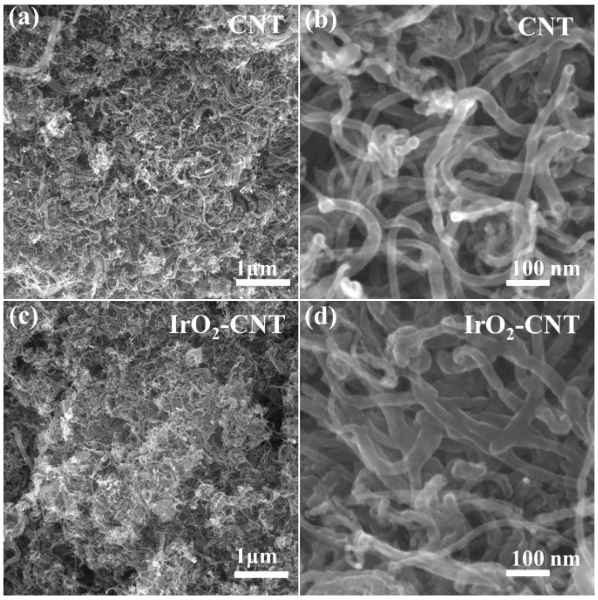

Figure S4. FESEM images of (a, b) CNT and (c, d) IrO_2-CNT.

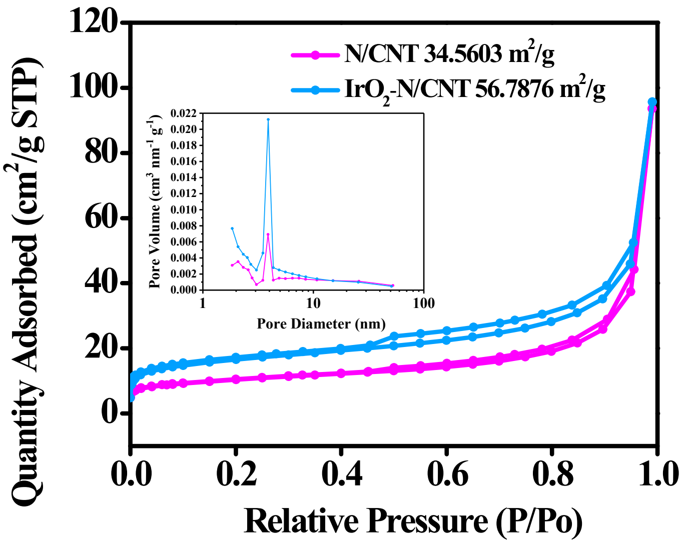

Figure S5. N_2 adsorption-desorption isotherms and the pore-size distribution (inset) of N/CNT and IrO_2-N/CNT.

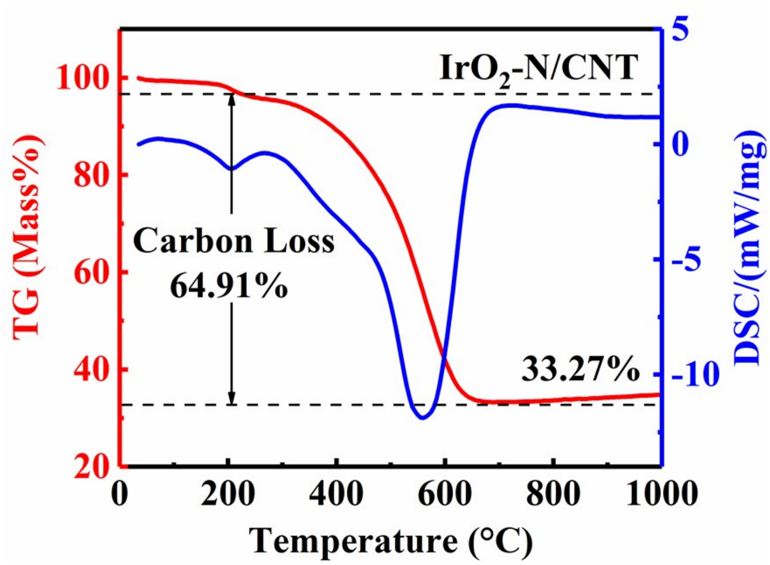

Figure S6. TGA-DTA curves of IrO_2-N/CNT.

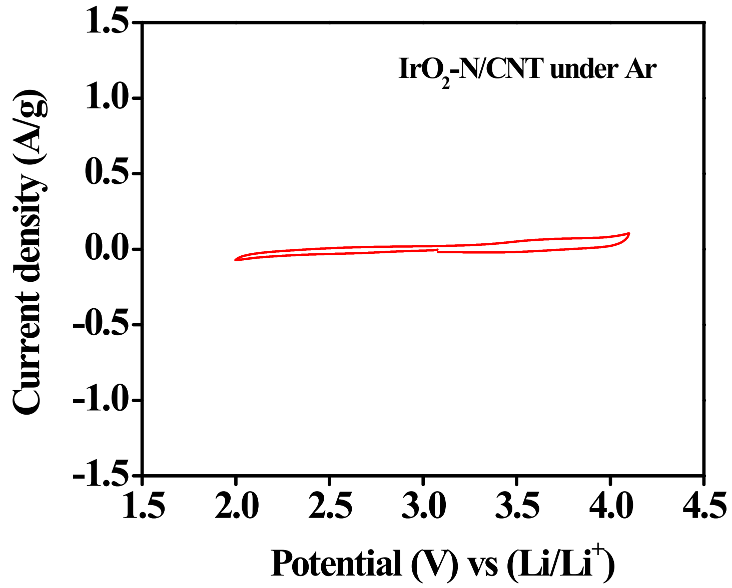

Figure S7. The CV curves of the Li-CO_2 batteries with IrO_2-N/CNT between 2.0-4.1 V at 0.5 mV/s under Ar atmosphere in TEGDME electrolyte.

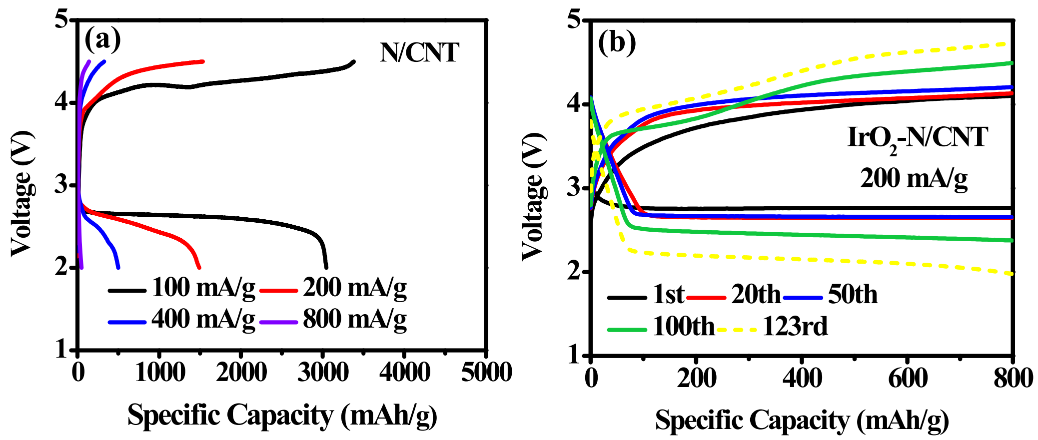

Figure S8. (a) The initial discharge-charge curves of Li-CO_2 batteries with N/CNT cathodes at different current density; (b) The cycling performance of IrO_2-N/CNT cathodes with a cutoff capacity of 800 mAh/g at a current density of 200 mA/g.

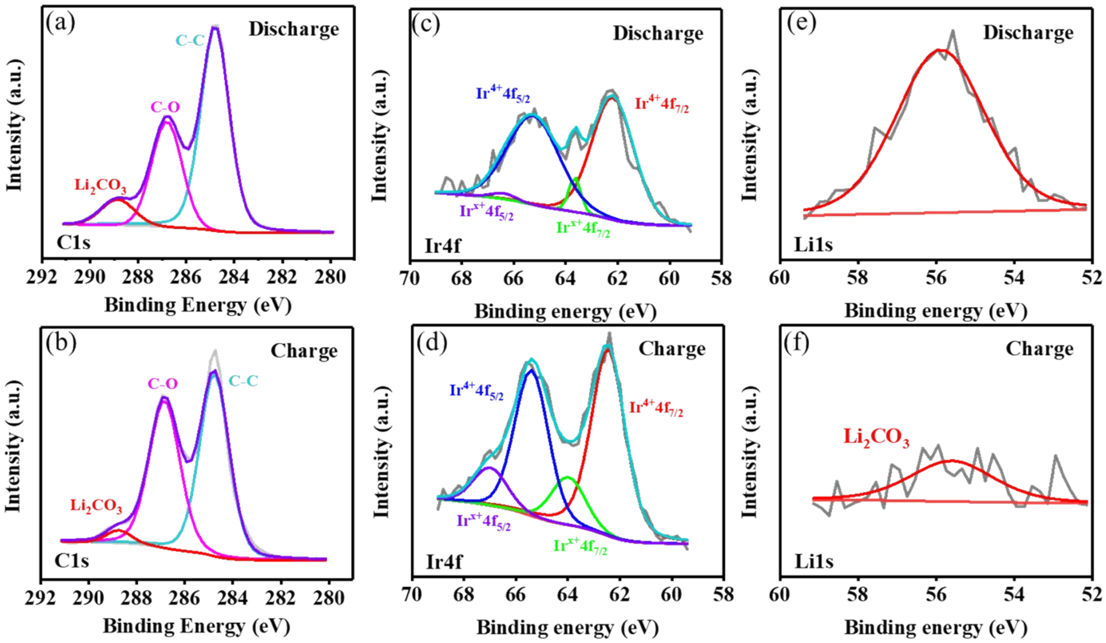

Figure S9. (a, b) C1s; (c, d) Ir4f and (e, f) Li1s XPS spectra of the cathodes after 20th discharge and charge with a curtailing capacity of 400 mAh/g at 100 mA/g.

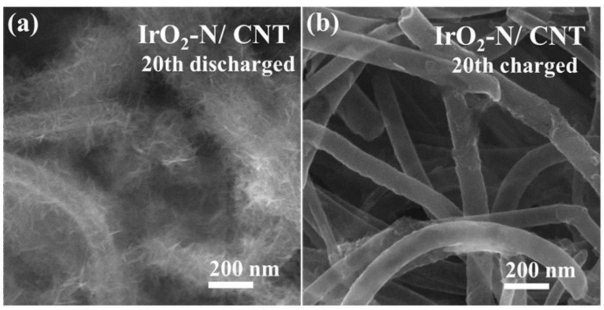

Figure S10. SEM of IrO_2-N/CNT cathodes (a) after 20th discharged; (b) after 20th charged with a limited capacity of 400 mAh/g at 100 mA/g.

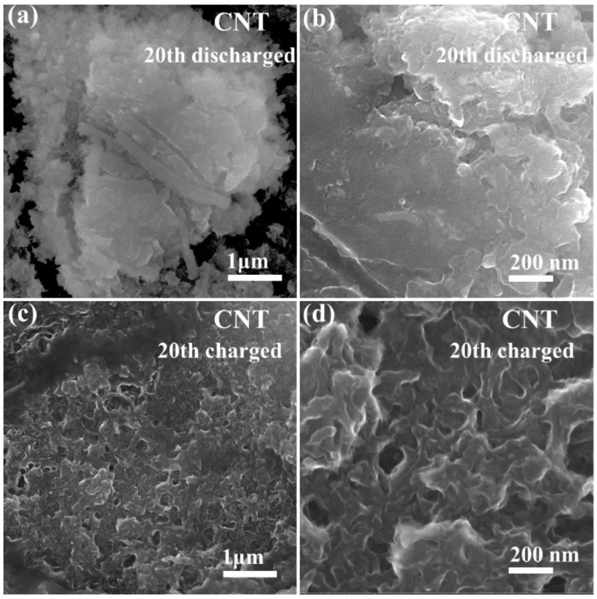

Figure S11. (a, b) SEM of CNT cathodes after 20th discharged (c, d) 20th charged with a limited capacity of 400 mAh/g at 100 mA/g.

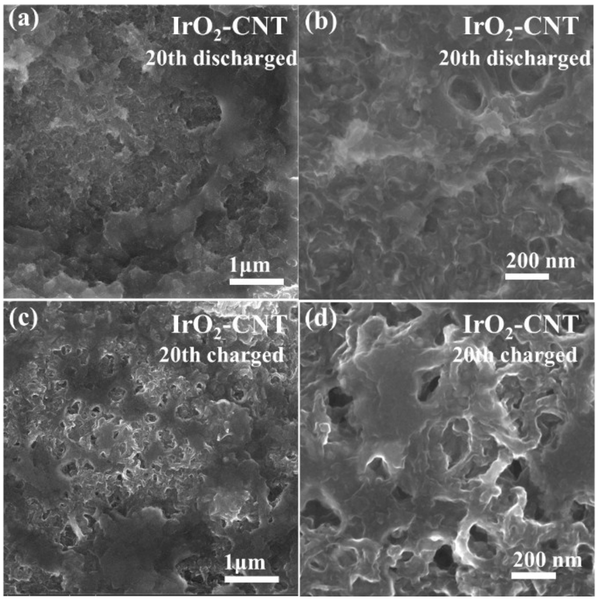

Figure S12. (a, b) SEM of IrO_2-CNT cathodes after 20th discharged (c, d) 20th charged with a limited capacity of 400 mAh/g at 100 mA/g.

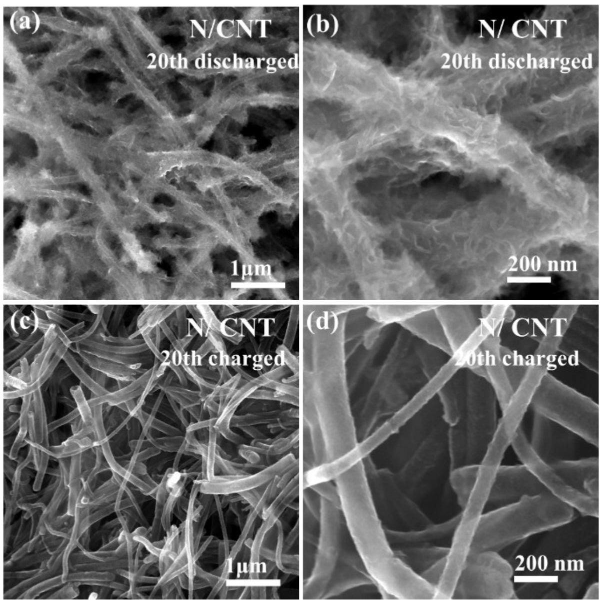

Figure S13. (a, b) SEM of N/CNT cathodes after 20th discharged (c, d) 20th charged with a limited capacity of 400 mAh/g at 100 mA/g.

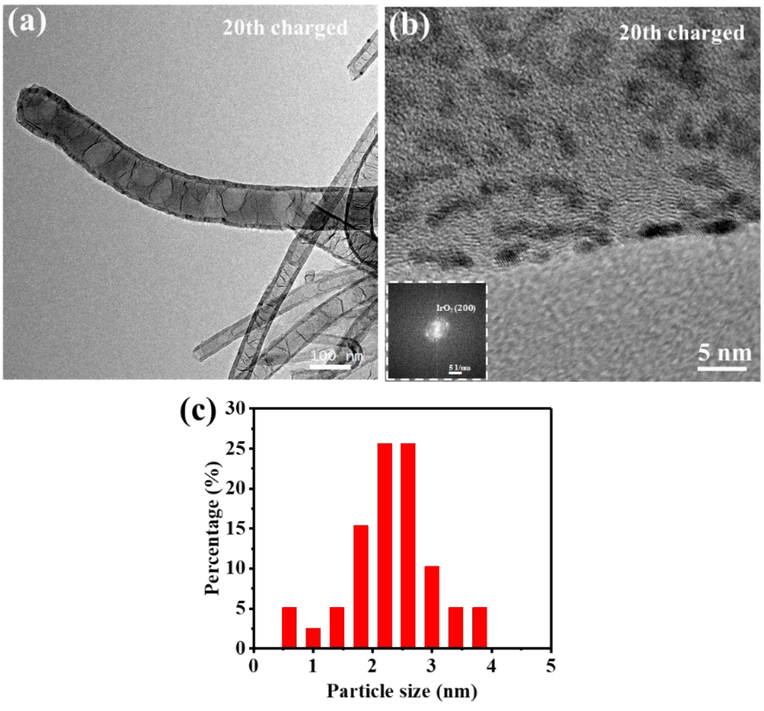

Figure S14. (a) TEM and (b) HRTEM of IrO_2-N/CNT cathodes after 20th charged with a limited capacity of 400 mAh/g at 100 mA/g.(c) The particle size of IrO_2 NPs on IrO_2-N/CNT surface.

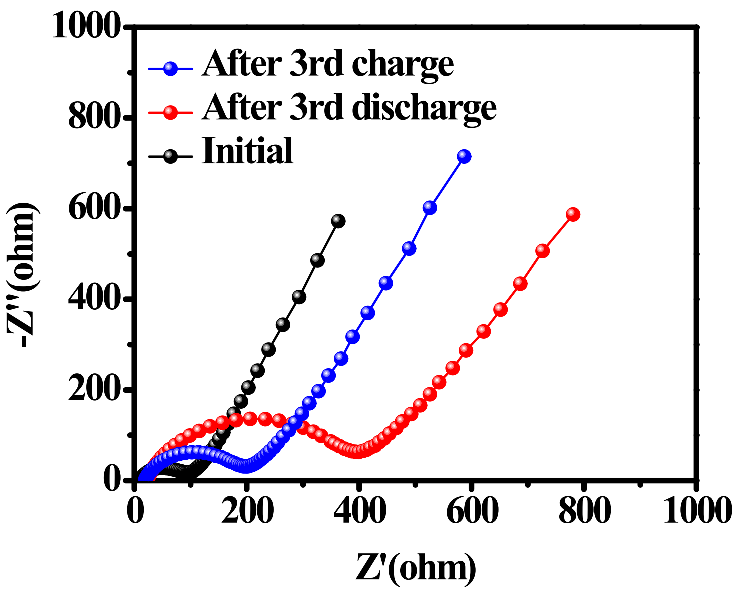

Figure S15. EIS curves of IrO_2-N/CNT cathode after 3rd discharge and charge at 100 mA/g.

Table S1. Comparison and summary of recent literatures on electrochemical performance of Li-CO_2 batteries with different cathodes at room temperature.

Materials	**Overpotential (V)**	**Charge Plateau (V)**	**Battery operation time (h)**	**References**
IrO_2-N/CNT	**1.10 (100 mA/g, 400 mA/g)**	**3.69**	**2500**	**This work**
N-CNT@Ti	1.37 (100 mA/g, 1000 mAh/g)	4.2	1000	*Ref.S1*
Ir NSs-CNFs	1.05 (500 mA/g,1000 mAh/g)	3.8	1600	*Ref.S2*
MoS_2 NFs	0.7 (100 mA/g,500 mAh/g)	-	2000	*Ref.S3*
B-NCNT	1.33 (100 mA/g,1000 mAh/g)	4.05	800	*Ref.S4*
CNT@RuO_2	1.51 (100 mA/g,500 mAh/g)	3.97	300	*Ref.S5*
Ru@Super P	1.71 (100 mA/g,1000 mAh/g)	4.25	1400	*Ref.S6*
Ir/CNFs	1.38 (100 mA/g,1000 mAh/g)	4.14	540	*Ref.S7*
NiO-CNT	1.40 (100 mA/g,1000 mAh/g)	4.1	500	*Ref.S8*

IrO_2/MnO_2	- (100 mA/g)	4.0	1890	*Ref.S9*
RuP_2-NPCF	1.30 (200 mA/g,1000 mAh/g)	4.0	2000	*Ref.S10*
Ru/NC	2.35 (100 mA/g,500 mAh/g)	4.1	1500	*Ref.S11*
CNTs	1.6 (100 mA/g,1000 mAh/g)	4.3	440	*Ref.S12*
Graphene	1.23 (100 mA/g,1000 mAh/g)	4.2	200	*Ref.S13*

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