Electronic Supporting Information

Co_3O_4@MnO_2/Ni nanocomposite as a carbon- and binder-free cathode for rechargeable Li-O_2 batteries

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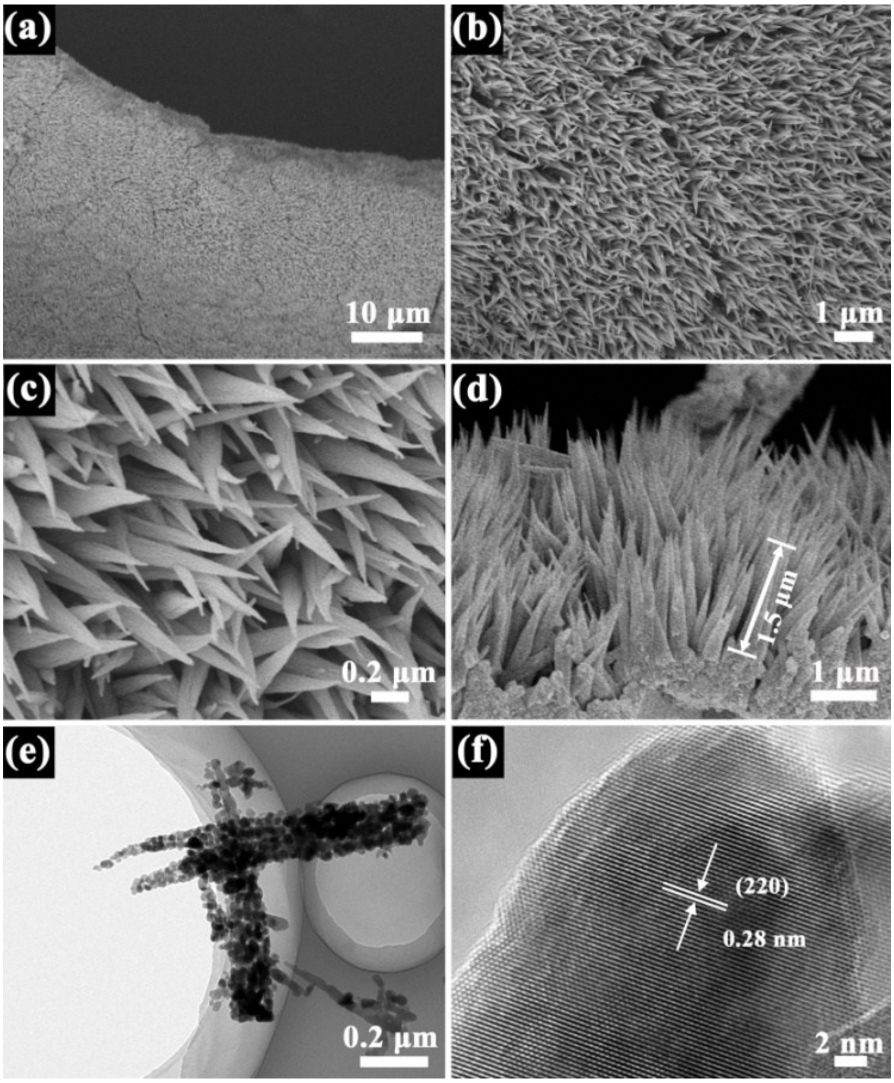

Fig. S1 (a-c) SEM images of Co_3O_4 nanohorns at various magnifications, (d) SEM image of the cross section of Co_3O_4 nanohorns, and (e) TEM and (f) HRTEM images of Co_3O_4 nanohorns.

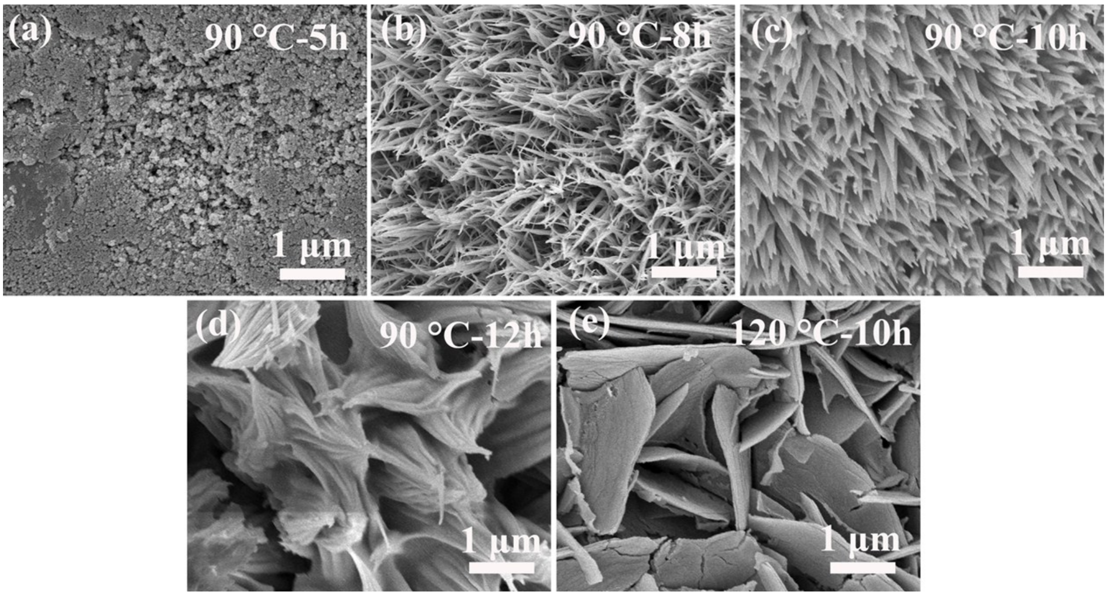

Fig. S2 SEM images of Co_3O_4 obtained at different hydrothermal reaction temperatures and durations.

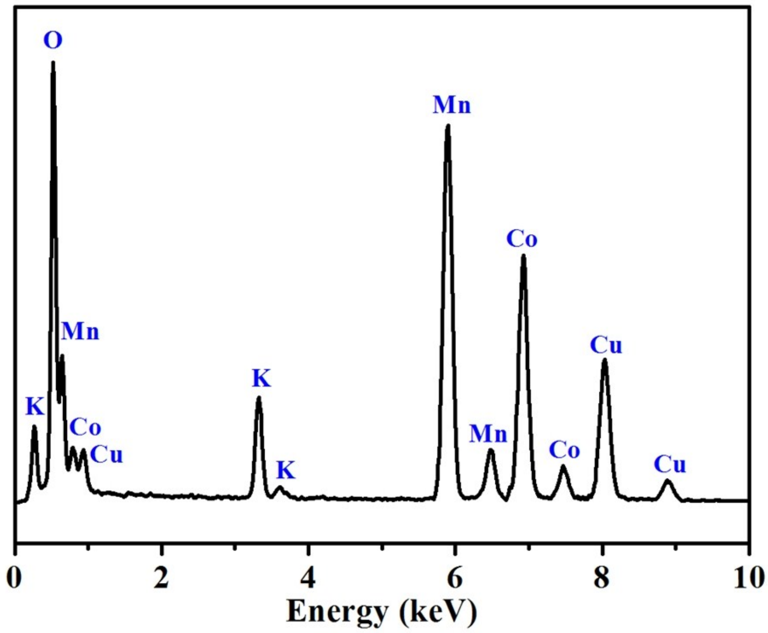

Fig. S3 EDS spectrum of the as-synthesized $Co_3O_4@MnO_2/Ni$. The signal of element potassium is ascribed to the K cations in the birnessite-type MnO_2, which stabilize the lattice structure of manganese oxide and originate from the precursor $KMnO_4$.

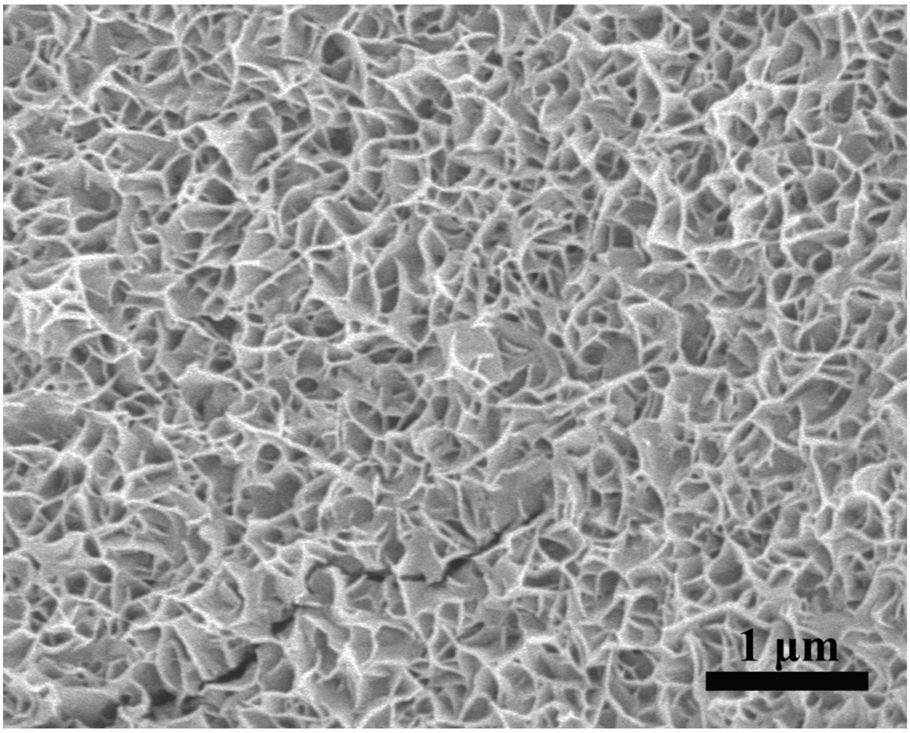

Fig. S4 SEM image of MnO_2 nanosheets supported on a Ni foam.

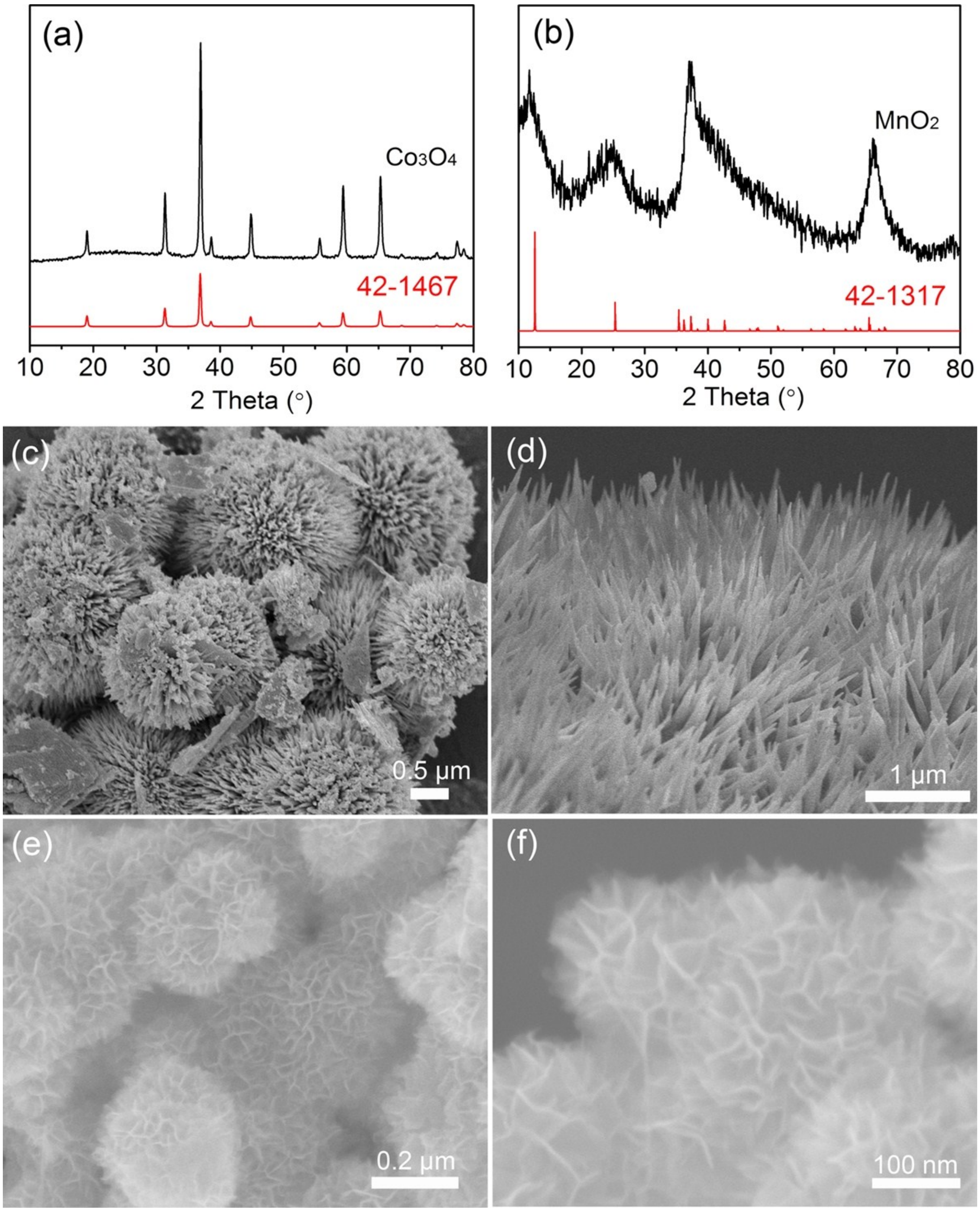

Fig. S5 XRD patterns and SEM images of Co_3O_4 (a, c and d) and MnO_2 (b, e and f) nanomaterials for the mechanically mixed Co_3O_4/MnO_2/C electrode. Without the support of Ni foam, the Co_3O_4 nanohorns tend to aggregate as porous microspheres. From the enlarged image in (d), it can be seen that the Co_3O_4 nanohorns are several micrometers in length and nanometers in diameter, which are in the same order of magnitude with those of the Co_3O_4@MnO_2 nanocomposite in Fig. 2. MnO_2 nanosheets were also obtained with similar thickness to those of the Co_3O_4@MnO_2 nanocomposite.

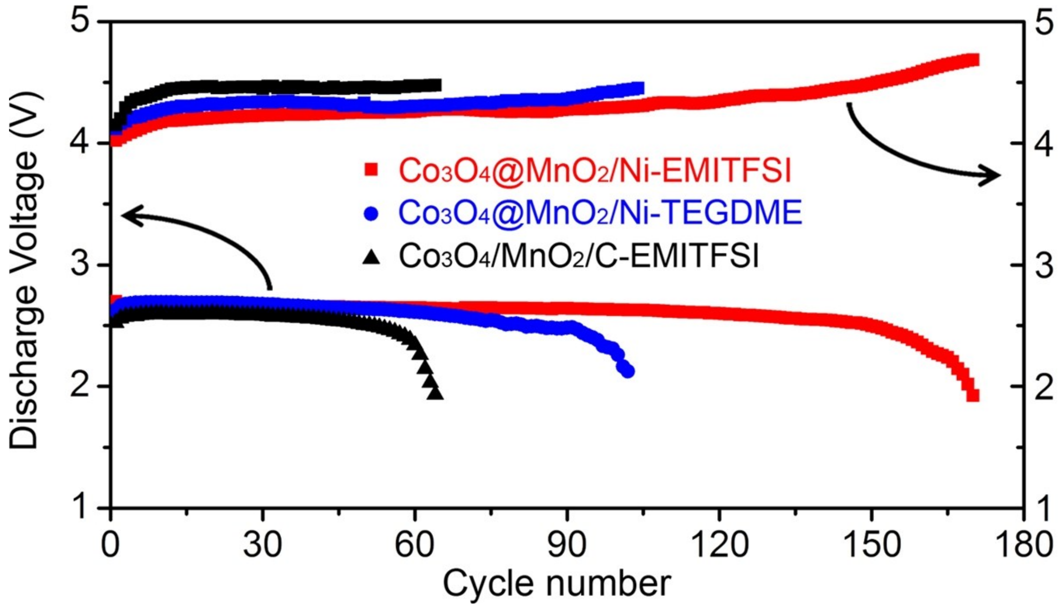

Fig. S6 Cycle performance of Li-O_2 batteries based on the *in-situ* formed nanocomposite of Co_3O_4@MnO_2/Ni and the mechanical mixture Co_3O_4/MnO_2/C cathode with the EMITFSI and TEGDME-based electrolyte.

Table S1 Comparison of $Li\text{-}O_2$ battery performance based on $Co_3O_4@MnO_2/Ni$ to the other reported cobalt or manganese-based cathode catalysts.

Catalysts	Loading (mg cm^{-2})	Overpotential /current density	Cycling performance/ cutoff capacity	Ref.
Mesoporous $Li_{0.5}MnO_2$	1.0	0.87 V/100 mA g^{-1}	190 cycles/1000 mA h g^{-1}_{carbon}	1
Co_3O_4/graphene nanoflakes	1±0.1	~ 1.3 V/200 mA g-1	80 cycles/1000 mA h g^{-1}	2
$MnCo_2O_4$/graphene hybrid	0.5	0.8 V/100 mA g^{-1}	40 cycles/1000 mA h g^{-1}	3
Co_3O_4/3D graphene	1.06	~ 1.0 V/100 mA g^{-1}	62 cycles/583 mA h g^{-1}	4
Porous $La_{0.75}Sr_{0.25}MnO_3$ nanotubes	0.9±0.1	~ 1.1 V/27.7 mA g^{-1}	124 cycles/1000 mA h g^{-1}	5
α-MnO_2/graphene composite	N/A	1.0 V/200 mA g^{-1}	30 cycles/3000 mA h g^{-1}_{carbon}	6
Porous $CaMnO_3$ nanostructure	N/A	0.98 V/50 mA g^{-1}	80 cycles/500 mA h g^{-1}_{carbon}	7
Meso-LaSrMnO /graphene	N/A	1.03 V/100 mA g^{-1}	50 cycles/500 mA h g^{-1}	8
δ-MnO_2/3D graphene	1.72±0.1	1.5 V/194 mA g^{-1}	132 cycles/1000 mA h g^{-1}_{carbon}	9
$NiCo_2O_4$ nanosheets	0.9	~ 1.2 V/200 mA g^{-1}	38 cycles/1000 mA h g^{-1}	10

Co_3O_4@MnO_2/Ni NAs	0.8	0.76 V/100 mA g^{-1}	170 cycles/1000 mA h g^{-1}	This work

References

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