Supporting Information

Configuration of Gradient-Porous Ultrathin $FeCo_2S_4$ Nanosheets Vertical Aligned on Ni Foam as Noncarbonaceous Freestanding Oxygen Electrode for Lithium-Oxygen Batteries

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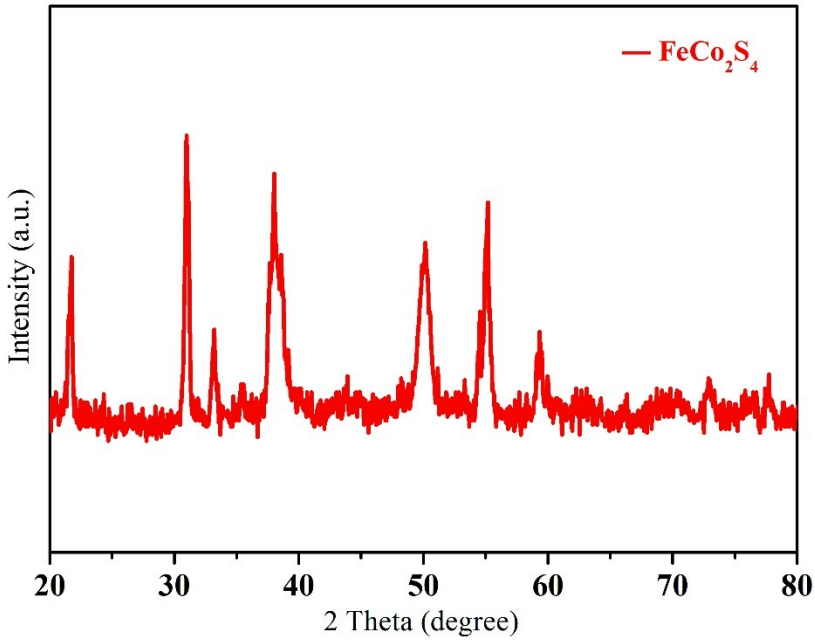

Fig. S1 XRD pattern of $FeCo_2S_4$ powder.

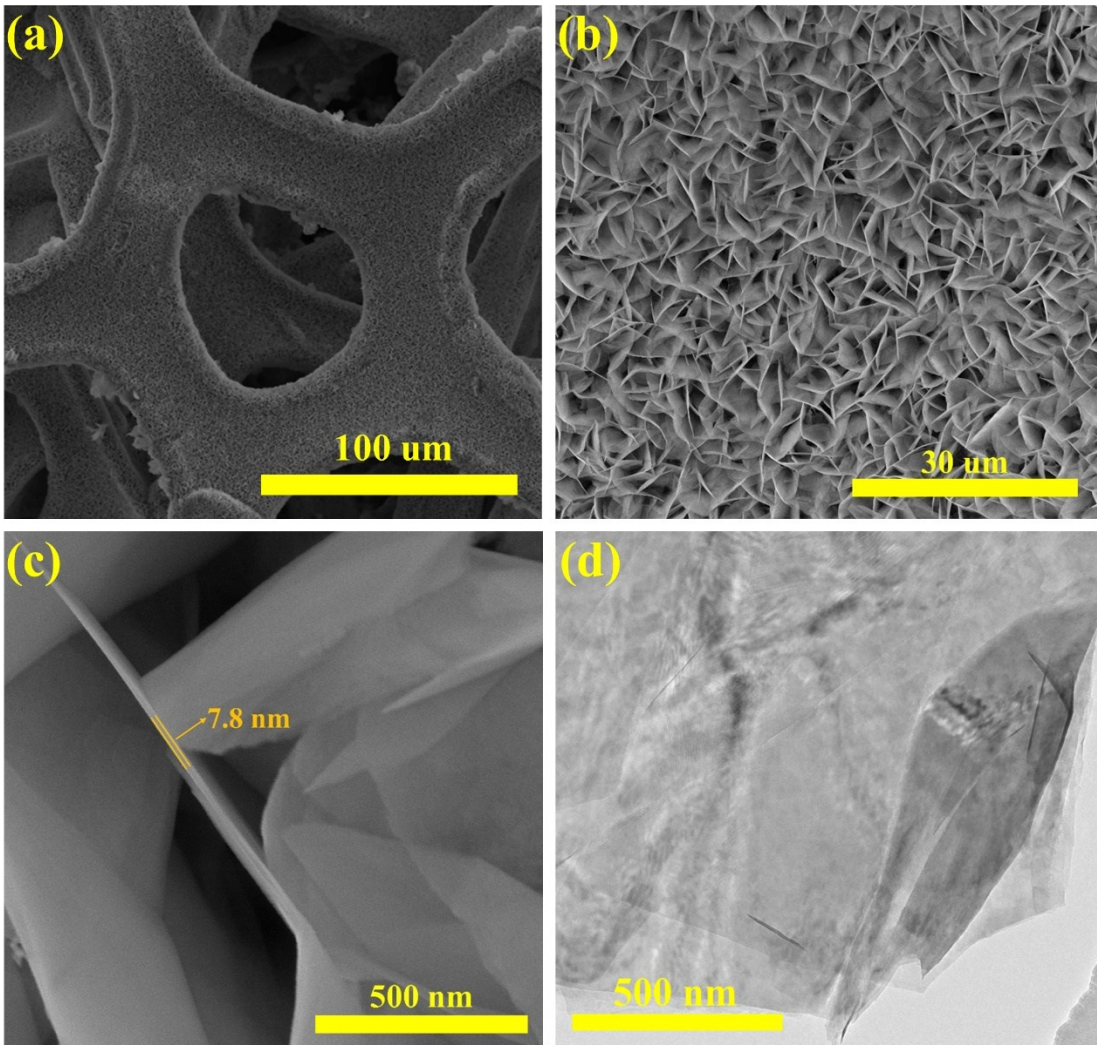

Fig. S2 (a-c) FESEM of $FeCo_2S_4$@Ni with different resolution, (d) TEM image of $FeCo_2S_4$ nanosheet.

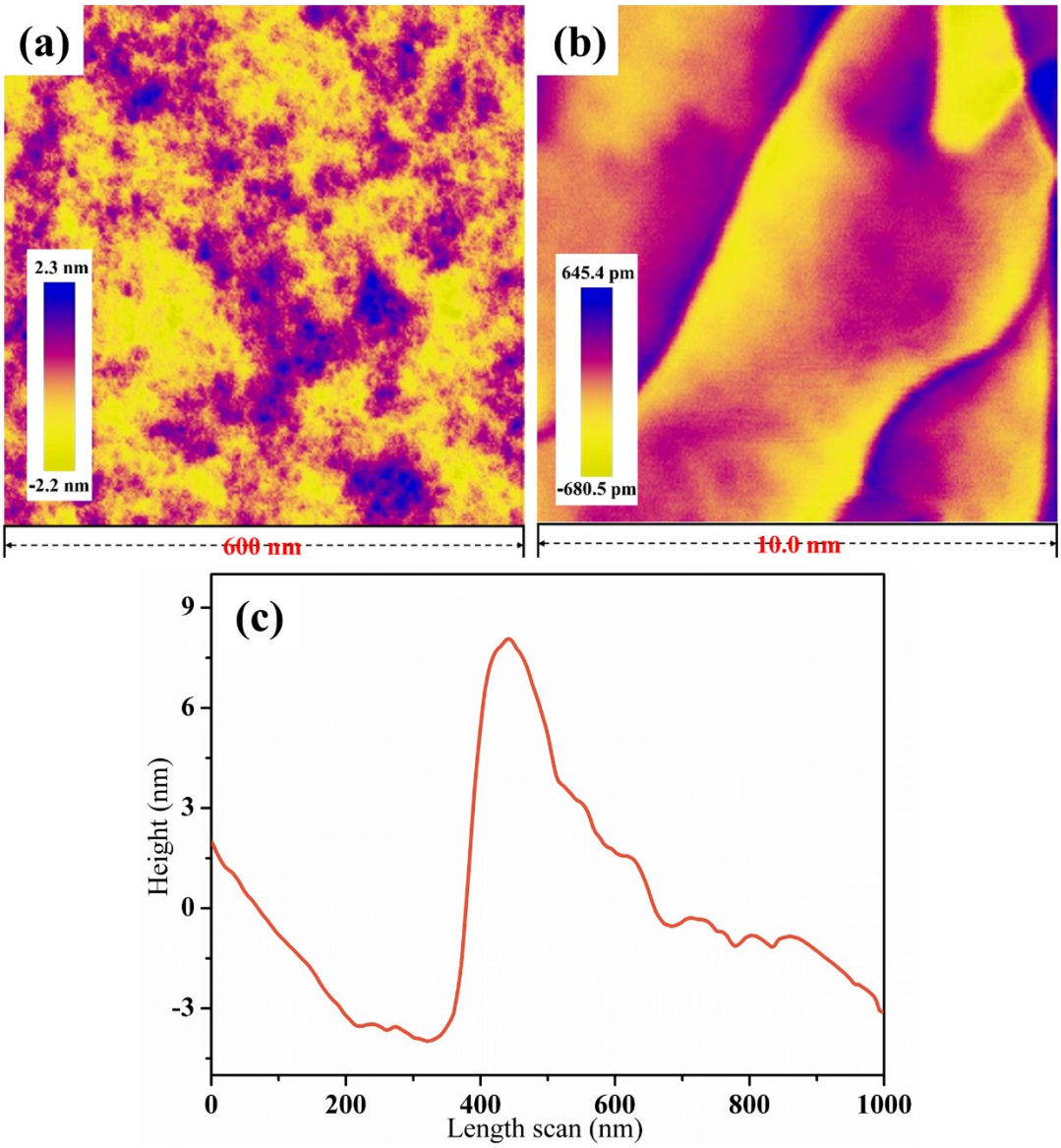

Fig. S3 (a-b) Typical 2D AFM images of $FeCo_2S_4$ nanosheets; (c) Line scanning of a diluted sample to measure the thickness of the sheets.

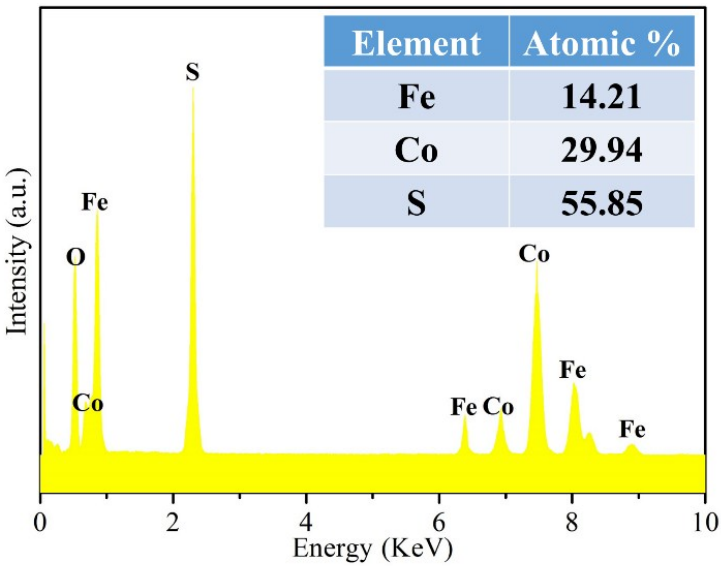

Fig. S4 EDS spectrum of $FeCo_2S_4$@Ni.

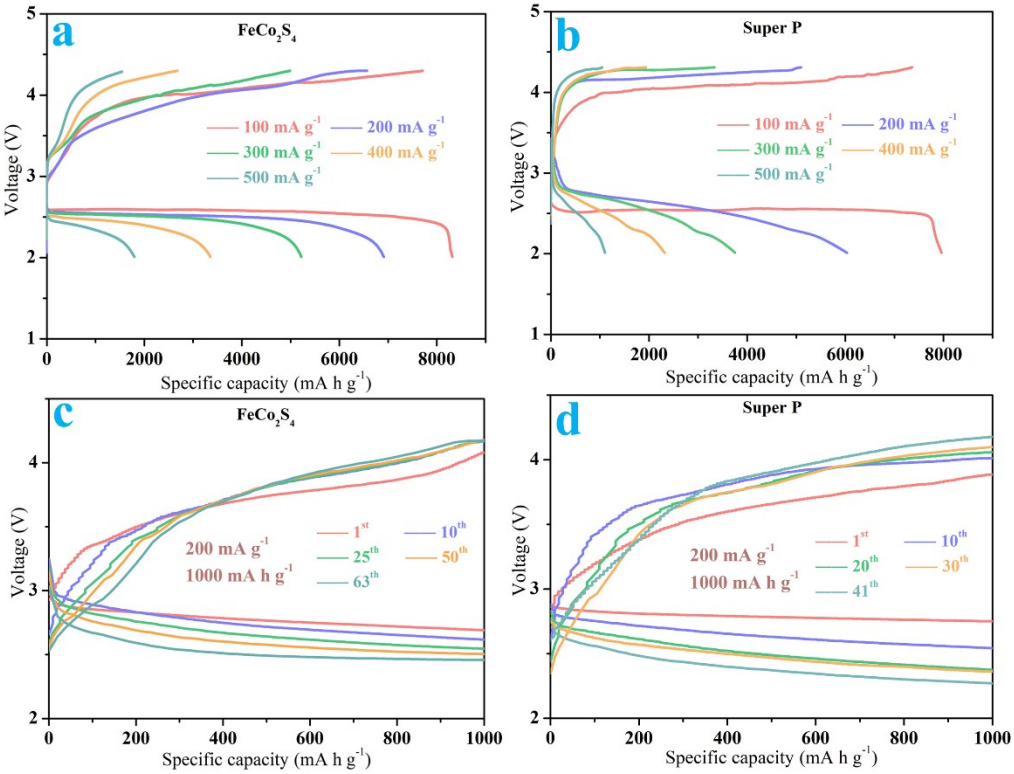

Fig. S5 (a) $FeCo_2S_4$ powder and(b) Super P based Li-O_2 cells at various current densities (100, 200, 300, 400, 500 mA g^{-1}); (c) and (d) $FeCo_2S_4$ powder, and Super P electrodes at a current density of 200 mA g^{-1} and with a restricted capacity of 1000 mA h g^{-1}.

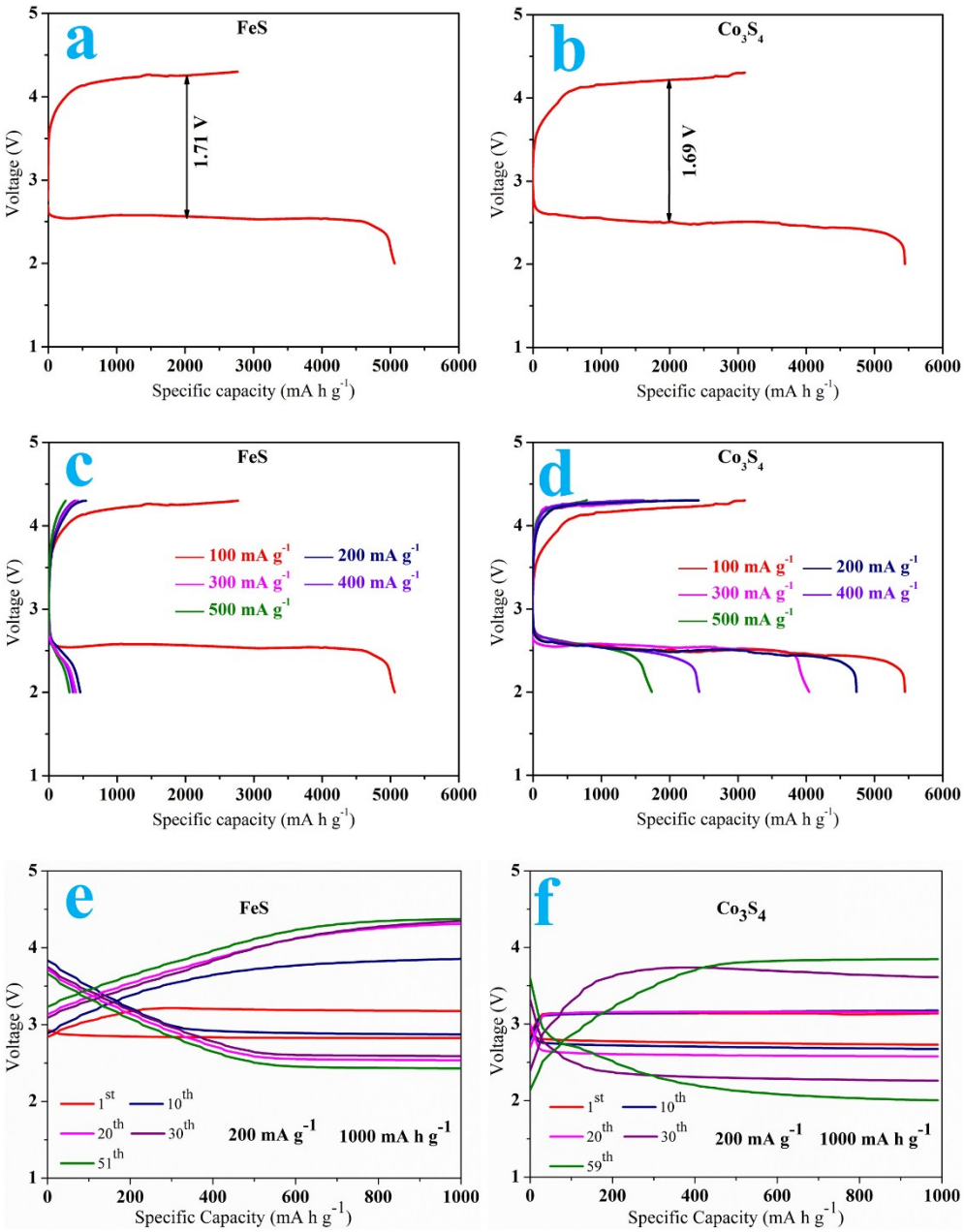

Fig. S6 (a) and (b) the fully discharge/charge profiles of Li-O_2 cells based on FeS powder, Co_3S_4 powder electrodes at a current density of 100 mA g^{-1}; (c) and (d) FeS powder, and Co_3S_4 powder based Li-O_2 cells at various current densities (100, 200, 300, 400, 500 mA g^{-1}); (e) and (f) FeS powder, and Co_3S_4 powder electrodes at a current density of 200 mA g^{-1} and with a restricted capacity of 1000 mA h g^{-1}.

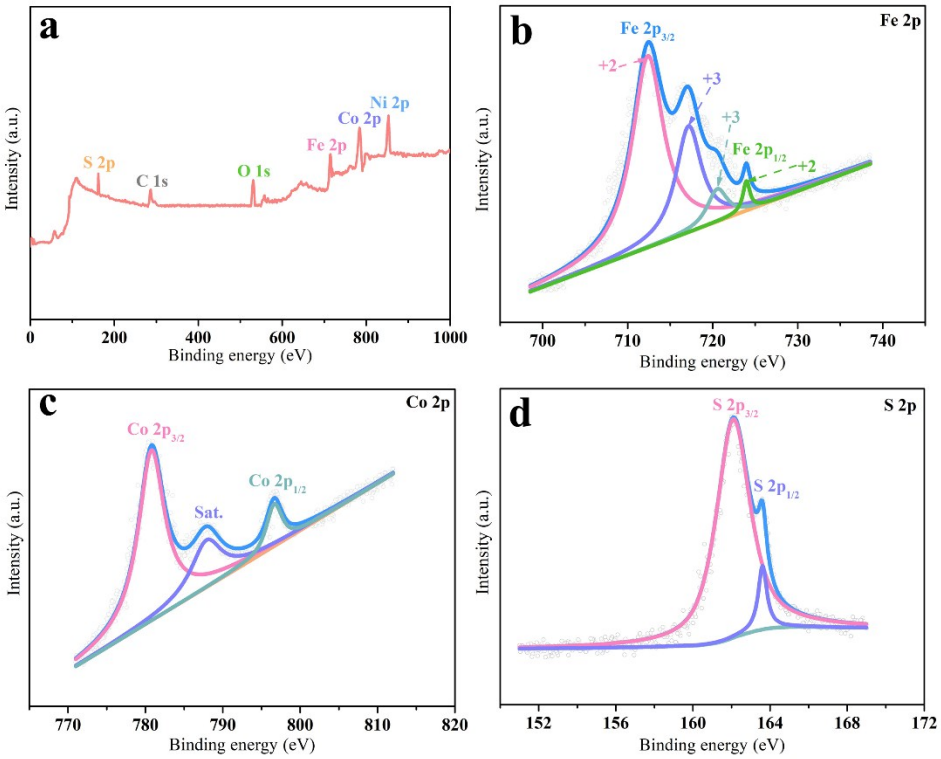

Fig. S7 XPS of $FeCo_2S_4$@Ni after 10th recharge: (a) survey spectrum, (b) Fe 2p, (c) Co 2p, (d) S 2p spectrum.

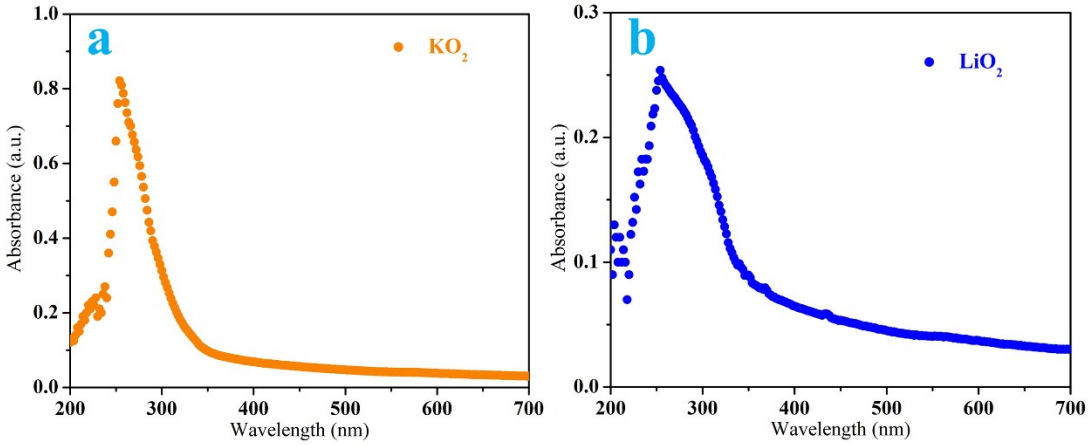

Fig. S8 Ultraviolet-visible spectrum of (a) KO_2 dissolved in DMSO solution and DMSO-extracted superoxide products from the discharged $FeCo_2S_4$@Ni-cathode based Li-O_2 battery after 10 hours (b).

Table S1. Recent reported results of different types of oxygen electrode electrochemical performance.

Material	Current density	Overpotential (V)	Cycling Performance (Cycles/Limited capacity)	First Discharge Capacity (mA h g^{-1})	Ref
$MnCo_2S_4$ nanosheets	200 mA g^{-1}	0.82	100/500	10760	S1
$CoFe_2O_4$@ MWCNTs	0.2 mA cm^{-2}	0.85	15/No limited capacity	1245	S2
$ZnCo_2O_4$/S WCNT	0.1 mA cm^{-2}	0.54	50/800	2750	S3
$ZnCo_2O_4$ microspheres	100 mA g^{-1}	1.15	35/1000	6024	S4
$NiFe_2O_4$	100 mA	—	100/1000	~980	S5
$NiCo_2S_4$	100 mA g^{-1}	—	144/500	3977	S6
$FeCo_2S_4$@ Ni	100 mA g^{-1}	0.81	236/1000	8801	This work

Reference

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