Supplementary Information

Self-template synthesis of hierarchical $CoMoS_3$ nanotubes composed of ultrathin nanosheets for efficient water electrolysis

Jinxue Guo[a], Xinqun Zhang[a], Yanfang Sun[b], Lin Tang[a], Xiao Zhang[a,*]

[a]*Key Laboratory of Sensor Analysis of Tumor Marker (Ministry of Education), College of Chemistry and Molecular Engineering, Qingdao University of Science & Technology, Qingdao 266042, China*

[b]*College of Science and Technology, Agricultural University of Hebei, Cangzhou 061100, China*

**Corresponding author. E-mail:* zhx1213@126.com (X. Zhang)

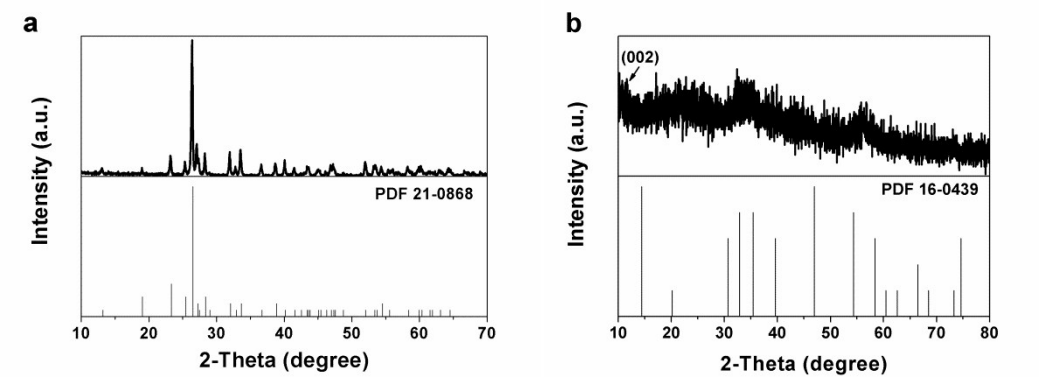

Fig. S1 XRD patterns of (a) $CoMoO_4$ nanorods and (b) hierarchical $CoMoS_3$ nanotubes.

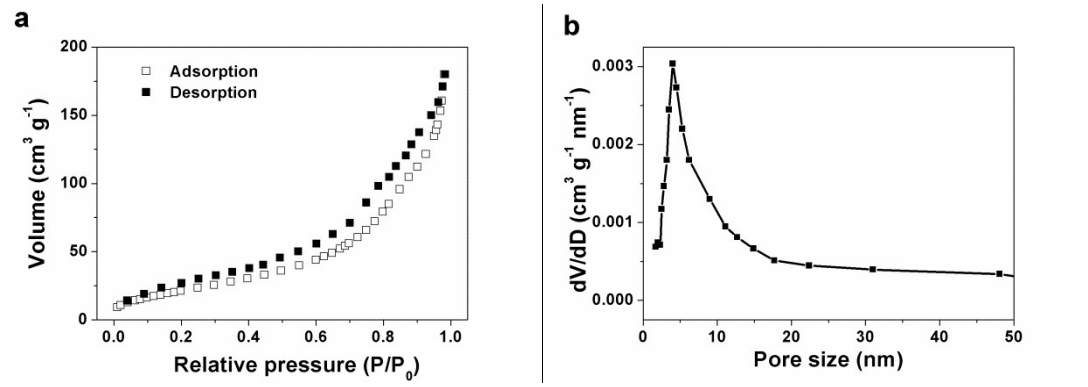

Fig. S2 (a) The N_2 adsorption/desorption isotherms and (b) corresponding pore size distribution of hierarchical $CoMoS_3$ nanotubes.

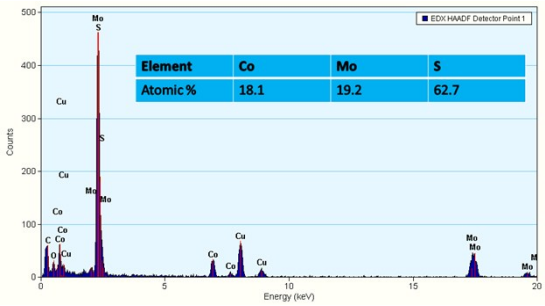

Fig. S3 EDX spectrum of hierarchical $CoMoS_3$ nanotubes.

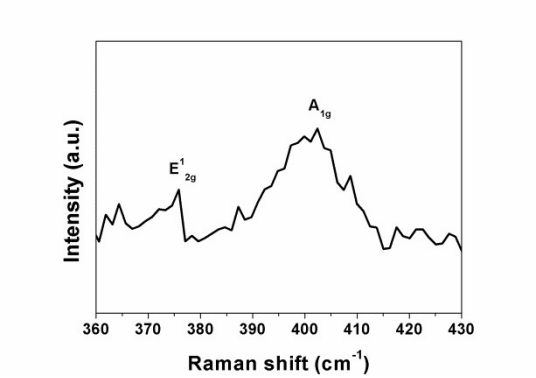

Fig. S4 Raman spectrum of hierarchical $CoMoS_3$ nanotubes.

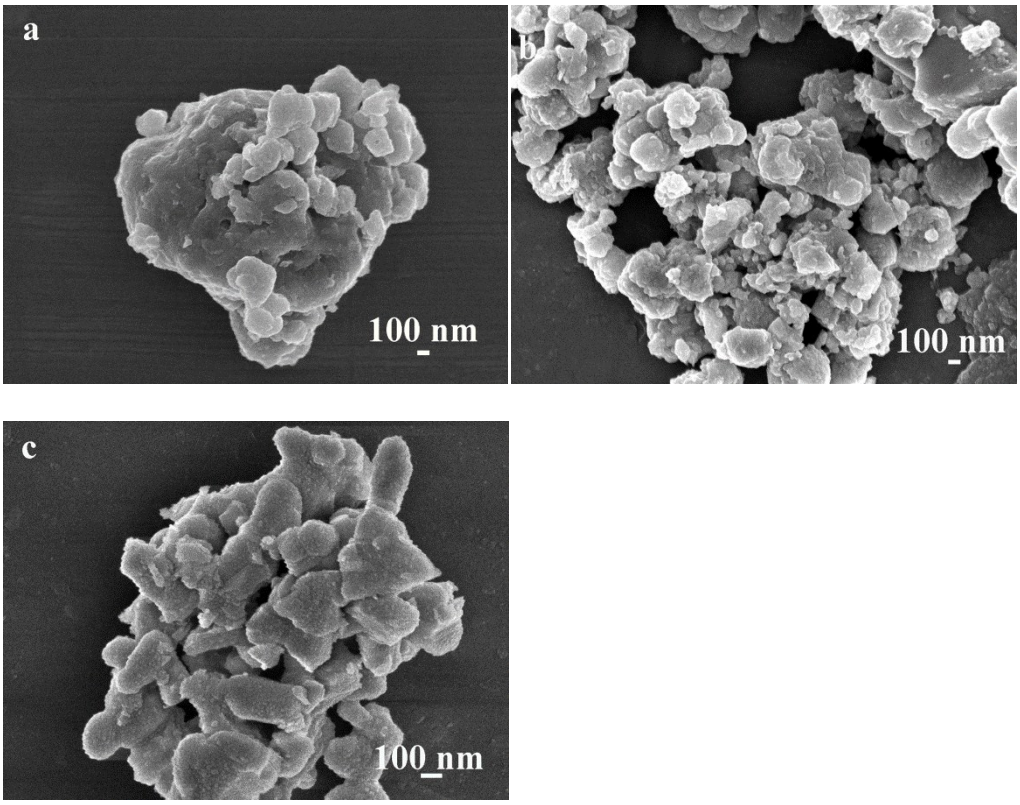

Fig. S5 (a) SEM image of pristine MoS_2 catalyst synthesized by a hydrothermal method: 200 mg of $Na_2MoO_4 \cdot 2H_2O$ and 400 mg of thioacetamide are dispersed in 90 mL of DI water, which is then heated at 190 ^oC for 24 h in 120 mL Teflon-lined autoclave. (b) SEM image of pristine CoS_2 catalyst synthesized by a hydrothermal method: 200 mg of $CoCl_2 \cdot 6H_2O$ and 400 mg of thioacetamide are dispersed in 90 mL of DI water, which is then heated at 160 ^oC for 24 h in 120 mL Teflon-lined autoclave. (c) SEM image of pristine $CoMoS_3$ catalyst synthesized by a hydrothermal method: 100 mg of $Na_2MoO_4 \cdot 2H_2O$, 100 mg of $CoCl_2 \cdot 6H_2O$ and 400 mg of thioacetamide are dispersed in 90 mL of DI water, which is then heated at 190 ^oC for 24 h in 120 mL Teflon-lined autoclave.

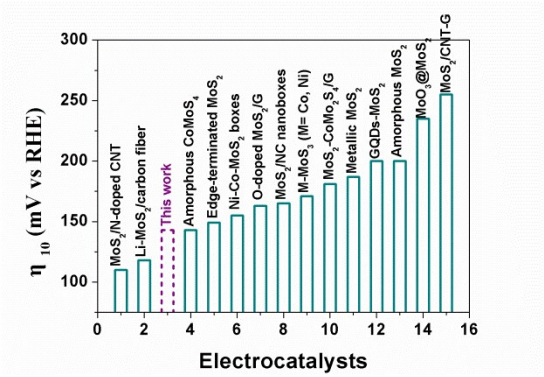

Fig. S6 Comparison of the overpotential required to generate a current density of 10 mA cm^{-2} (η_{10}) on various MoS_2-based electrocatalysts in 0.5 M H_2SO_4, such as MoS_2/N-doped CNT [1], Li-MoS_2/carbon fiber [2], amorphous $CoMoS_4$ [3], edge-terminated MoS_2 [4], Ni-Co-MoS_2 nanoboxes [5], O-doped MoS_2/graphene [6], MoS_2/N-doped carbon nanoboxes [7], M–MoS_3 (M = Co, Ni) hollow structures [8], MoS_2-$CoMo_2S_4$/graphene [9], metallic MoS_2 [10], graphene quantum dots (GQDs) doped MoS_2 [11], amorphous MoS_2 [12], MoO_3@MoS_2 nanowires [13], and MoS_2/CNT-graphene [14].

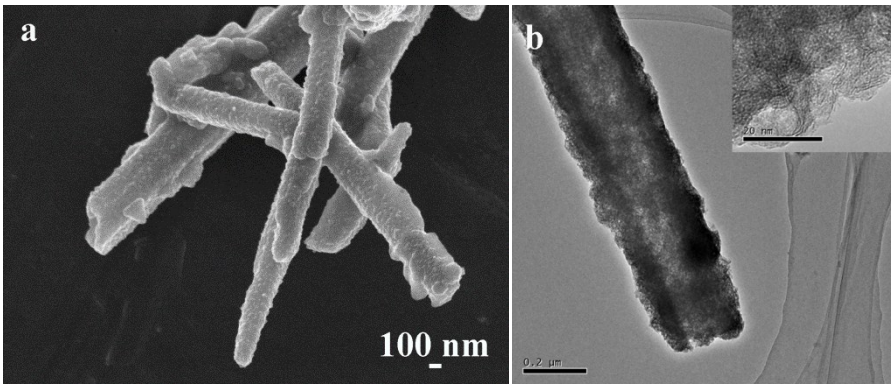

Fig. S7 (a) SEM and (b) TEM images of $CoMoS_3$ nanotubes after durability test of 10 h. The inset in (b) shows the HRTEM image.

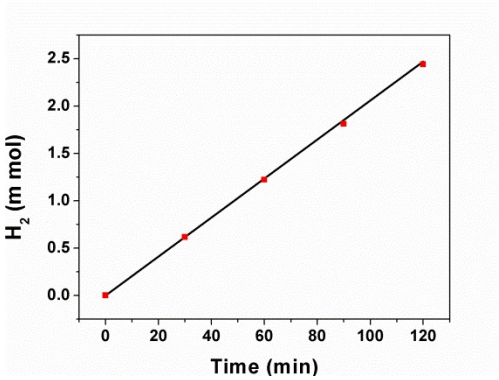

Fig. S8 The theoretically calculated (black line) and experimentally measured (red squares) amount of the evolved hydrogen versus time for $CoMoS_3$ nanotubes at -0.25 V for 120 min in 0.5 M H_2SO_4.

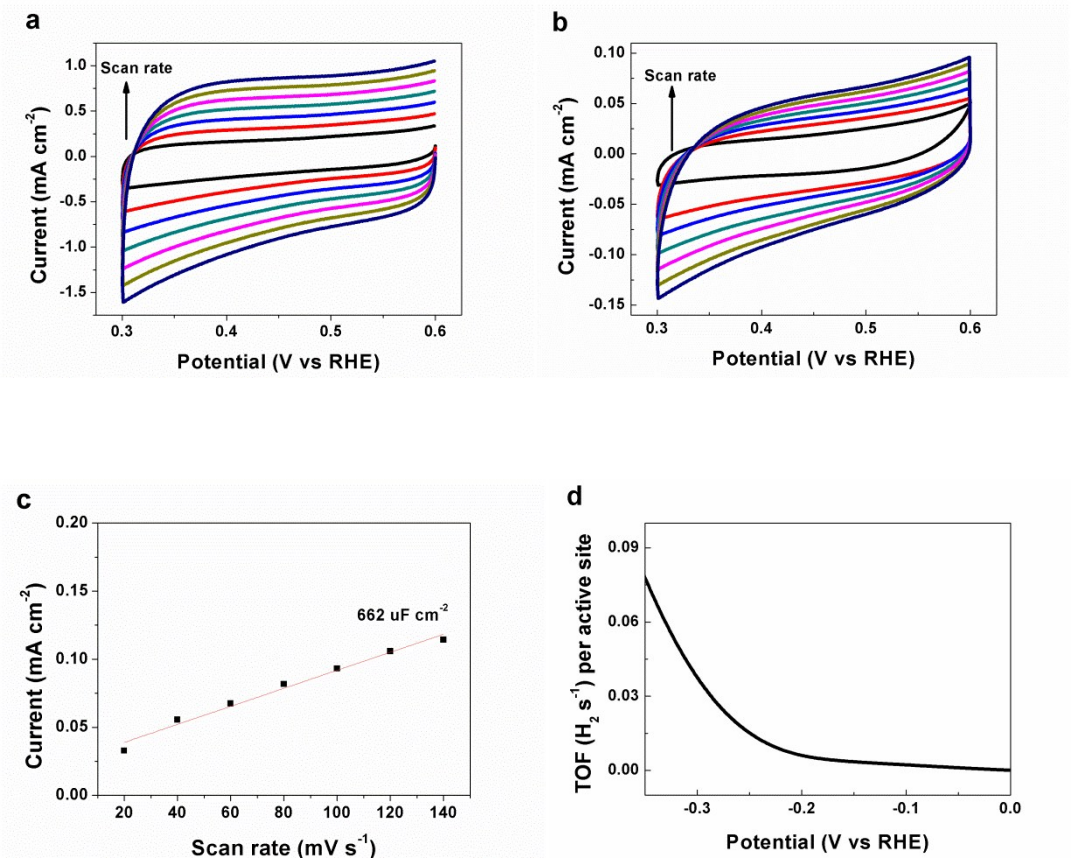

Fig. S9 (a) Cyclic voltammograms of $CoMoS_3$ nanotubes obtained in a potential range where no faradic processes. Electrochemical capacitance measurements of MoS_2: (b) Cyclic voltammograms obtained in a potential range where no faradic processes, (c) measured capacitive currents plotted as a function of scan rate, (d) the corresponding TOF value.

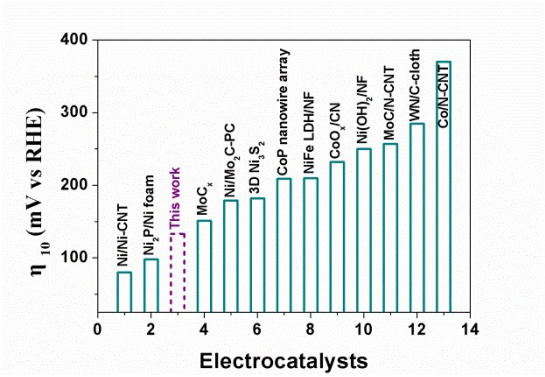

Fig. S10 Comparison of the overpotential required to generate a current density of 10 mA cm^{-2} (η_{10}) on various non-noble-metal electrocatalysts in basic solution (1 M KOH or NaOH), such as NiO/Ni-CNT [15], Ni_2P/Ni faom [16], porous MoC_x nano-octahefrons [17], porous carbon-supported Ni/Mo_2C [18], 3D Ni_3S_2 superstructures [19], nanoporous CoP nanowire array [20], NiFe-LDH/Ni foam [21], CoO_x/N-doped carbon [22], $Ni(OH)_2$/Ni foam [21], MoC/N-doped CNT [23], WN nanorod array/carbon cloth [24], and Co/N-rich CNT [25].

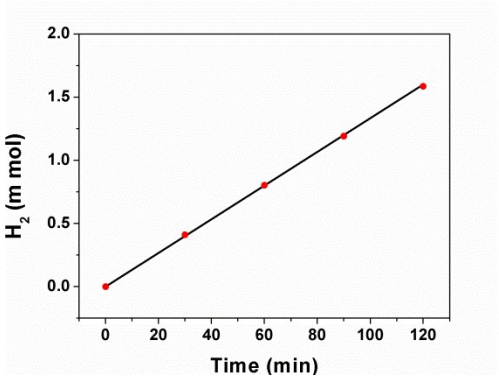

Fig. S11 The theoretically calculated (black line) and experimentally measured (red dots) amount of evolved hydrogen versus time for $CoMoS_3$ nanotubes at -0.25 V for 120 min in 1 M KOH.

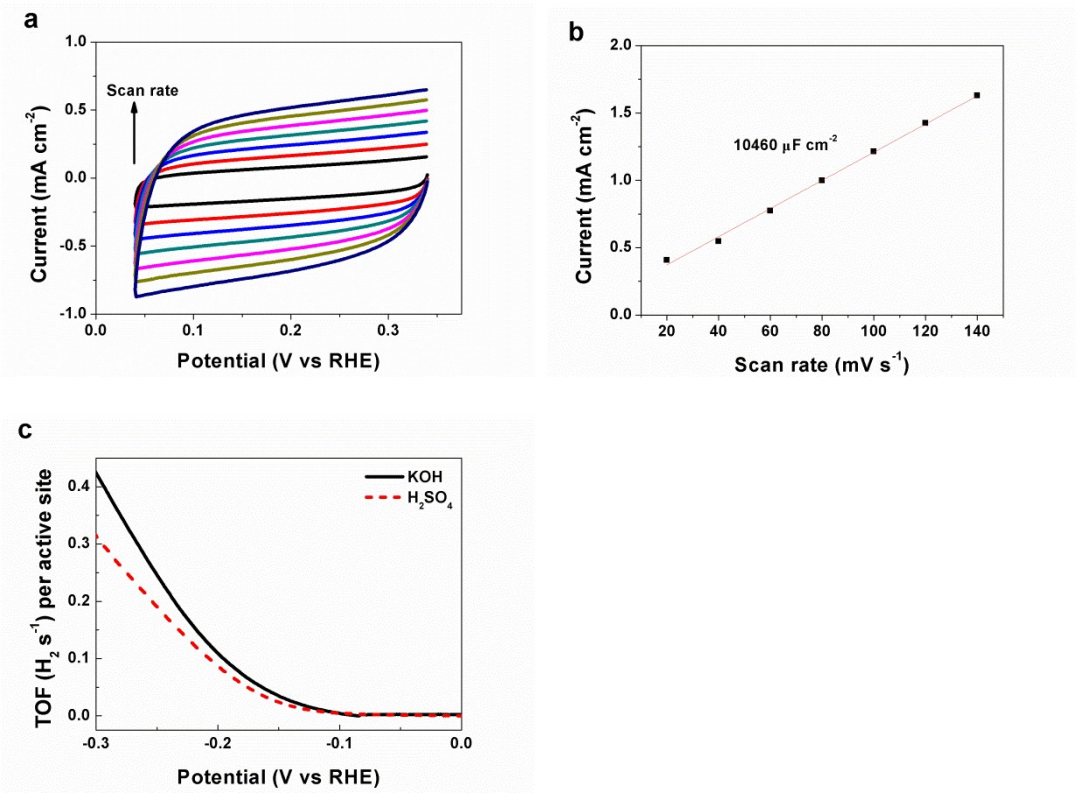

Fig. S12 Electrochemical capacitance measurements of $CoMoS_3$ in 1 M KOH solution: (a) Cyclic voltammograms obtained in a potential range where no faradic processes and (b) measured capacitive currents plotted as a function of scan rate, (c) the corresponding TOF value.

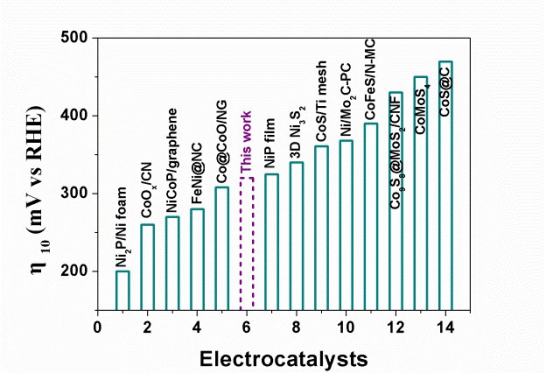

Fig. S13 Comparison of the overpotential required to generate a current density of 10 mA cm^{-2} (η_{10}) on various non-noble-metal electrocatalysts in basic solution (1 M KOH or NaOH), such as Ni_2P/Ni faom [16], CoO_x/N-doped carbon [22], $Ni_{2-x}Co_xP$/graphene [26], FeNi@NC [27], Co@CoO/N-doped graphene [28], NiP nanoparticle film [29], 3D Ni_3S_2 superstructures [19], CoS nanosheet/Ti mesh [30], porous carbon-supported Ni/Mo_2C [18], $Co_{0.5}Fe_{0.5}S$/N-doped mesoporous carbon [31], Co_9S_8@MoS_2/carbon nanofibers [32], amorphous $CoMoS_4$ [3], and Co_xS_y@N, S doped carbon [33].

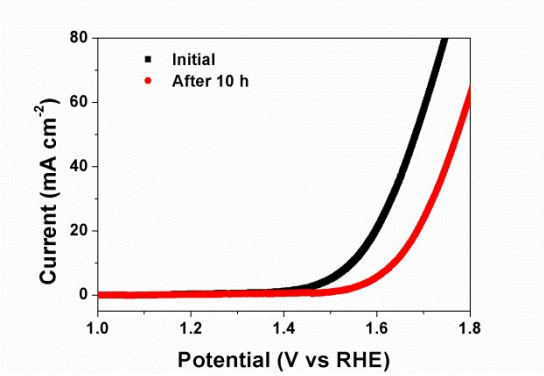

Fig. S14 OER polarization curve of hierarchical $CoMoS_3$ nanotubes after continuous 10 h durability test compared with the initial curve.

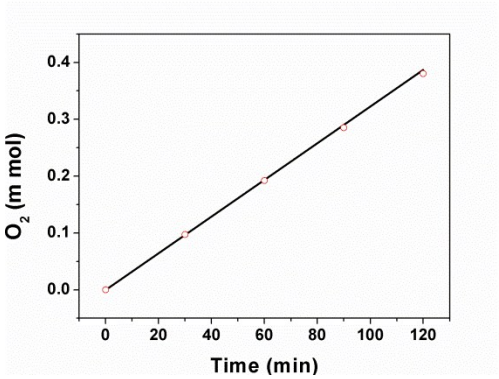

Fig. S15 The theoretically calculated (black line) and experimentally measured (red circles) amount of evolved oxygen versus time for $CoMoS_3$ nanotubes at 1.6 V for 120 min in 1 M KOH.

Supplementary References

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