Supporting Information for

Hierarchical $CoTe_2$ Nanowire Array: An Effective Oxygen Evolution Catalyst in Alkaline Media

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Content

Experimental Section

Materials: Hydrazine hydrate ($N_2H_4 \cdot H_2O$, 85%), hydrochloric acid (HCl, 35 wt%) and KOH were purchased by Chengdu Kelon Chemical Reagent Factory. Na_2TeO_3 was purchased from Sigma-Aldrich. Cobaltous nitrate ($Co(NO_3)_2 \cdot 6H_2O$), ammonium fluoride (NH_4F), urea ($CO(NH_2)_2$) were purchased from Aladdin Ltd. (Shanghai, China). Ti mesh (TM) was purchased from Phychemi Hong Kong Company Limited. All the chemicals in the experiment were analytical grade and used without further treatments. The water use throughout all experiments was purified through a Millipore system.

Preparation of Co(OH)F/TM: In a typical procedure, $Co(NO_3)_2 \cdot 6H_2O$ (1 mmol), NH_4F (8 mmol) and $CO(NH_2)_2$ (10 mmol) were dissolved in 36 mL of water and stirred to form a transparent and homogeneous solution. Prior to utilization, Ti mesh (about 3 cm × 2 cm) was carefully cleaned with concentrated HCl solution (37 wt.%) in an ultrasound bath for 5 min in order to remove the surface TiO layer, and then deionized water and absolute ethanol were used for 5 min each to ensure the surface of the Ti mesh was well cleaned. The aqueous solution and the Ti mesh were transferred to a 40 mL Teflon-lined stainless-steel autoclave, which was sealed, maintained at 100 °C for 8 h, and then allowed to cool to room temperature naturally.

Preparation of $CoTe_2$ NA/TM: 2 mM Na_2TeO_3 was added into a Teflon autoclave and dissolved by 70 mL water. Then 10 mL $N_2H_4 \cdot H_2O$ (98%) was added into the solution under vigorous stirring. The prepared Co(OH)F NA/TM were then transferred into the homogeneous solution. The tightly sealed autoclaves were placed in an electric oven and kept at 180 °C for 15 h. After cooling down naturally and washed by water and ethanol, the samples were dried in vacuum for 2 h.

Preparation of RuO_2: In brief, 0.01 mol of $RuCl_3 \cdot 3H_2O$ was dissolved in 100 mL deionized water and heated under air atmosphere at 100 °C for 10 min, followed by the addition of 1 mL of 1.0 M KOH solution. The reaction mixture was maintained at this temperature under stirring for 45 min. After that, the solution was centrifuged for 10 min and filtered. The precipitate was washed several times with deionized water to

remove the remaining chlorides. The resulting Ru-hydroxide was dried for 5 h at 80 °C and then calcined in air at 300 °C for 3 h to obtain RuO_2.

Characterizations: XRD data were obtained from a LabX XRD-6100 X-ray diffractometer with Cu Kα radiation (40 kV, 30 mA) of wavelength 0.154 nm (SHIMADZU, Japan). XPS measurements were performed on an ESCALABMK II X-ray photoelectron spectrometer using Mg as the exciting source. SEM images were collected from the tungsten lamp-equipped SU3500 scanning electron microscope at an accelerating voltage of 20 kV (HITACHI, Japan). TEM images were obtained from a Zeiss Libra 200FE transmission electron microscope operated at 200 kV.

Electrochemical measurements: All the electrochemical measurements were conducted using a CHI660E potentiostat (CH Instruments, China) in a typical three-electrode setup with an electrolyte solution of 1.0 M KOH, a graphite rod as the counter electrode and Hg/HgO as the reference electrode. *IR* correction was determined using electrochemical impedance measurements. All potentials measured were calibrated on a reversible hydrogen electrode (RHE) scale (E (RHE) = E (Hg/HgO) + 0.924) except specifically explained. All electrolytes were saturated by oxygen (for OER) bubbles before and during the experiments. Polarization curves were obtained using LSV with a scan rate of 5 mV s^{-1}. The long-term durability test was performed using chronopotentiometric measurements. All currents presented are corrected against the ohmic potential drop and all LSV curves subtracted the capacitance current (average of anodic and cathodic scans). These Tafel plots are fitted to equation: η = b log j + a (η for overpotential, b for Tafel slope, j for current density and a for Tafel constant). Multi-step chronopotentiometric curve can be obtained with the current changing from 40 to 480 mA cm^{-2} (an increment of 40 mA cm^{-2} per 500 s) in 1.0 M KOH.

FE determination: The oxygen generated at anode was measured quantitatively by using a calibrated pressure sensor to monitor the change in the anode compartment of a H-type cell. The FE was calculated by comparing the amount of measured O_2 generated by anodal electrolysis with calculated O_2 (assuming 100% FE). Pressure

data during electrolysis were recorded using a CEM DT-8890 Differential Air Pressure Gauge Manometer Data Logger Meter Tester with a sampling interval of 1 point per second.

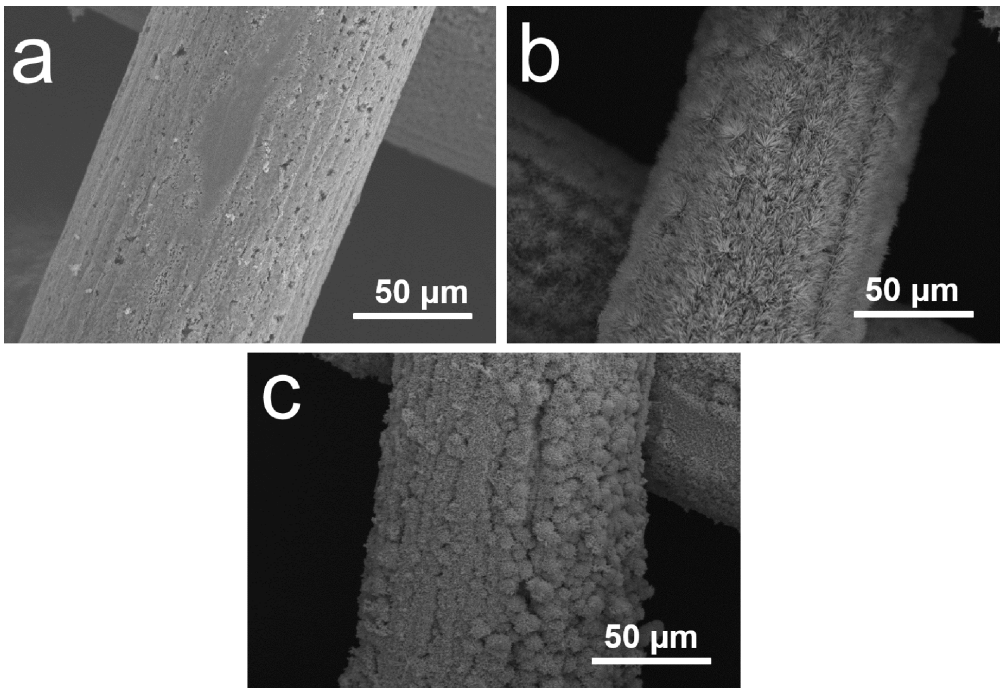

Figure S1. Low-magnification SEM images of (a) TM, (b) Co(OH)F NA/TM, and (c) $CoTe_2$ NA/TM.

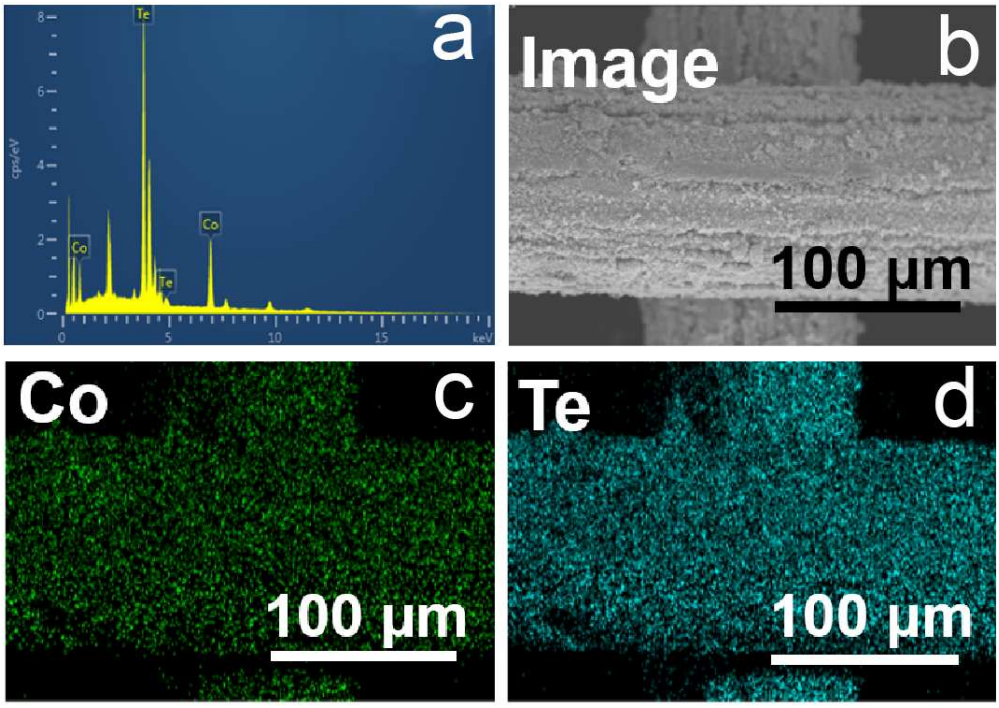

Figure S2. (a) EDX spectrum for $CoTe_2$ NA/TM. (b) SEM and corresponding EDX element mapping images of (c) Co and (d) Te for $CoTe_2$ NA/TM.

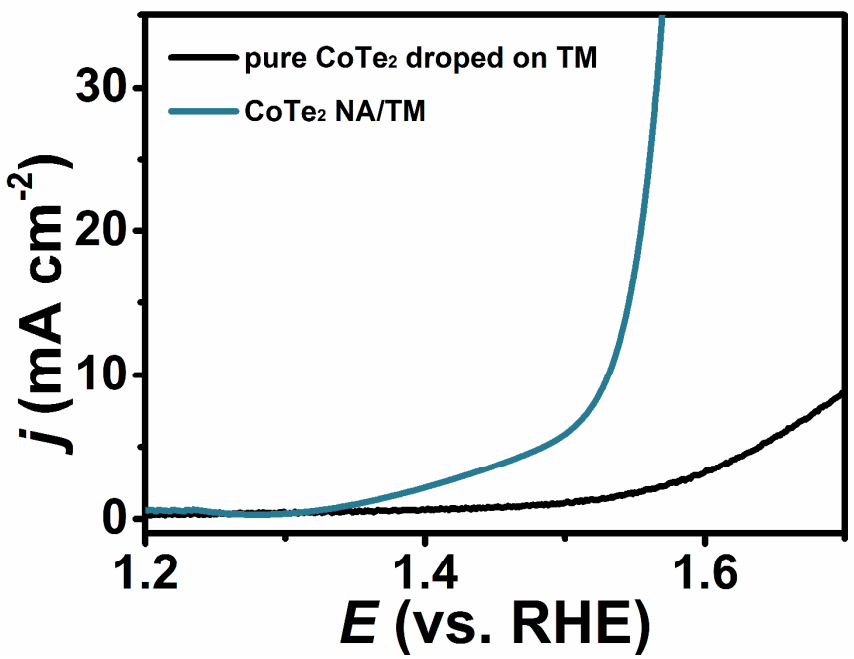

Figure S3. LSV curves of $CoTe_2$ NA/TM and pure $CoTe_2$ on TM.

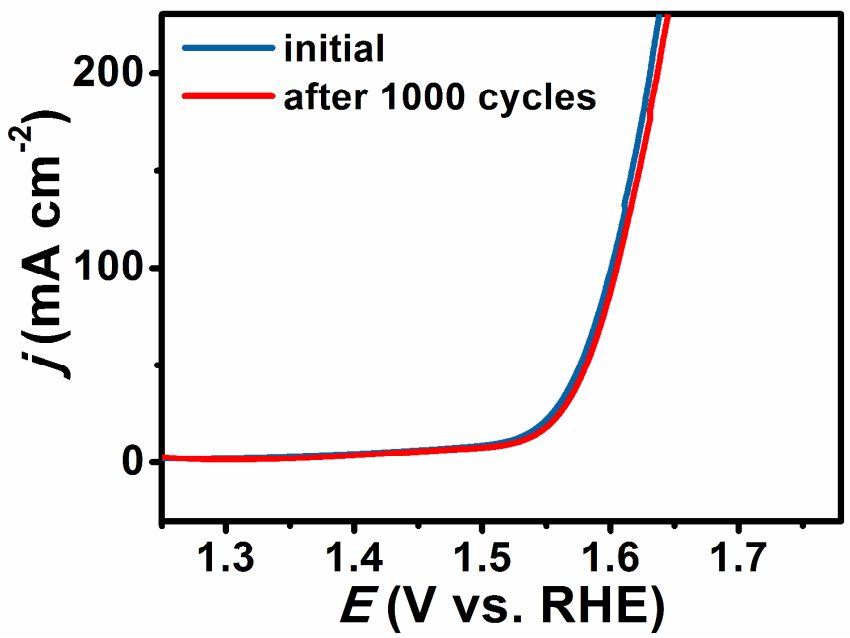

Figure S4. LSV curves recorded for $CoTe_2$ NA/TM before and after 1000 cyclic voltammetry cycles in 1.0 M KOH.

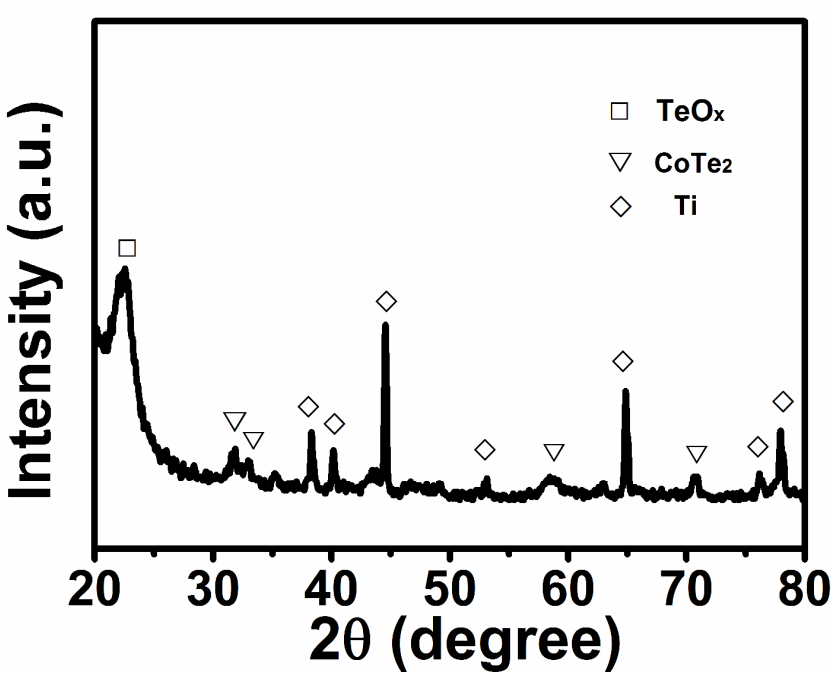

Figure S5. XRD pattern of $CoTe_2$ NA/TM after durability test.

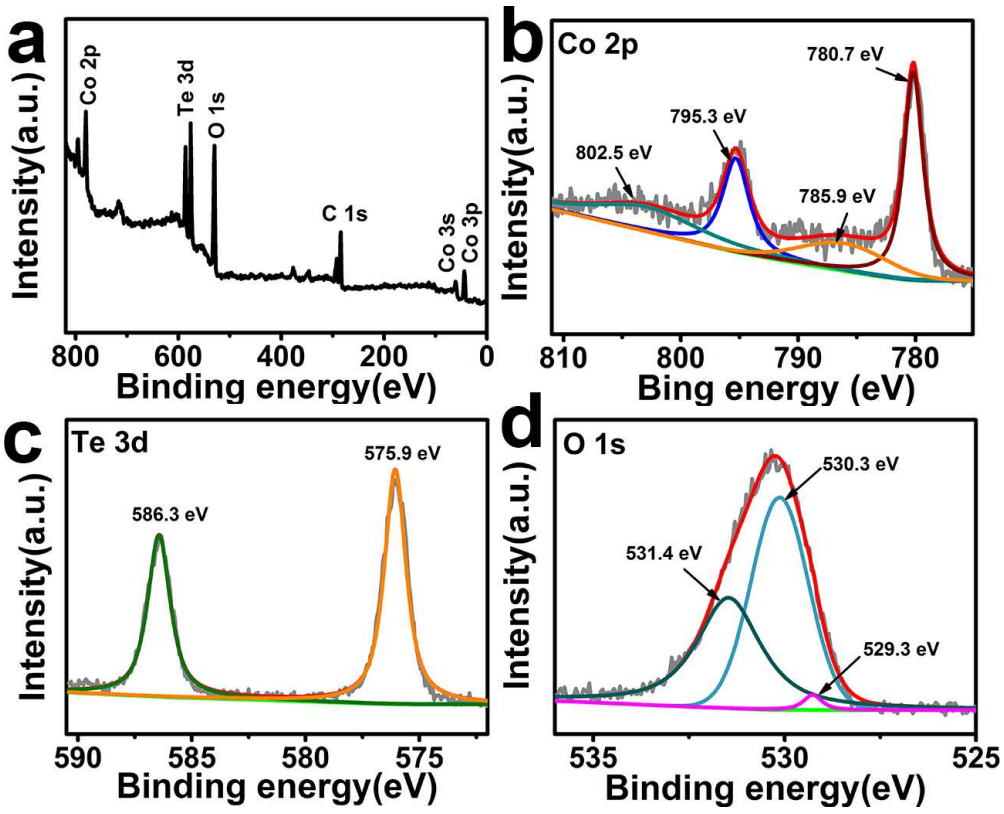

Figure S6. (a) XPS survey spectrum of $CoTe_2$ after OER test. XPS spectra in the (b) Te 3d, (c) Co 2p, and O 1s regions for $CoTe_2$ after durability test.

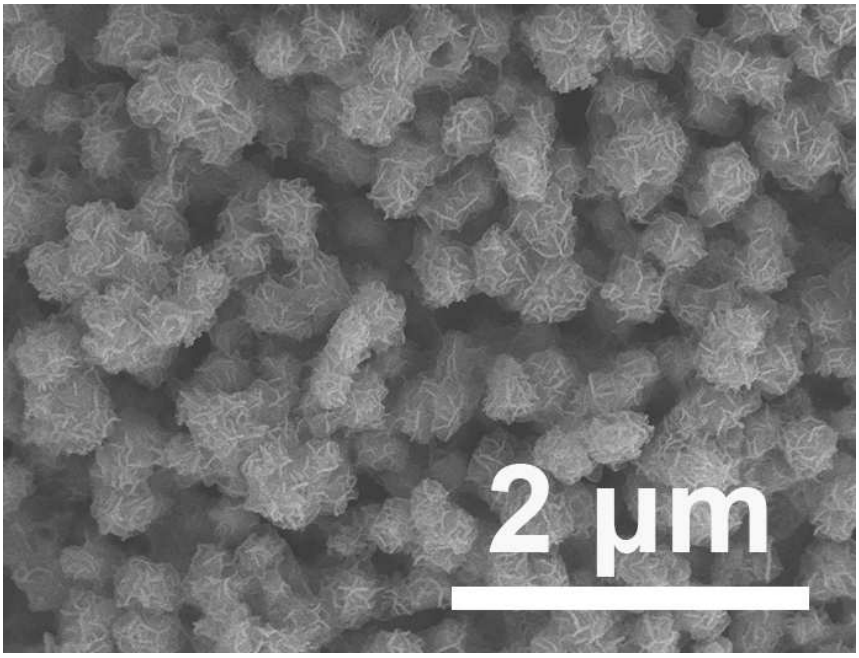

Figure S7. SEM image of $CoTe_2$ NA/TM after durability test.

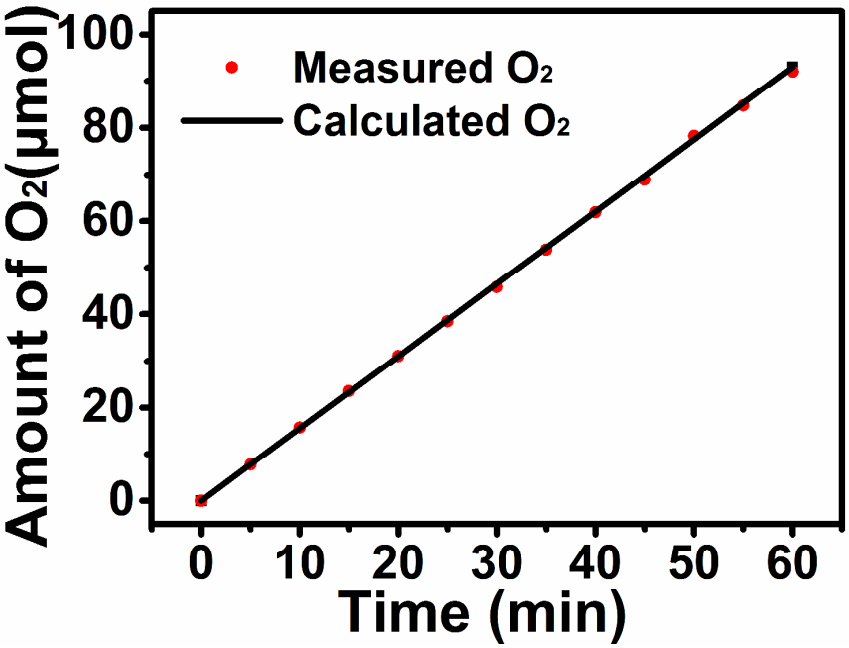

Figure S8. The amount of gas theoretically calculated and experimentally measured vs. time for $CoTe_2$ NA/TM in 1 M KOH.

Table S1. Comparison of OER performance in alkaline media for $CoTe_2$ NA/TM with other electrocatalysts.

Catalyst	Electrolyte	j (mA cm^{-2})	Overpotential (mV)	Ref.
$CoTe_2$ NA/TM	1.0 M KOH	50	340	This work
CoTe film	1.0 M KOH	10	370	(1)
$CoTe_2$	1.0 M KOH	10	357	(2)
CoTe	1.0 M KOH	10	365	(2)
$CoTe_2/CoO_x$	1.0 M KOH	10	380	(3)
Co-P film	1.0 M KOH	10	345	(4)
NiCo LDHs	1.0 M KOH	10	367	(5)
Ni-Co oxide hierarchical nanosheets	1.0 M KOH	10	340	(6)
Co_3O_4	1.0 M KOH	10	400	(7)
Fe/mCo_3O_4	1.0 M KOH	10	380	(8)
$CoCr_2O_4$	1.0 M KOH	10	422	(9)
CoCo LDHs	1.0 M KOH	10	350	(10)
Co_3O_4/SWNTs	1.0 M KOH	10	570	(11)
$NiCo_2S_4$@N/S-rGO	1.0 M KOH	10	470	(12)
$CoMoO_4$ nanorod	1.0 M KOH	10	343	(13)
$Cu_xCo_yO_4$	1.0 M KOH	10	391	(14)
$NiMoO_4$ Nanotubes	1.0 M KOH	10	359	(15)
$Ni\text{-}Co_2\text{-}O$	1.0 M KOH	10	362	(16)
$CuCo_2O_4$/NrGO	1.0 M KOH	10	360	(17)
$Zn_xCo_{3-x}O_4$	1.0 M KOH	50	400	(18)
$Ni_{30}Fe_7Co_{20}Ce_{43}O_x$	1.0 M KOH	10	410	(19)
$Fe(OH)_3$:$Cu(OH)_2$/CF	1.0 M KOH	10	~365	(20)

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