Electronic Supplementary Material (ESI)

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Supporting Information

Ultrathin Porous Co_3O_4 Nanoplates as Highly Efficient Oxygen Evolution Catalysts

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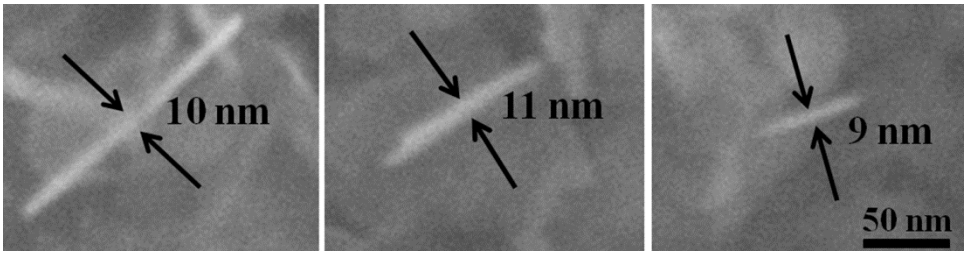

Fig. S1. SEM images of vertically aligned β-$Co(OH)_2$ nanoplates. The scale bar for all three images is 50 nm. The thickness of nanoplates is around 10 nm.

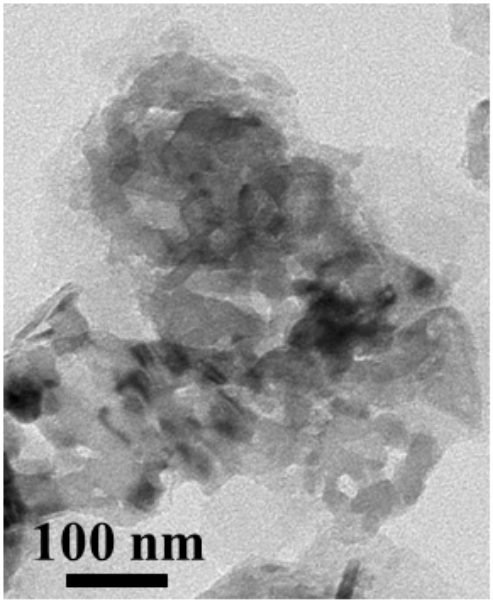

Fig. S2. TEM image of β-$Co(OH)_2$ nanoplates annealed at 600 ºC .

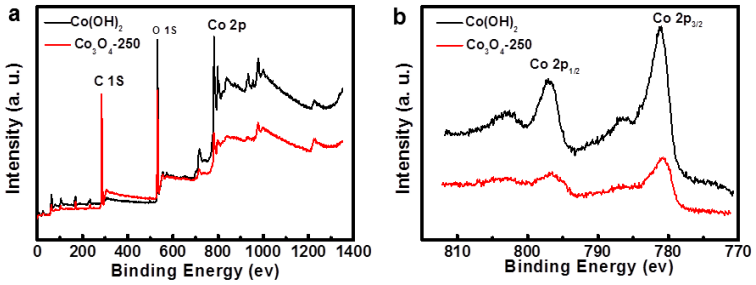

Fig. S3. XPS specture (a) and high-resolution spectra (b) for $Co(OH)_2$ and Co_3O_4-250.

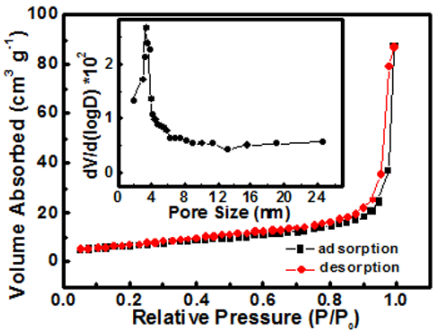

Fig. S4. Nitrogen adsorption/desorption isotherms of the Co_3O_4-250. Inset is pore size distribution of the Co_3O_4-250.

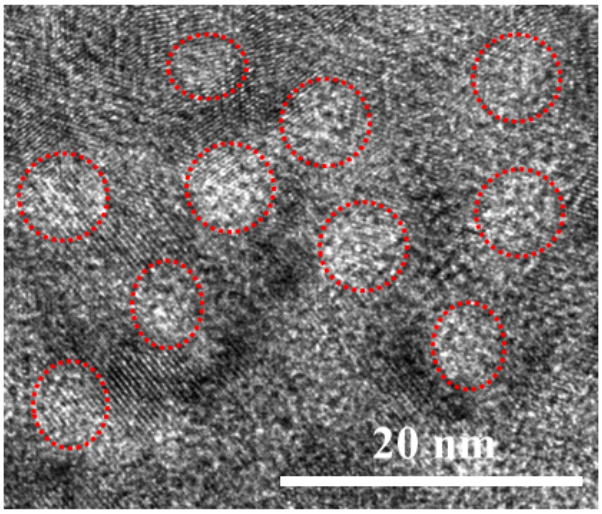

Fig. S5. HRTEM image of Co_3O_4-250 for observing the pore size (red circle).

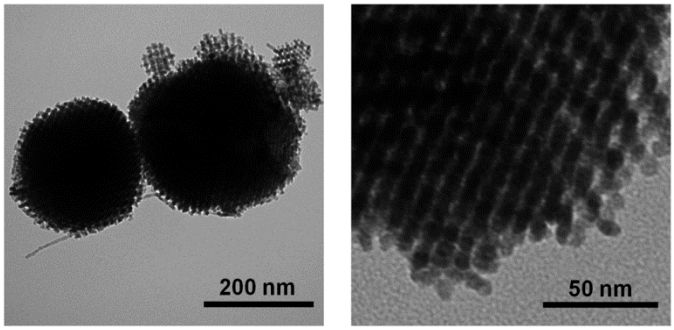

Fig. S6. TEM images of ordered mesoporous Co_3O_4 synthesized through a nanocasting method. KIT-6 mesoporous silica was used as the template and synthesis was performed at 35 ºC.

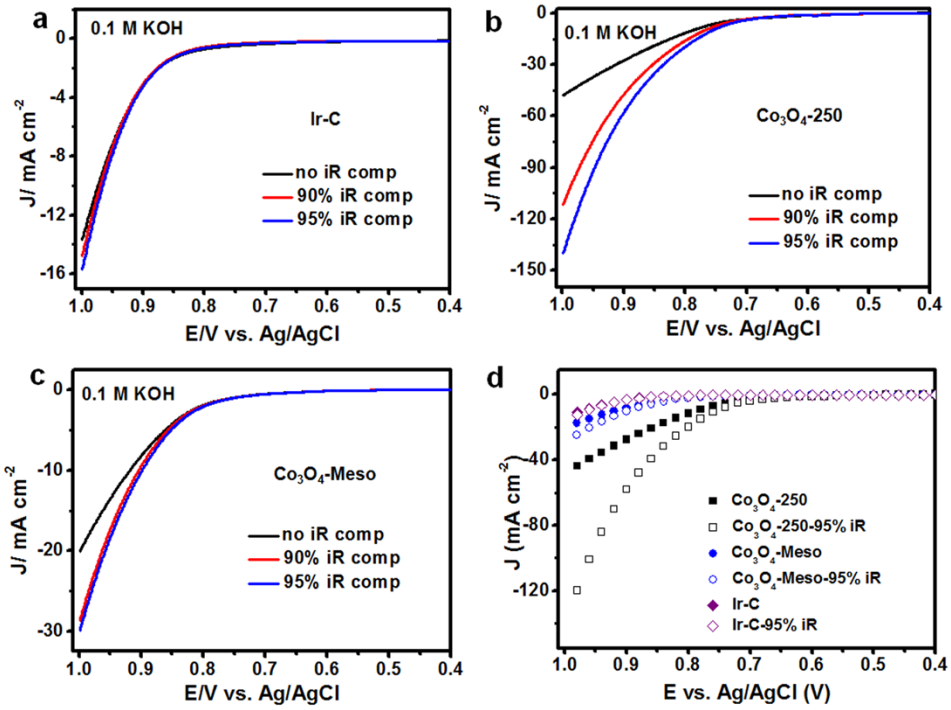

Fig. S7. Electrochemical performance of three catalysts after 90% and 95% iR corrections in 0.1 M KOH solution. (a) Co_3O_4-250, (b) Co_3O_4-Meso, and (c) Commercial available 10wt % Ir/C. (d) Electrochemical performance of Co_3O_4-250, Co_3O_4-Meso and commercial 10 wt% Ir/C after 95% iR corrections in 0.1 M KOH..

3. Photocatalytic Oxygen Evolution from Water

The photocatalytic oxygen evolution activities of the catalysts were studied in a Clark electrode system. In a typical Clark electrode experiment, a solution composed of 8 ml of aqueous buffer solution (pH=5.8), 5 mg of catalyst, 4.6 mg of $Ru(byp)_3Cl_2 \cdot 6H_2O$, 13 mg of $Na_2S_2O_8$, and 40 mg of Na_2SO_4 was first prepared and diluted eightfold. 1 ml of the dilute solution was used for the Clark electrode system. Before the Clark electrode system was exposed to 150 W Xe light, the solution was degassed with high purity Ar for 30 min. Oxygen evolution was continuously monitored for 1 min by the Clark electrode system. OER reactions for each catalyst were repeated for 5 times under the identical conditions.

Calculation of TOF

Turnover frequency (TOF) value is calculated from the equation[1, 2]

$$TOF = \frac{J \times A}{4 \times F \times m}$$

J (A cm^{-2}) is the current density at a specified overpotential. A is the area of the ITO electrode. F is the faraday constant (96485 C mol^{-1}). The m is the number of moles of the active materials loaded onto the ITO.

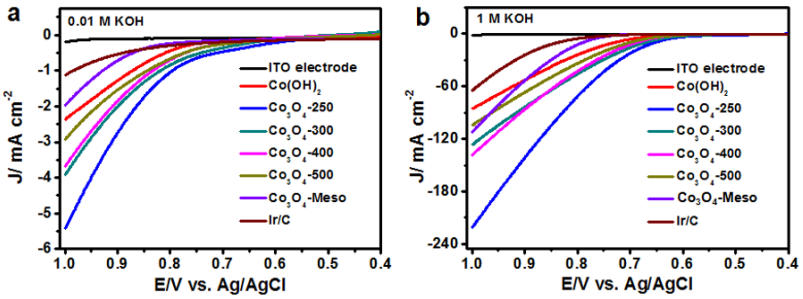

Fig. S8. Electrochemical performance of ITO bare electrodes, commercial 10 wt% Ir/C, β-$Co(OH)_2$ nanoplates, and porous Co_3O_4-250, Co_3O_4-300, Co_3O_4-400 and Co_3O_4-500 nanoplates loaded on ITO electrodes in 0.01 and 1.0 M KOH electrolyte solutions. (a) Linear sweep voltammograms of all catalysts in 0.01 M KOH solution. (b) Linear sweep voltammograms of all catalysts in 1.0 M KOH solution.

References

[1] X.M. Zhou, Z.M. Xia, Z.Y. Zhang, Y.Y. Ma, Y.Q. Qu, J. Mater. Chem. A 2 (2014) 11799.
[2] M. Gong, Y.G. Li, H.L. Wang, Y.Y. Liang, J.Z. Wu, J.G. Zhou, J. Wang, T. Regier, F. Wei, H.J. Dai, J. Am. Chem. Soc. 135 (2013) 8452.