

Supporting information

Architecting Mesoporous N-Doped Graphitic Carbon Framework Encapsulating CoTe₂ as Efficient Oxygen Evolution Electrocatalyst

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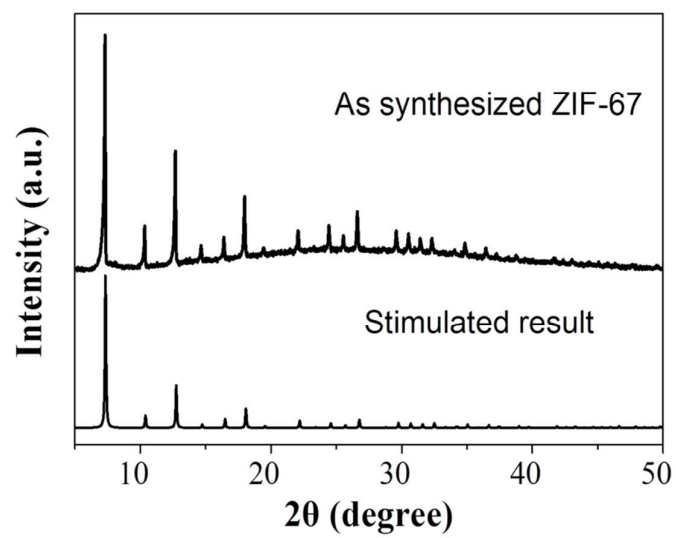


Figure S1. Experimental and simulated XRD pattern of ZIF-67.

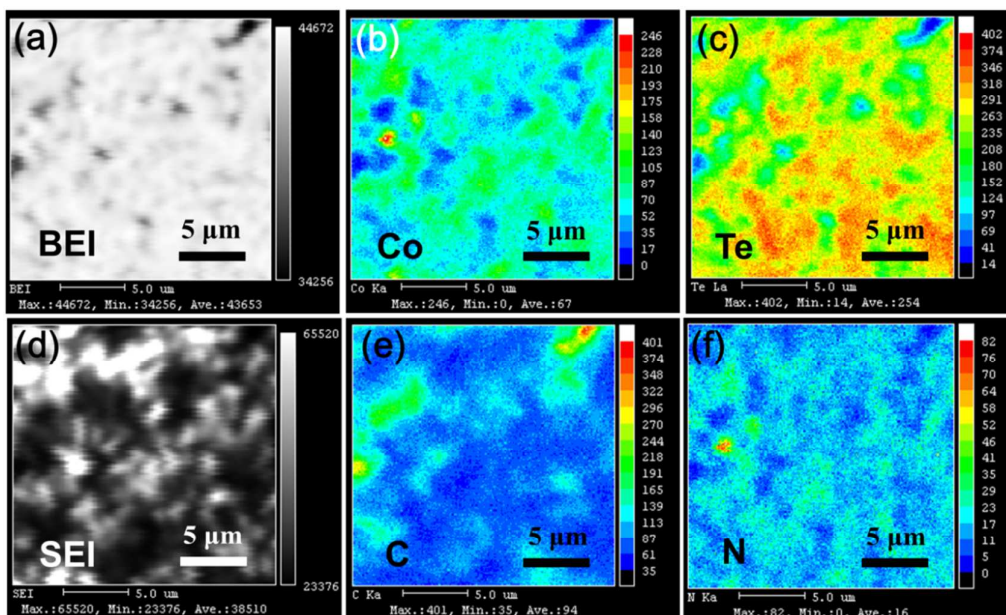


Figure S2. a) Backscattered electron image (BEI) and d) secondary electron image (SEI) of the CoTe₂@N-GC powder. Compositional mapping of b) Co, c) Te, e) C and f) N with the electron probe microanalyzer.

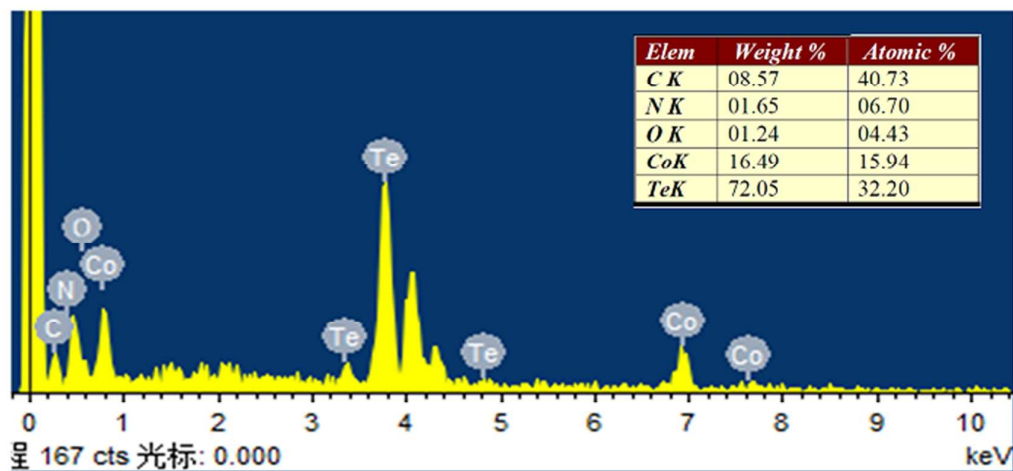


Figure S3. EDS profiles for the CoTe₂@N-GC.

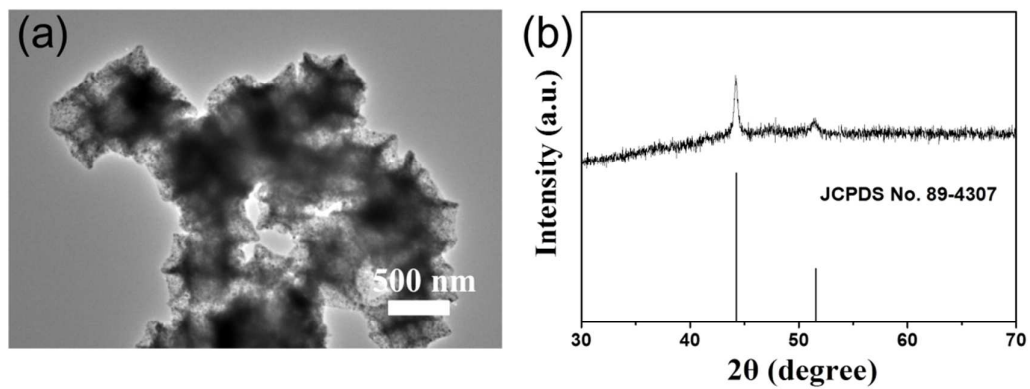


Figure S4. a) TEM image and b) XRD pattern of Co@N-GC.

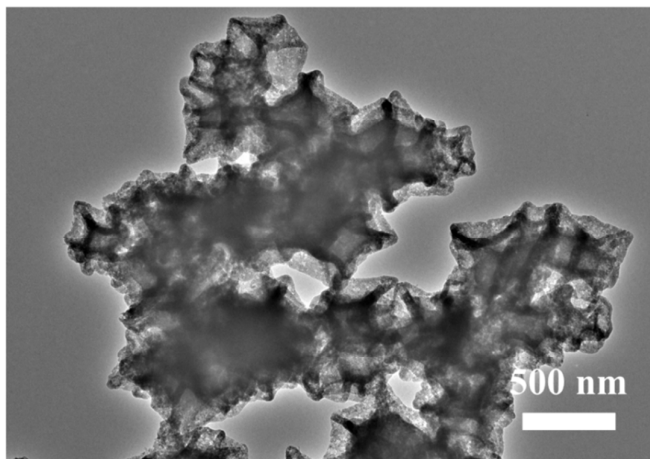


Figure S5. TEM porous carbon matrix was obtained by etching
Co@N-GC.

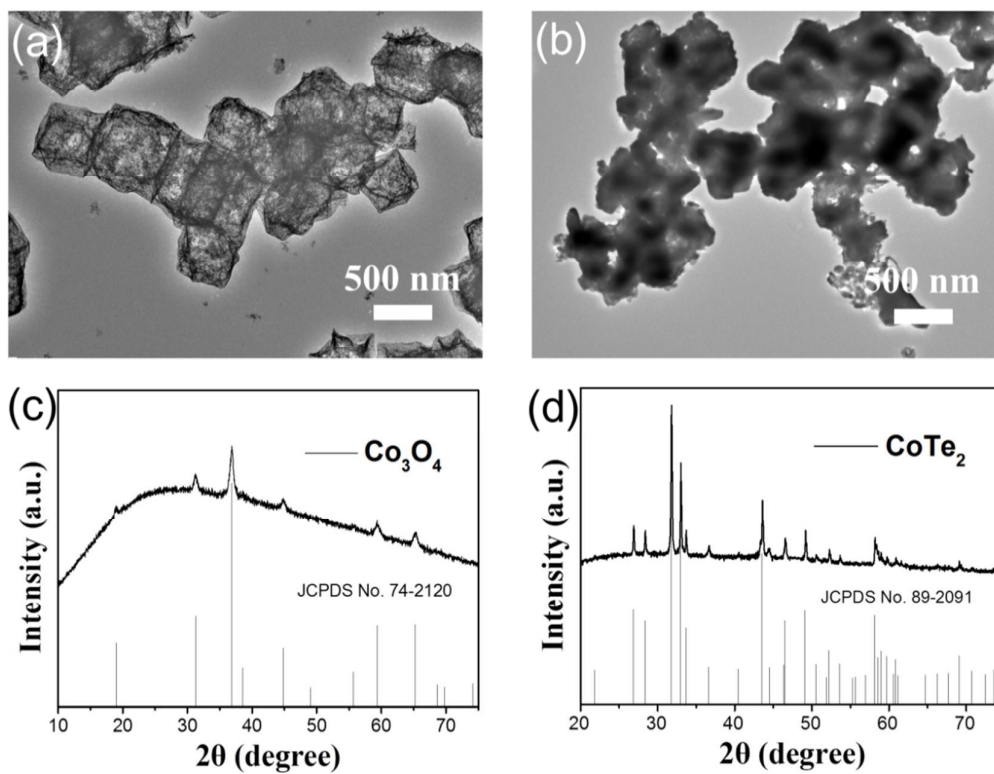


Figure S6. TEM images of a) Co₃O₄ and b) CoTe₂ powder. XRD patterns of c) Co₃O₄ and d) CoTe₂ powder.

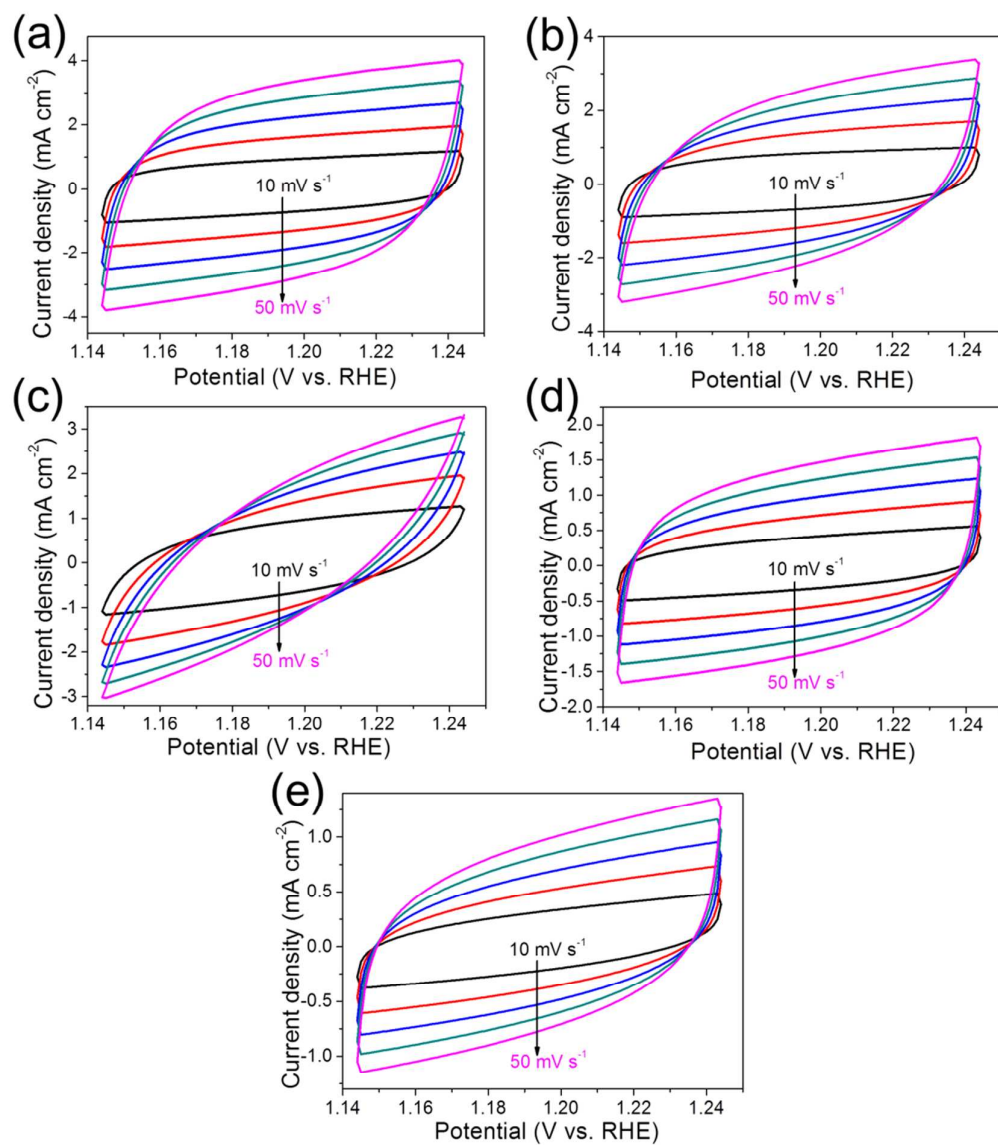


Figure S7. CV curves of a) CoTe₂@N-GC, b) CoTe₂ power, c) N-GC, d) ZIF-67 and e) CP.

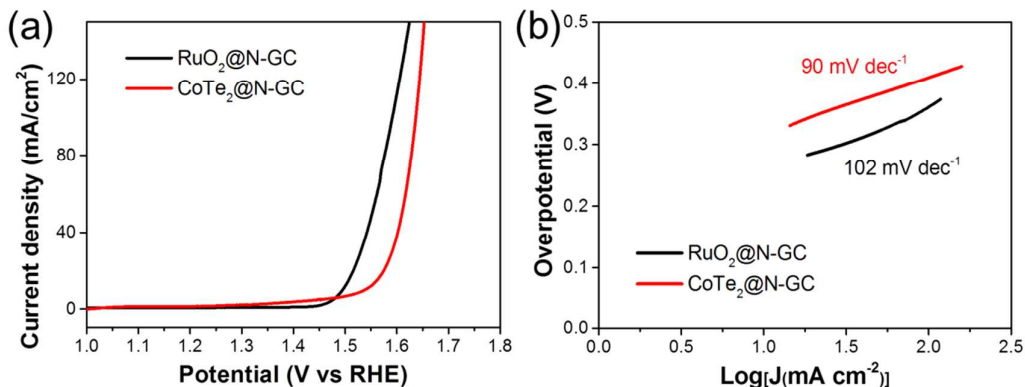


Figure S8. (a) LSV curves and (b) Tafel plots of CoTe₂@N-GC and RuO₂@N-GC.

The obtained mesoporous N-GC via etching Co@N-GC was used as the carrier to load RuO₂. 0.5 mmol RuCl₃•3H₂O was dissolved into 50 mL deionized water before 15 mg N-GC being dispersed uniformly. The mixture was heated to 100°C for 10 min. 1 M KOH solution was used to adjust the pH value to 11. It was kept at 100°C for another 45 min under stirring. The precipitate was centrifuged and rinsed three times with water and ethanol. After drying at 80°C overnight, the powder was annealed at 300 °C for 3 h under Ar atmosphere to gain RuO₂@N-GC. The comparison of CoTe₂@N-GC with RuO₂@N-GC for OER is shown in the following figure. Apparently, the catalytic performance of our CoTe₂@N-GC was found to be comparable to that of precious RuO₂@N-GC.

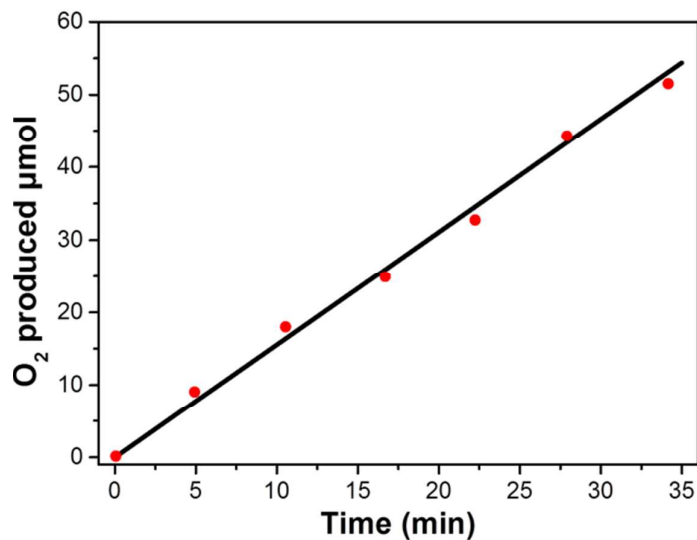


Figure S9. Electrocatalytic efficiency of CoTe₂@N-GC for OER.

The experimental O₂ amount is $n_{O_2}(\text{experimental}) = V_{O_2}/22.4$, where V is the volume of collected O₂ which is equal to the volume of water drainage. The ideal O₂ amount is $n_{O_2}(\text{theoretical}) = i \cdot t / 4F$, where t is the reaction time (s) under constant current i (A). F is the faraday constant (96500 C mol⁻¹). It's obvious that all the data fall on the theoretical line roughly giving nearly 100% Faradaic yield over the time scale of OER. It indicates that the electrocatalytic currents flew through the CoTe₂@N-GC electrode are exclusive to pure OER. The results plotted in the following figure reveal that the experimental data operated at 10 mA cm⁻² vs. time is consistent with the theoretical value. A 96.7% Faradaic yield is estimated over ~ 35 min.

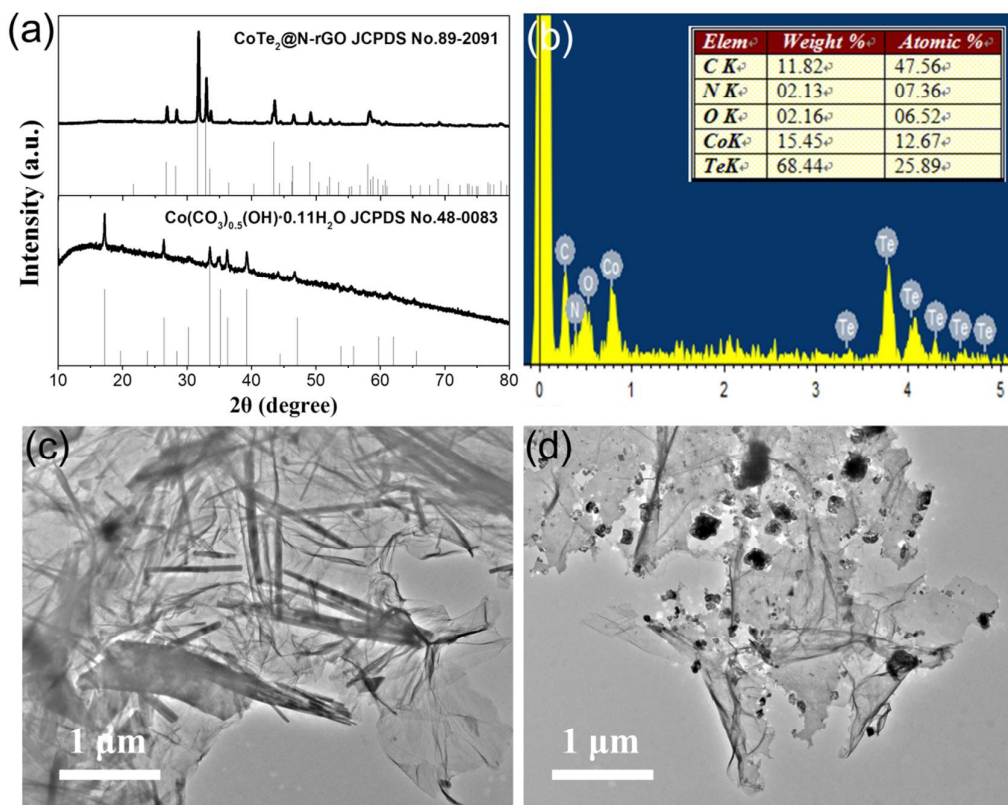


Figure S10. (a) XRD spectra of 2D Co(CO₃)_{0.5}(OH)·0.11H₂O@N-rGO and 2D CoTe₂@N-rGO. (b) EDS profile of 2D CoTe₂@N-rGO. TEM images of (c) 2D Co(CO₃)_{0.5}(OH)·0.11H₂O@N-rGO and (d) 2D CoTe₂@N-rGO.

First, GO powder was prepared via a modified Hummers method.¹ 30 mg of GO powder was dispersed in an aqueous solution containing 0.1 M CoCl₂·6H₂O and 0.1 M urea by sonication for 30 min. The mixture was transferred into a Teflon-lined stainless steel autoclave followed by hydrothermal at 120 °C for 16 h. The precipitate was collected by centrifugation, washing with ethanol for several times, and drying in a vacuum oven at 60 °C overnight. As characterized by SEM and XRD, cobalt carbonate hydroxide precursor has been successfully deposited on

GO. Moreover, as we know, it is facile to realize nitrogen doping in GO by the in-situ hydrothermal treatment with urea, which can be further verified by the EDX results in the following.²[Small 2016, 12, 3849] The tellurization and electrocatalytic measurements were conducted by the similar procedure to CoTe₂@N-GC.

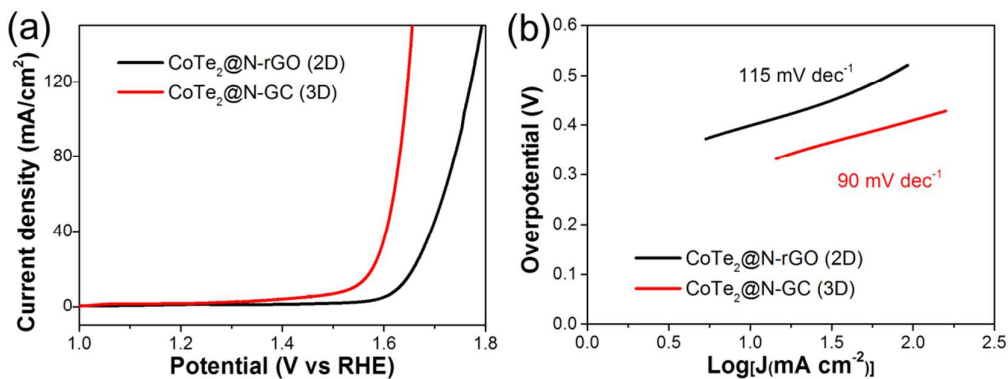


Figure S11. (a) LSV curves and (b) Tafel plots of CoTe₂@N-GC and CoTe₂@N-rGO.

Polarization curve was recorded to examine the OER catalytic activity of 2D CoTe₂@N-rGO. Obviously, it exhibited an overpotential of 390 mV at 10 mA cm⁻², which was larger than that of 3D CoTe₂@N-GC. Furthermore, 2D CoTe₂@N-rGO delivered a Tafel slope of 115 mV dec⁻¹ larger than that of 3D CoTe₂@N-GC (90 mV dec⁻¹), confirming a slower OER. This comparison strongly demonstrates the enhancement achieved with the CoTe₂@N-GC, which can be ascribed to the 3D mesoporous architecture.

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- (1) Marcano, D. C.; Kosynkin, D. V.; Berlin, J. M.; Sinitskii, A.; Sun, Z.; Slesarev, A.; Alemany, L. B.; Lu, W.; Tour, J. M. Improved Synthesis of Graphene Oxide. *ACS Nano* **2010**, *4*, 4806-4814.
- (2) Yao, X.; Guo, G.; Zhao, Y.; Zhang, Y.; Tan, S. Y.; Zeng, Y.; Zou, R.; Yan, Q.; Zhao, Y. Synergistic Effect of Mesoporous Co₃ O₄ Nanowires Confined by N-Doped Graphene Aerogel for Enhanced Lithium Storage. *Small* **2016**, *12*, 3849-3860.