

Supporting Information

Development of a Reactor with Carbon Catalysts for Modular-scale, Low-cost Electrochemical Generation of H₂O₂

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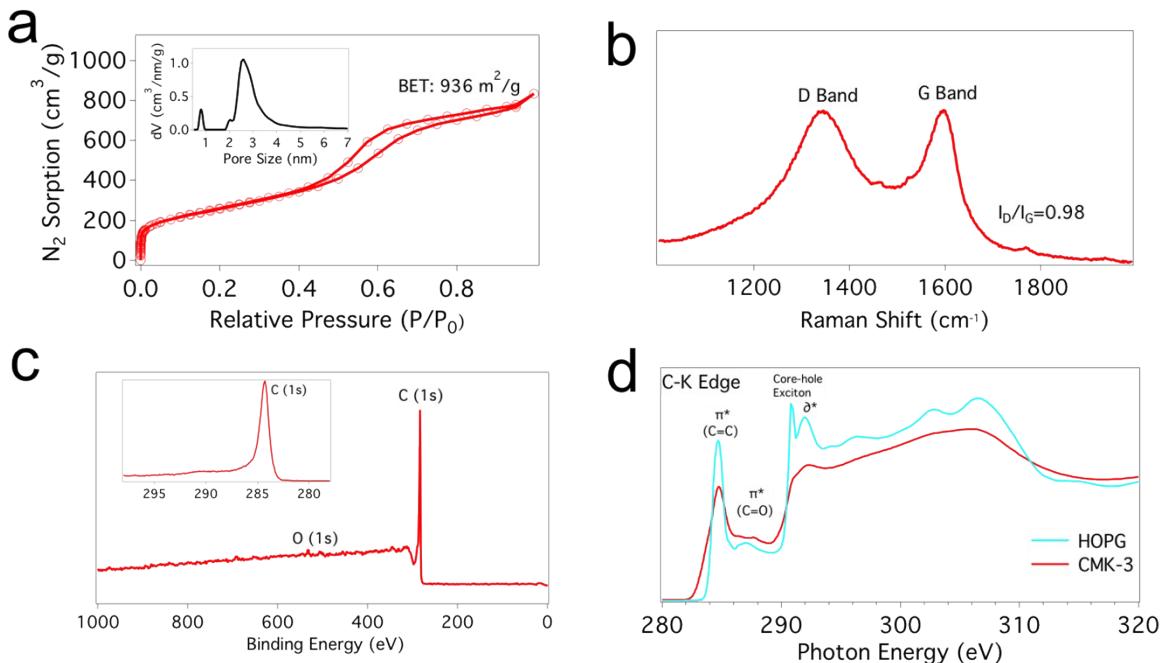


Figure S1:(a) Nitrogen adsorption and desorption isotherms at 77K and pore size distributions of CMK-3 (b) Raman spectra for CMK-3. The I_D/I_G is indicated. (c) XPS survey scan for CMK-3. High resolution scans for C (1s) peaks are shown in the inset. (d) NEXAFS spectra of C-K Edge for HOPG and CMK-3.

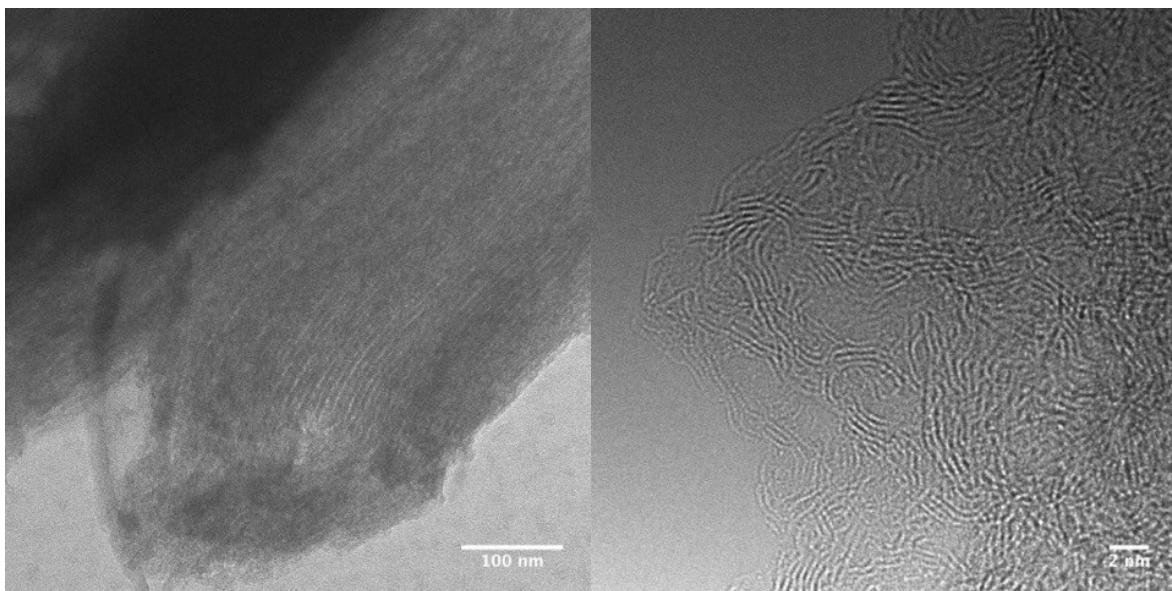


Figure S2. TEM images of CMK-3 at different magnifications

Number of electrons exchanged in the ORR (n) determined via Koutecky-Levich plots

The Koutecky-Levich plots were obtained by running cyclic voltammograms in the ORR region at different rotation rates. The Koutecky-Levich equation is as shown:

$$\frac{1}{j} = \frac{1}{j_k} + \frac{1}{j_L} = \frac{1}{j_k} + \frac{1}{\hat{I} \cdot \omega^{1/2}}$$

$$\hat{I} = 0.62nFD_o^{2/3}\nu^{-1/6}C_o^*$$

where j , j_k , and j_L are the measured, true kinetic, and diffusion-limited current density respectively, ω is the shaft rotation rate, F is the Faraday constant, A is the electrode area, D_o is the diffusion coefficient of oxygen, ν is the kinematic viscosity of the electrolyte, and C_o^* is the bulk O_2 concentration in the electrolyte. The slope of a Koutecky-Levich plot (j^{-1} vs. $\omega^{-1/2}$) gives β^{-1} , from which n , the number of electrons exchanged in ORR, can be determined. For a 0.1 M KOH electrolyte at 25 °C, the values of D_o , ν , and C_o are $1.85 \times 10^{-5} \text{ cm}^2 \cdot \text{s}^{-1}$, $0.89 \times 10^{-2} \text{ cm}^2 \cdot \text{s}^{-1}$, and $1.21 \times 10^{-6} \text{ mol} \cdot \text{cm}^{-3}$ respectively.

Number of electrons exchanged in the ORR (n) determined via RRDE measurements

The number of electrons exchanged in ORR for the carbon catalyst was also determined via rotating ring disk electrode (RRDE). The following equation shows the relationship between n and the ring and disk currents:

$$n = \frac{4I_D}{I_D + I_R/N}$$

where I_D and I_R are the disk and the ring currents respectively, and N is the collection efficiency which was determined via the $[\text{Fe}(\text{CN})_6]^{4-}/^{3-}$ redox couple to be 0.212 and 0.255 for our system.

Estimation of reactant (O_2) conversion

A conversion rate of 5 % was calculated based on an estimated flow rate of O_2 into the cell at 8 sccm, approximately $5.4 \times 10^{-6} \text{ mol/s}$. The total cell current of approximately 50 mA represents O_2 consumption of $2.6 \times 10^{-7} \text{ mol/s}$, leading to a conversion of approximately 5 %.

$$\text{conversion rate} = \frac{\frac{\text{flow rate (sccm)}}{(60 \frac{\text{s}}{\text{min}})(1000 \frac{\text{cm}^3}{\text{L}})(24.8 \frac{\text{L}}{\text{mol}_{O_2}} \text{ at ambient } T, P)}}{\frac{\text{current (mA}}{\text{current (mA} = \frac{\text{mA}}{\text{s}}\text{)}}}{(96,485 \frac{\text{C}}{\text{mol}_{electrons}})(2 \frac{\text{mol}_{electrons}}{\text{mol}_{O_2}})(1000 \frac{\text{mA}}{\text{C}})}}$$