Supporting Information

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Biotemplated Palladium Catalysts Can Be Stabilized on Different Support Materials

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Shear stress calculations

The shear stress imparted by a rotating disc electrode used in these experiments is calculated as [1]:

$$\Gamma_{\text{avg}} = \frac{\tau_{\text{avg}}}{\mu} = \frac{du}{dz} \frac{\omega R}{3Z}$$

Equation (1)

where $R$ is the radius of the disk (m), $Z$ is the height above the bottom of the electrochemical cell (m), and $\omega$ is the angular velocity (rad/s).

The wall shear stress of fluid flowing by a pipe is calculated as [1]:

$$\Gamma_{\text{avg}} = \frac{32Q}{\pi D^3}$$

Equation (2)

where $Q$ is the volumetric flowrate (m$^3$/s), and $D$ is the pipe diameter (m). A formic acid fuel cell constructed for high power densities [2] was operated with a flowrate of and had an active surface area of 5cm$^2$ (2.23 cm x 2.23 cm). Assuming a total chamber volume of 0.25 cm$^3$ and a length of 2.23 cm, the effective diameter of a pipe of similar volume would be 0.36 cm.

The shear stress through porous media is described by [3]:

$$\Gamma_{\text{avg}} = \frac{3n + 1}{4n} \frac{12G}{\rho \sqrt{150k \varepsilon}}$$

Equation (3)

$$G = \rho V_0$$

Equation (4)

$$k = \frac{D_p^2 \varepsilon^3}{(150 - \varepsilon)^2}$$

Equation (5)

where $\rho$ is the density of water, $\varepsilon$ is the fractional void volume, $V_0$ is the apparent velocity in the system, $k$ is the permeability, and $D_p$ is the particle diameter. The fluid is assumed to be Newtonian, so the power law coefficient, $n$, is assumed to be 1 in Eq 3. The fractional void volume was assumed to be 0.7.

Shear stress ($\tau$) is calculated by multiplying the shear rate by the dynamic viscosity, $\mu$ (kg/s-m).
Figure SI1. Current densities produced by support materials without palladium at 0.6 V. The scale here is ten times smaller than when palladium was used.
Figure SI2. Porous palladium structures formed on graphite electrodes and coated with (A-B) PANI 15, (C-D) PDMS 5%, (E-F) Nafion 5%. The catalyst layer could not be examined when coated by the 5% Nafion solution due to the inability of the electron beam to penetrate the layer without destroying it.
Figure SI3. Schematic of modified RDE to allow direct testing of different support materials. The cap is made from Teflon and the contact between the electrode and the RDE is made from stainless steel. The resistance between the surface of the electrode and the RDE is less than 1 Ω for all tests.
References

