

HIGH PERFORMANCE DIRECT METHANOL AND DIRECT ETHANOL FUEL CELLS WITH MICROSCALE BIPOLAR INTERFACE

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Technology Description

Engineers in Prof. Vijay Ramani's laboratory have developed a bipolar interface membrane to prevent fuel crossover and improve the performance of direct methanol and direct ethanol fuel cells (DMFC and DEFC). This membrane separator is designed to maintain a steep pH gradient, thus enabling efficient energy storage with easily transported liquid fuel (i.e., methanol and ethanol) in mobile, automotive or military applications.

DMFCs and DEFCs are easier to store and transport than hydrogen fuel cells. However, they suffer from high levels of fuel crossover which greatly reduces their energy efficiency. This pH-gradient enabled microscale-bipolar interface solves that problem by replacing the traditional Nafion in the membrane electrode assembly. The new interface effectively separates the alcohol fuel (methanol or ethanol) and the hydrogen peroxide oxidant by maintaining a large pH gradient between them. The resulting fuel cell device has much greater cell voltage and power density than cells with uniform pH. Using this interface to produce high performance DMFCs and DEMCs could enable in transportation such as fuel cell-based automobiles as well as portable and off-grid energy storage.

Stage of Research

The inventors demonstrated this technology in lab scale devices:

DMFC - open circuit voltage of 1.9V with peak power density of 280 mW/cm²

DEFC - open circuit voltage of 1.5V with peak power density of 150 mW/cm²

Related Publication: Wang, Z., Parrondo, J., He, C., Sankarasubramanian, S., & Ramani, V. (2019). [Efficient pH-gradient-enabled microscale bipolar interfaces in direct borohydride fuel cells](#). *Nature Energy*, 4(4), 281-289.

Applications

- **Fuel cells** – ion exchange membrane for DMFC or DEFC in mobile and off-grid energy storage, particularly for uses such as automobiles and military applications

Key Advantages

- **High performance** – high voltage cells with peak power densities of 280 mW/cm² for DMFC and 150mW/cm² for DEFC
- **Easy fuel storage and transport** – bipolar interface enables energy storage with liquid fuels which are easier to store than compressed hydrogen, particularly for portable and mobile applications

Patents: Provisional application pending

Related Web Links: [Ramani Electrochemical Engineering Research Laboratory](#)