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Multipass Separated Flow Membraneless Microfluidic Fuel Cell

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Intellectual Property Status

Patent Pending

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Background

Portable power sources with high energy densities and extended lifetimes have long been needed for use in remote environments. Batteries are commonly used, but radiate excessive heat, provide power for a relatively short period of time and require recharging or replacement. For many field applications, the power source is the heaviest system component and can weigh down portable electronics or unmanned vehicles. Fuel cells present an appealing alternative for producing power with less thermal release and longer usage lifetimes. A major problem with existing fuel cell designs is that intermixing of fuel and oxidant reactants yields waste that can no longer be used to generate electricity.

Invention Description

Researchers at ASU have developed a Multipass Microfluidic Fuel Cell system that moves unused reactants through a series of reaction zones. Fuel and oxidant are introduced and flowed through a porous anode and cathode, respectively. An electrolyte stream is introduced between the two electrodes, maintaining a separated laminar interface between the reacting streams. The outlets for each stream, which contain the electrolyte and the unreacted portion of the reactant, can then be utilized in another reaction zone. Recycling can be repeated multiple times, which allows for an efficient process that reduces thermodynamic losses. A separated fuel and oxidant flow pattern can maintain high voltages while extracting the maximum faradaic current out of the reactants due to multiple cells.

One possible architecture for the Multipass Fuel Cell features a radial flow pattern, which maximizes the in plane ion transfer zones. The reaction zones are now along a single axis, so the flow pattern is azimuthally symmetric. Electrodes are positioned so that electrons from an oxidation feed to the nearest neighbour reduction. This setup reduces ohmic losses in the fuel cell since electrons are shuttled directly to the reactions sites, except the connecting ends, as opposed to traveling through the porous anode and the load to reach the cathode.

Potential Applications

- Portable power sources
- Unmanned vehicles
- Remote in-situ sensing or surveillance

Benefits and Advantages

- Eliminates the problems of reactant intermixing
- Reactants can be reclaimed and reused
- Extracts maximum current
- Flow pattern maintains high voltages to minimize thermodynamic losses
- Architecture reduces ohmic losses