Unitized Regenerative Fuel Cells with High-Temperature Proton Exchange Membranes

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Decarbonizing the energy sector is essential to reducing greenhouse gas emissions and curtailing climate change. This necessitates transitioning from fossil fuel-generated energy to renewable energy sources.[1] The latter's intermittent nature is causing a rise in the demand for seasonal storage energy. A Unitized Regenerative Fuel Cell (URFC) is an attractive technology for seasonal energy storage operating in two modes: a) electrolysis mode and b) fuel cell mode. Operating at low temperatures water management is challenging for the oxygen electrode. Water should be present in the electrolysis mode and removed in the fuel cell mode, as water flooding in the last case prevents the transport pathways of the oxygen gas.[2] Switching to a vapor phase URFC simplifies the water management issue, introducing however, ohmic, kinetic, and mass transport losses in the system, that overall affect the electrochemical performance. URFCs necessitate membrane electrode assemblies (MEAs) that can handle both humidified gases and fully flooded conditions. Herein, we aim to establish the operation of a single device (URFC) at high temperatures (100-250°C), preparing the electrodes, and fabricating polymer electrolyte ion-pair membranes that are more tolerant to water content than acid-base membranes.[3,4] High temperature increases the saturated vapor pressure of water reducing cell polarization during the electrolysis. Determining the impact of the operating parameters on the URFC activity and stability will enhance the design of rigid MEAs for URFCs. In the future, we will investigate how the different membrane dopants affect the activity and stability of the URFCs.

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