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MEA Design for improved Cathode durability under Startup Shutdown automotive conditions

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ABSTRACT

Startup/shutdown stressors in automotive fuel cell applications are damaging to cathode catalyst.[1-3] As the catalyst loading is decreased, the impact of startup/shutdown stressors on degradation becomes more significant. Some mitigation strategies which have been considered are alternative catalyst supports[4] and system-enabled solutions[4] such as load on startup, shutdown with hydrogen stored on both sides of the MEA, gas purging to the anode before startup and after shutdown, exhaust gas recycling or purging with reactant gases, electronic shorting to prevent high cathode potentials and an auxiliary load to consume residual gases, but most of these approaches have the disadvantage of additional cost and/or system complexity. Further MEA design advancements are necessary to enable lower catalyst loadings and thereby enable cost reduction.

We propose a novel MEA design solution - a selectively conducting anode structure which acts as an “intelligent switch” to provide protection of the cathode catalyst layer from degradation caused by startup/shutdown events.[5] This unique approach adapts gas sensor-type materials[6] like metal oxides that exhibit several orders of magnitude change in resistance depending on its gas environment[5] to PEM fuel cell anodes. The high resistance of the new layers in air environments prevents corrosion loop currents and therefore the corrosive stressors are substantially reduced. In hydrogen environments, the layers become conductive and therefore, regular fuel cell performance is not hindered.

For this study, the selective oxide is incorporated into the MEA design as a distinct layer. The oxide is deposited on the microporous layer side of the anode gas diffusion layer and assembled into a MEA. In-situ fuel cell test results demonstrate a successful reduction in cathode peak potentials during startup events and reduced performance degradation is observed in startup/shutdown stress tests. This strategy of preventing corrosion loop currents is compatible with various catalyst types and with different catalyst loadings. This approach enables a path to catalyst reduction and/or the use of less robust catalysts.

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