Proton Conductor based Solid Oxide Fuel Cells
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High efficiency operation is one of the primary attractions to use solid oxide fuel cells as the energy conversion device. High efficiency requires maximizing of the product of operating voltage and fuel utilization. The maximum possible operating voltage however is limited by the Nernst potential near the fuel exhaust. In oxygen conducting electrolyte based fuel cells (O-SOFC) as the fuel utilization increases, the Nernst potential continues to decrease with the dilution of fuel by the reaction products. In contrast, in a proton conducting electrolyte based fuel cell (P-SOFC) the reaction product is formed on the cathode side allowing for high operating voltage at high fuel utilization.

Two challenges that must be overcome in the development of P-SOFC are the phase instability of the traditional perovskite materials in the presence of CO_2 containing fuels and their low proton conductivity. A composite electrolyte was evaluated to overcome the stability problem. Addition of well-dispersed second phase consisting of doped ceria has shown significant improvement in materials stability when exposed to syngas at target cell operating temperature range. Anode supported thin electrolyte cells have been fabricated and tested using the composite electrolyte. Power densities of 0.2 W/cm2 was obtained at 700°C. Initial long-term stability test in simulated syngas shows promise. Preliminary results from a short stack test show the potential of composite electrolyte in improving stack stability.