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Thin Film Proton Conducting Membranes for Micro-Solid Oxide Fuel Cells by Chemical Solution Deposition

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Abstract

Micro solid oxide fuel cells (µ-SOFC) were manufactured with perovskite type proton conductors on silicon substrates and with structured Pt-grid electrodes. In order to miniaturize the µ-SOFCs and to shorten the ion path through the electrolyte, the thin film proton conductors were only ~ 510 nm thick. The thin films consist of 10 mol% yttrium-doped $BaZrO_3$ (BZY10) and they were deposited by means of chemical solution deposition (CSD). CSD was applied, because it represents a highly attractive fabrication method, considering the relatively low investment costs and flexibility with regard to stoichiometry. The backsides of the µ-SOFCs on the substrates were opened by wet chemical and plasma etching to form the freestanding membranes. The completed µ-SOFCs resist up to a temperature of 450 °C. Their electrical properties, such as permittivity, and resistivity were investigated. By means of electrochemical impedance spectroscopy (EIS) in the temperature range of 100 °C to 450 °C, the resistivity properties and the activation energies of the model µ-SOFC were studied with humid hydrogen in nitrogen at the anode and different oxygen partial pressures at the cathode. The results provide a clear hint for a dominating protonic defect transport mechanism in the electrolyte. In the 450 °C measurement, the model µ-SOFCs reached an open circuit voltage of 600 mV with 100 % oxygen at the cathode and humid hydrogen in nitrogen at the anode.