Faculty of Electrical Engineering & Computer Science
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Nanostructured Solid Acid Fuel Cell Electrodes via Spraydrying.

ABSTRACT - Masterthesis

Solid acid fuel cells are one of the promising future renewable technologies which are currently performance limited by the electrochemical reaction kinetics at the electrodes. Fuel cells are evaluated by their power output and for acceptable power output, precious metal catalysts such as platinum are required, making the current technology too expensive for commercial utilization. This thesis explores the development of new ways to fabricate nanostructured solid acid fuel cell electrodes with the aim of reducing the catalyst loading without sacrificing performance.

Stable, porous, nanostructured electrodes were successfully fabricated via Spraydrying deposition technique in which the dissolved solute is fed to a spray head which consists of piezo actuator and fine aerosol droplets are produced. These droplets are gently dried by the laminar drying gas and finally the dried particles are collected at the collecting electrode. Co-deposition of the CSH_2P0_4 nanoparticles together with a stabilizing surfactant polyvinylpyrrolidone (PVP) allows the creation of highly stable, porous, nanostructured electrodes. In the absence of the surfactant, the structure was morphologically unstable at the fuel cell working condition.

These nanostructures were directly deposited onto fuel cell components, such as the carbon paper current collector or the electrolyte pellet which serve as electrodes. The direct deposition of CSH_2P0_4 nanoparticles with the stabilizing surfactant PVP onto a CSH_2P0_4 electrolyte pellet and subsequent magnetron sputtering of a 10 nanometer thin platinum film lead to higher catalyst-mass normalized electrode activities for solid acid fuel cell anodes. Electrochemical impedance spectroscopy under humidified hydrogen at 240°C indicated an impedance of ~ 3.5 Ω cm^2 with platinum loading of 0.023 mg cm^{-2}. The reported 12.5 S/mg mass normalized activity is the highest reported to date for porous electrodes. A remarkable 6-fold increase in the mass normalized activity has been achieved with the fabrication method of nano spraydrying and sputter deposition as compared to electrospray fabrication method.