Impact of Trace Hydrocarbons from Coal Syngas on SOFC Anode Long-Term Operation

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Strategies of energy generation are trending toward high efficiency and fuel flexibility in the contemporary energy market. When integrated with a gasification process, a fuel cell can produce electricity from coal or biomass at greater than 50% efficiency. The synthesis gas (syngas) derived from these fuels may contain unwanted trace species (including antimony, arsenic, lead, cadmium, mercury, phosphorus, selenium, sulfur, and hydrocarbons) that adversely affect SOFC performance. Specifically, this work addresses the knowledge gap in the effect of trace hydrocarbon species on SOFC performance.

The impact on SOFC button cell performance when fueled with certain trace hydrocarbon (including benzene, naphthalene, and ethylene) doped syngas is evaluated over a 500 h period at 800°C. Cell performance is probed during operation by electrochemical impedance spectroscopy and exposed samples are post-operationally analyzed by SEM, XPS, and TEM for carbon deposits, formation of secondary anode phases, and formation of metal solutions. Data are analyzed to predict lifetime performance by applying linear and/or exponential degradation models. Possible mechanisms of carbon-induced performance degradation are discussed and benzene, naphthalene, and mercury exposure limits are postulated.