Biogas Catalytic Reforming Studies on Nickel-Based Solid Oxide Fuel Cell Anodes - DTU Orbit (09/11/2017)

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Heterogeneous catalysis studies were conducted on two crushed solid oxide fuel cell (SOFC) anodes in fixed-bed reactors. The baseline anode was Ni/ScYSZ (Ni/scandia and yttria stabilized zirconia), the other was Ni/ScYSZ modified with Pd/doped ceria (Ni/ScYSZ/Pd-CGO). Three main types of experiments were performed to study catalytic activity and effect of sulfur poisoning: (i) CH4 and CO2 dissociation; (ii) biogas (60% CH4 and 40% CO2) temperature-programmed reactions (TPRxn); and (iii) steady-state biogas reforming reactions followed by postmortem catalyst characterization by temperature-programmed oxidation and time-of-flight secondary ion mass spectrometry. Results showed thatNi/ScYSZ/Pd-CGO was more active for catalytic dissociation of CH4 at 750°C and subsequent reactivity of deposited carbonaceous species. Sulfur deactivated most catalytic reactions except CO2 dissociation at 750°C. The presence of Pd-CGO helped to mitigate sulfur deactivation effect; e.g. lowering the onset temperature (up to 190°C) for CH4 conversion during temperature-programmed reactions. Both Ni/ScYSZ and Ni/ScYSZ/Pd-CGO anode catalysts were more active for dry reforming of biogas than they were for steam reforming. Deactivation of reforming activity by sulfur was much more severe under steam reforming conditions than dry reforming; a result of greater sulfur retention on the catalyst surface during steam reforming.

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