Mechanical Engineering Doctoral Defense

Investigating the Solid Oxide Fuel Cell Anode Degradation Mechanism Under Siloxane Contamination

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Abstract

Siloxane, a common contaminant present in biogas, is known for adverse effects on cogeneration prime movers. In order to investigate the solid oxide fuel cell nickel-yttria stabilized zirconia (Ni-YSZ) anode degradation mechanism due to poisoning by siloxane, the experiments with different fuels, different deposition substrate materials; different structure of contamination siloxane (cyclic and linear) and entire failure process are conducted in this study. The electrochemical and material characterization methods such as EIS, SEM-WDS, XPS, XRD, Raman spectroscopy were all applied for the anode degradation mechanism investigation. The electrochemical characterization results show that the SOFCs performance degradation caused by siloxane contamination is irreversible. The results contradict the previously proposed degradation mechanism as the experimental results show that water can inhibit anode deactivation. For anode materials, Ni is considered as a major factor in siloxane deposition reactions in Ni-YSZ anode. Based on the results of XPS, XRD and WDS analysis, carbon deposition at the initial phase was observed and considered as a critical process for the siloxane deposition reaction. Based on the experimental results in this study and previous studies about siloxane deposition on metal oxides, a new adsorption mechanism is proposed which includes initial carbon deposition; siloxane polymerization and amorphous silicon dioxide deposition.

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