High Temperature Fuel Cells: An Emerging Green Energy Technology

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Abstract: due to their inherent internal reforming capability, high temperature fuel cells, in particular solid oxide fuel cells (SOFC), are amenable for utilization of various fuels including synthetic gas produced from coal via gasification, gas originating from municipal waste, as well as bio gas produced from wood, switch grass etc. These cells can also be used with bio-diesel and similar higher hydrocarbon fuels with external reforming. However, such alternative renewable fuels inevitably contain many impurities, such as species of Sulfur, Arsenic, Phosphorus, etc. which can be detrimental to the operation of the cell even when only trace amounts of are present. A review of the current status of various high temperature fuel cells, e.g. direct carbon cells and SOFC’s, will be presented first. Then, experimental and numerical results will be presented from an ongoing study at West Virginia University aiming at understanding the degradation mechanisms of various contaminants for a typical SOFC. Experiments show that a typical SOFC could loose up to 80% of its power within several hundred minutes when exposed to 5-10 ppm of PH3. Detailed measurements have revealed that PH3 reacts with Ni to form secondary phases hence leading to loss of active sites in the anode. Modeling results indicates that the severest degradation occurs when PH3 reaches the anode–electrolyte inter-phase and starts to deactivate electrochemical reactions. Model studies indicate that the degradation rates under various operation conditions can be predicted in accordance with measurements, hence enabling life time predictions for a given concentration of impurity. Implication of the current study for future prospects and challenges in utilization of renewable fuels in high temperature fuel cells will be discussed.