Remedies for poisonous effects of coal syngas impurities on SOFC anodes

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Researchers from the National Institute for Fuel Cell Technology (NIFT) at West Virginia University (WVU) have been studying the effects of trace impurities found in coal syngas and other complex fuels on the operation of Solid Oxide Fuel Cells. The goal is to enable direct utilization of coal syngas and other alternate fuels such as biogas in Solid Oxide Fuel Cells (SOFC's). To this end comprehensive ex-situ and in-situ experiments have been performed to identify the effects of phosphine, hydrogen sulfide and other coal syngas impurities on the nickel/ yttria-stabilized zirconia (Ni/YSZ) based SOFC anodes. New findings for phosphine contaminant include faster degradation in the presence of steam and reaction of phosphine with YSZ along with nickel. Nickel and iron based prefilters have been shown to remove phosphine from syngas fuel effectively to levels which are not harmful to the Ni-YSZ anode. With proper filter design, the Ni-YSZ SOFC can operate on contaminated coal-syngas without degradation over a prescribed period of time. Novel anode materials and coatings have been designed and demonstrated to be effective in resisting the degradation due to common syngas contaminants. Computational modeling has been used to study the effect of contaminants on performance and structural degradation of SOFCs at low concentrations, to find correlations for cell lifetime predictions, and to aid experimental work. The mathematical models which are based on physico-chemical principles use accelerated test results to determine reaction rates, and predict slow degradation rates and the life time of cells running with relatively low concentrations of impurities.