Anode Materials for a Solid Oxide Fuel Cell Utilizing Hydrogen Sulfide as Fuel

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An electrochemical cell to be used for cogeneration of energy and sulfur dioxide from feed streams containing hydrogen sulfide is being tested at the lab scale. Feed streams containing varying concentrations of H_2S are passed by the anode of the cell. Air is supplied to the cathode. The half-cell reactions for the hydrogen sulfide fuel cell differ hydrogen fuel cells only on the anode side of the cell. There are two possible reactions that occur at the anode side of the cell depending on the level of gas utilization. At operating temperatures, the reversible potentials for the two reactions are very similar.

The primary goal of our work is to find a suitable anode material for application to thin film yttria-stabilized zirconia (YSZ) in hydrogen sulfide fuel cells. Previous work has demonstrated that $LiCoO_2$ gives good performance over an extended period of time, while tungsten sulfide is not stable as a hydrogen sulfide fuel cell anode for an extended period of time and gives only mediocre performance. We have recently tested a new ceramic material that appears stable and conductive over large ranges in concentration as well as temperature. Fuel cell work has begun, utilizing this material as well as comparison with known materials.

Results will be presented for the performance of several anode materials, including $LiYCa_{(0.1)}FeO_3$, Co_9S_8, and NiS. Operation temperatures were varied from 600°C to 1000°C, while the system was operated at a constant pressure of 1 atm. The other electrochemical cell components consist of tubular samples of YSZ on strontium doped lanthanum manganite (LSM).

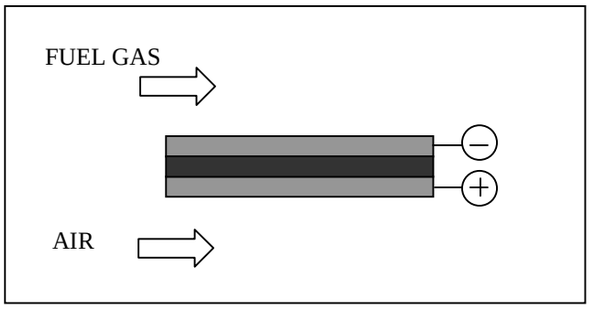

Figure 1. Basic Fuel Cell Structure

Cathode Reaction:

$$O_2 + 4e^- \rightarrow 2O^{2-}$$

Anode Reactions:

$$H_2S + O^{2-} \rightarrow H_2O + {}^1/_2\, S_2 + 2e^-$$

$$H_2S + 3O^{2-} \rightarrow H_2O + SO_2 + 6e^-$$

Figure 2. Half Cell Reactions