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Chemical Sensors for Fuel Cell Systems

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Abstract

Power generation systems based on fuel cells require sensors to detect numerous volatiles at extremely low levels (0.1 ppm) in the presence of hydrogen and other gaseous components (N_2, CO_2, methane and steam). In the case of PEM fuel cells presence of carbon monoxide and sulfur-bearing species in the gas stream is undesirable, as these are known to poison the Pt anode. The automotive fuel cell application requires a sensor to detect low levels of carbon monoxide (~1ppm CO) in order to control the fuel processor and sulfur (~0.1ppm) in order to protect the anode. However, their monitoring in a hydrogen-rich reformate (~40% hydrogen) is a challenging task and standard combustion based sensors will no longer work in environments lacking oxygen. The measurement becomes more daunting in presence of appreciable amount of carbon dioxide, and water vapor in the reformate gas. Figure 1 shows a schematic of the multiple catalytic steps in fuel processing.

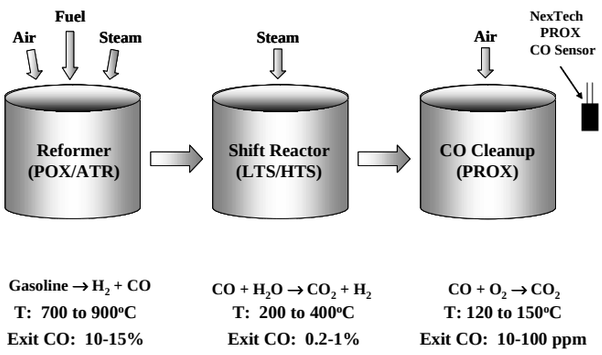

Fig. 1. Schematic showing steps in fuel processing,

At NexTech, research strategies have been employed to address this issue. We have succeeded in developing a novel sensor for the detection of carbon monoxide in a mixture of hydrogen and nitrogen as well as in dry syngas, in the temperature range normally encountered in the operation of PEMFCs (1-2).

The sensing approach pursued here is based on the reversible adsorption of CO onto and complexation with metal halide films. When suitable film synthesis conditions are used, the resistance of the device exhibited a rapid and reversible sensitivity to carbon monoxide, even in the presence of 50vol% hydrogen.

The temperature range as well the sensitivity of these films was greatly enhanced by compositing with suitable oxides as shown in Figure 2.

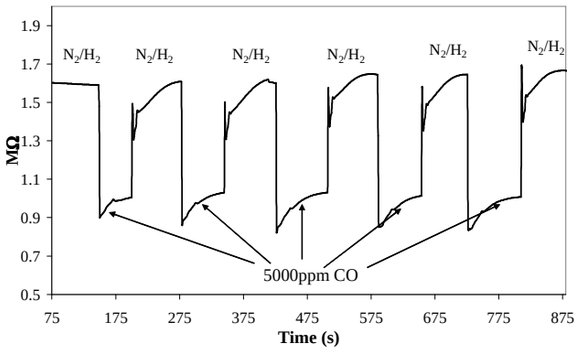

Fig. 2. CuCl response with second phase metal oxide to 5000ppm CO in nitrogen hydrogen background.

An overview of NexTech's sensor development efforts for fuel cell systems will be presented with emphasis on carbon monoxide sensors for PEMs.

References:

1. P. Dutta, R.R. Rao, S.L. Swartz and C.T. Holt, Sensing Carbon monoxide in reducing environments, Sensors and Actuators B 84 (2002) 189.
2. C.T. Holt, A.-M. Azad, S.L. Swartz, R.R. Rao, and P. Dutta, Carbon monoxide sensor for PEM fuel cell systems, Sensors and Actuators B 87 (2002) 414.