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Effect of Surface Adsorbing Contaminants on NanoStructured Thin Film (NSTF) Electrodes

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Recently, an international team (ISO TC197 WG-12) developed hydrogen fuel product specifications for use in proton exchange membrane fuel cell applications for road vehicles; (ISO 14687-2:2012). Fuel cells tested with the fuel specification indicated that ammonia, carbon monoxide and hydrogen sulfide were the critical contaminants; i.e. the impurities that were the most harmful to PEMFC performance and/or its durability. While the fuel specification was based on actual PEMFC data from MEAs using conventional dispersed Pt/C catalysts; the DOE target loading for platinum has been continuously lowered and is currently based on novel materials that were unavailable during the development of the ISO standard. Therefore, there is still uncertainty in whether or not the fuel standard may need revising to accommodate these novel catalyst layers and low loadings. In this talk we will present results of PEMFC performance utilizing these novel materials in the presence of surface adsorbing contaminants.

The current status of PEMFC technology as monitored by the DOE Fuel Cell program in based on NanoStructured Thin Film (NSTF) materials. MEAs based on these novel materials show great promise for reduced cost (better performance at lower precious metal loadings) and greater durability over conventional Pt/C electrodes.[1] However, their thin electrode structure may face water management challenges, especially during low temperature operations[2]. In addition, LANL scientists showed that an increase in local water may actually enhance performance with certain impurities.[3]

Tests were conducted on 50cm^2 MEAs using the current DOE total platinum loading of 0.15 mg/cm^2. The NSTF anode was 0.03 mg Pt/cm^2, the NSTF cathode was 0.125 mg Pt/cm^2 (Pt_3Ni_7, dealloyed and annealed), and the electrolyte was 24 μm 3M 850EW electrolyte-PEM. The gas diffusion layers (GDLs) used were also provided by 3M; 2979 GDL at both the cathode and anode. The MEAs were subjected to 50 hours of exposure to either 4 ppb H_2S or 100 ppm CO in the anode feed stream of a fuel cell operating at 50A constant current held at 80 °C. Figures 1 and 2 highlight the voltage response over time of fuel cells operated at 100% RH and 30 psig back pressure. The hydrogen sulfide caused ≈ 198mV drop in the fuel cell performance, while an ≈106 mV voltage drop was observed when the FC was exposed to carbon monoxide.

References

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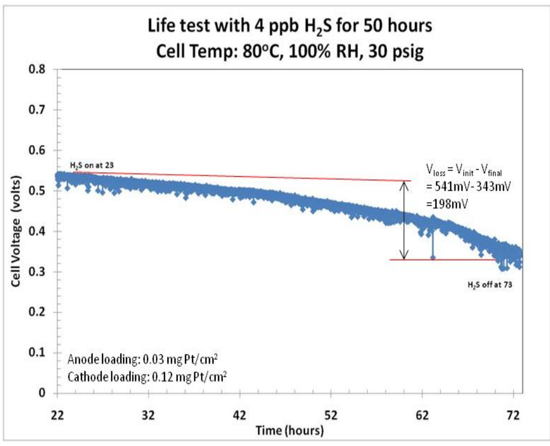

Figure 1. Voltage loss during 50h of exposure to 4 ppb H_2S at an operating current of 1A/cm^2. (Total losses observed ≈198 mV) .

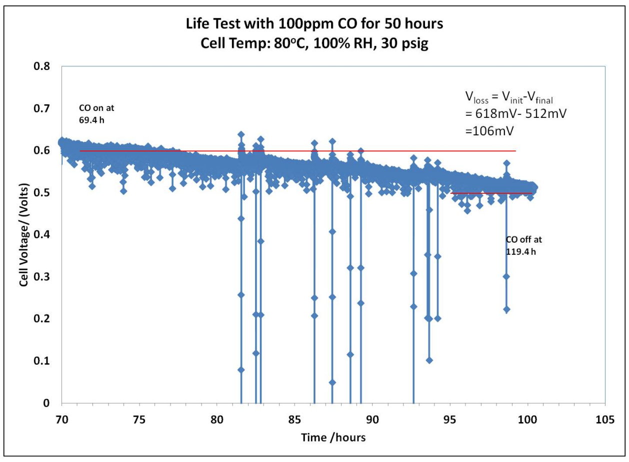

Figure 2. Voltage loss during 50h of exposure to 100 ppm CO at an operating current of 1A/cm^2. (Total losses observed ≈106 mV)