# DEVELOPMENT OF A NOVEL METHOD FOR MEASURING CHROMIUM VAPORIZATION FROM SOFC INTERCONNECT MATERIALS

by

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**ABSTRACT:**

One factor limiting solid oxide fuel cell (SOFC) performance is the degradation of chromium containing, ferritic stainless steel, interconnects during operation. [6,9,14] When chromium-containing steels are used as interconnect materials a chromium oxide layer forms on the surface. Under SOFC operating conditions (Cathode gas 800$^{o}$C and 2.5-3.1% $H_2O$) chromium ions are vaporized by the cathode gas and reduced at catalytically active sites within the cathode resulting in the formation of Chromium (III) Oxide. The $Cr_2O_3$ deposition physically blocks (poisons) the active sites resulting in significant performance degradation over the life of a fuel cell stack. This degradation has traditionally been measured using the transpiration method. [3-7] The transpiration method is a very effective, high cost, low-throughput method that utilizes ICP-MS to quantitatively measure chromium concentration. Alternative low cost, *high-throughput* evaluation techniques are necessary to understand the vaporization kinetics and identify potential interconnect materials and chromium retention coatings. In this work a novel method that relates solution conductivity to chromium vaporization was developed to supplement the standard transpiration measurement. Conductivity is linearly correlated to the amount of dissolved ionic species in a deionized water (DI water) solution. Initial tests show that chromium concentration can be continuously monitored as a function of time using the solution conductivity method. This test method simulates SOFC operating conditions to vaporize chromium species from the sample. The vaporized species are then condensed in a water solution and their effect on conductivity is measured. The amount of chromium species dissolved in the water solution is derived from a calibration curve. Initial tests indicate that chromium concentration can be continuously monitored as a function of time using the solution conductivity method. The results indicate an average chromium release rate (flux) of $6x10^{-10}$ kg/m$^2$s, $5x10^{-10}$ kg/m$^2$s, and $4x10^{-10}$ kg/m$^2$s for 99% Chromia, E-Brite and Crofer 22 APU, respectively, after 100 hours of operation. The effect of water vapor partial pressure, flow rate, and time on vaporization is discussed.