Solventless Electrochemical Decomposition of Trichloroethylene at Fuel Cell Cathodes: A GC-MS, XRD Study of Catalyst Degradation Mechanisms

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A single cell fuel cell is an electrochemical reactor that consists of a bipolar membrane electrode assembly (MEA) housed between a pair of conductive flow field blocks (typically graphite). Figure 1 shows the front face of a flow field block. This block has grooves (see expansion) to guide the flow of fuel or oxidant across the surface of the catalytic layer. Figure 2 shows an exploded view of an MEA housed between two flow field blocks. The MEA is a tri-layer that consists of a polymer membrane (Nafion) sandwiched between two catalyzed gas diffusion layers (GDLs). The GDLs are catalyzed on the face in contact with the Nafion membrane. Figure 3 shows the fully assembled single cell fuel cell used in this study. In this study, the anode side consists of Pt while the cathode side has carbon supported Pd (Pd/C). Such cathodes have been shown to be active for acid catalyzed isomerization reactions as well as Faradaic reduction processes. [1,2] More recently, it has been shown that the fuel cell cathode can be used to degrade chlorinated hydrocarbons.[3] In this study, the de-chlorination of trichloroethylene (TCE) at a fuel cell cathode catalyzed with carbon supported Pd is further elucidated by GC-MS. The product distribution as a function of time is related to the degradation of the catalyst layer. XRD of the Pd catalyst in the membrane electrode assembly are analyzed by Scherer's equation to determine the effects of the catalytic processes on particle size. Future work focused on mitigation of the degradation processes are suggested by the data.

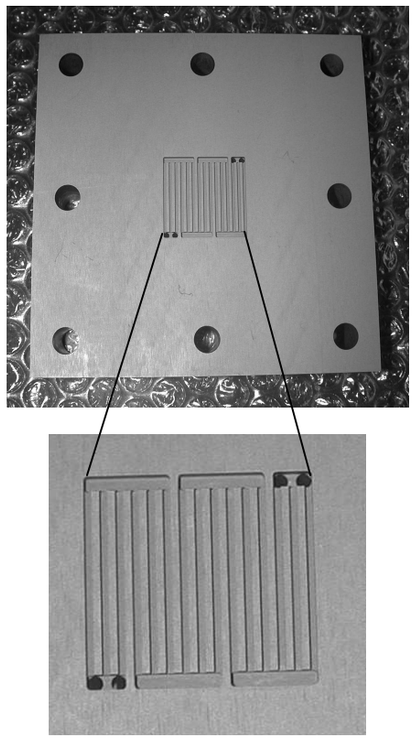

Figure 1. The Fuel Cell's flow fields

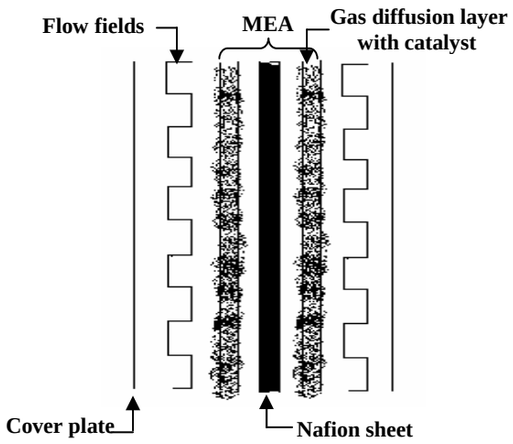

Figure 2. Schematic view of the fuel cell assembly

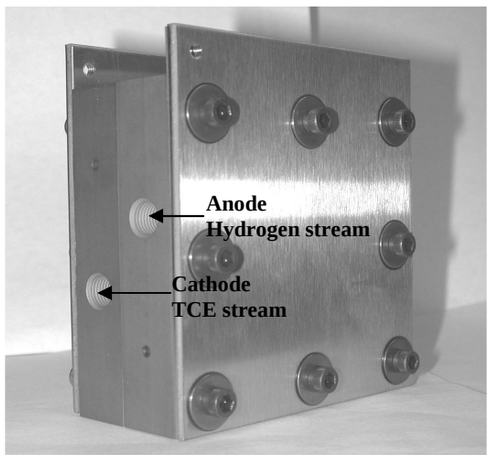

Figure 3. The fuel cell reactor

[1] L. PLoense, Maria Salazar, Bogdam Gurau and E. S. Smotkin, "*Proton Spillover Promoted Isomerization of n-Butylenes on Pd-Black Cathodes/Nafion 117"*, **J. Am. Chem. Soc.**, 119, 11550-11551 **(1997)**

[2] L. Ploense, Maria Salazar, Bogdan Gurau, E. S. Smotkin, "*Spectroscopic Study of NEMCA Promoted Alkene Isomerizations at PEM Fuel Cell Pd-Nafion Cathodes"*, **Solid State Ionics** 136-137 (0); 713-720 **(2000)**

[3] Zhijie Liu, Robert G. Arnold, Eric A. Betterton, and Eugene Smotkin "*Reductive Dehalogenation of Gas Phase Chlorinated Solvents Using a Modified Fuel Cell"*.**Environmental Science & Technology; (2001);** 35 (21); 4320-4326