Technology for Sustainability
Room 313 - Session TS-TuM

Fuel Cells, Hydrogen Economy, Sustainable Manufacturing

Moderator: P.J. Maroulis, Air Products and Chemicals, Inc.

9:20am **TS-TuM4 Direct Oxidation of Hydrocarbon Fuels in a Solid Oxide Fuel Cell: Studies of Carbon Formation***, V.K. Medvedev, L.M. Roen,* ***E.M. Stuve****,* University of Washington

Solid oxide fuel cells (SOFC) provide an opportunity for fuel-flexible fuel cells that operate at higher efficiencies than other types of fuel cells. These advantages arise from the high temperature of SOFC operation, 800-1000 °C, which facilitates direct oxidation and reforming of hydrocarbon fuels and a source of high quality waste heat. This work examines direct oxidation of hydrocarbon fuels on a SOFC installed in a vacuum system with facilities for accurate measurement of fuel and oxygen partial pressures and measurement of reaction products by a calibrated mass spectrometer. The measurements highlight the interplay of fuel oxidation kinetics, carbon deposition on the anode, and transport of oxide ions through the electrolyte. The SOFC consisted of a Gd-doped ceria electrolyte (Gd@sub 0.1@Ce@sub 0.9@O@sub 2@) with platinum anode and cathode. Fuels of study included methanol, ethanol, methane, ethylene, carbon monoxide, and hydrogen. The reactions were studied over the temperature range of 800-1000 °C with fuel and oxygen partial pressures of 0-10 Torr and 0-70 Torr, respectively. Hydrogen, CO, methanol, and ethanol showed similar reaction characteristics, with high open circuit voltages of 0.6 V and above and maximum current densities of approximately 2 mA/cm@super 2@. By contrast, ethylene and methane showed much slower reaction rates, with open circuit voltages of approximately 0.1 V and maximum current densities of approximately 0.01 mA/cm@super 2@. Post-reaction titration of the anode surface with oxygen showed evidence of extensive carbon formation under the low reaction conditions. The dynamic response of the system under changing fuel and oxygen partial pressures provided further evidence of carbon formation. These experiments help establish the mechanism of direct fuel oxidation in solid oxide fuel cells and the conditions for avoiding carbon deposition on the anodes. This work was supported by the Office of Naval Research.

9:40am **TS-TuM5 Hydrogen as an Energy Carrier: Its' Promises and Challenges***,* ***G.R. Keenan****,* Air Products and Chemicals, Inc. **INVITED**

No Abstract Text Submitted

10:20am **TS-TuM7 Development of Sustainable Technology and Practices in the Semiconductor Industry***,* ***W. Worth****,* SEMATECH **INVITED**

The semiconductor industry has for years been held up as an example of a "clean", progressive, and environmentally friendly industry. To maintain this image and to ensure the long-term sustainability of the industry, SEMATECH, the R&D consortium of the major chip manufacturers, has diligently worked for many years on resource conservation including energy, water and chemical reduction. This paper will discuss the ideas that the industry has successfully implemented or is studying in each of these areas. Energy reductions have been achieved through HEPA velocity and tool exhaust reduction, and optimization of onsite nitrogen generation and use. The current focus is on improving tool heat dissipation and tool idle energy use. Similarly, recognizing that the industry uses significant amounts of water for wafer etching, rinsing and chemical mechanical planarization (CMP), SEMATECH has focused on ultra pure water (UPW) recycle, optimization of wafer rinse processes and non-process water use in CMP. More recent efforts have centered on improved CMP slurry utilization and reduction of consumables such as pads and post-CMP clean brushes. In the chemicals arena, the industry is working closely with regulatory agencies globally to reduce emissions of undesirable chemicals such as perfluorocompounds (PFCs) and perfluorooctane sulfonates (PFOS). In addition, SEMATECH and the World Semiconductor Council (WSC) have emphasized the need for more comprehensive and timely access to environment, safety and health (ESH) data for the many new chemicals being introduced into manufacturing to meet the performance needs of the advanced semiconductor products. By providing more data to the technologists as they design the new processes and tools it is hoped the industry can avoid the use of materials that may be unacceptable from a long-term industry sustainability perspective.

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