

**WEDNESDAY, AUGUST 25, 2004, P.M.**

**SESSION 53: INTERNATIONAL SYMPOSIUM ON MATERIALS FOR FUEL EFFICIENT AUTOMOBILES**

MATERIALS FOR ADVANCED PROPULSION SYSTEMS

Sponsor: Iron and Steel, The Metallurgical Society of CIM

Room: ALBION C

Chairmen: D. WILKINSON, T. PETRIC and M. JAIN, McMaster University, Hamilton, Ontario, Canada

PAPER 53.1 — 14:00

NEW DEVELOPMENTS IN ELECTRODEPOSITION OF OXIDE AND COMPOSITE FILMS.

I. ZHITOMIRSKY, McMaster University, Hamilton, Ontario, Canada

Electrodeposition is widely recognized as an essential tool for fabrication of advanced films and coatings for automotive applications. Fundamental works on the development of novel electrochemical strategies and novel precursors open an avenue for cathodic electrolytic deposition of oxide films, including individual oxides, complex oxide compounds and composites. Another significant achievement was the discovery of novel electrochemical methods for cathodic co-deposition of ceramics and polymers. The new technology enables fabrication of thick films and composites for applications in fuel cells, batteries, supercapacitors, corrosion protection of metals, advanced electrodes and other applications.

PAPER 53.2 — 14:25

OXIDE PROCESSING ROUTE FOR A METAL SUPPORTED SOLID OXIDE FUEL CELL.

X. LIU, A. PETRIC and X. DENG, McMaster University, Hamilton, Ontario, Canada

The objectives of this paper were to develop metal (Fe-Cr alloy) supported solid oxide fuel cells. Cell membrane starting from iron oxide and chromium oxide powder so that the processing steps can be carried out in the air. Conventional materials are used for the rest of the cell (NiO-YSZ anode, YSZ electrolyte). Layers of each component were tape cast and laminated, then co-fired in air at 1300°C. Pt paste was used as cathode. The cell was reduced by H<sub>2</sub> at 900°C. This converts the Fe<sub>2</sub>O<sub>3</sub>-Cr<sub>2</sub>O<sub>3</sub> into a porous Fe-Cr alloy, while YSZ sinter to a dense electrolyte layer. The NiO is also reduced to Ni and forms a porous Ni+YSZ anode. This structure allows the fabrication of layer, crack-free with high strength and toughness. The final cell configuration consisted of dense YSZ thin film electrolyte (20 µm), a porous Ni/YSZ thin film anode (30 µm) and a porous Fe-Cr alloy support (200 µm). Porosity and pore size of the alloy support is larger than that in anode functional layer. The dense electrolyte has good interfacial contact with the porous anode. The performance of an alloy supported SOFCs with 1 cm<sup>2</sup> active area is shown. The maximum power density obtained was 440 mW/cm<sup>2</sup>.

PAPER 53.3 — 14:50

MICRO SOLID OXIDE FUEL CELL FOR AUTOMOBILE.

P. SARKAR, H. RHO, L. YAMARTE and L. JOHANSON, Alberta Research Council, Edmonton, Alberta, Canada

The Alberta Research Council Inc. (ARC) is developing Tubular Micro Solid Oxide Fuel Cell (mSOFC). Small diameter SOFC has two main potential advantages, substantial increase in the electrolyte surface area per unit volume of a stack and quick start up. Since fuel cell power is directly proportional to the electrolyte surface area, a mSOFC stack has a high potential to substantially increase the power per unit volume. Simple calculation shows a decrease of tube diameter from 22mm to 2mm will increase the electrolyte surface area in a stack at least seven times. Due to its thin wall, a mSOFC has extremely high thermal shock resistance and low thermal mass. These low thermal mass and high thermal shock resistance characteristics are fundamental to reducing start up and turn off time for the SOFC system. High volumetric power density, together with rapid start up will make tubular-mSOFC's a candidate for automobile applications and should be considered seriously. This presentation will describe fabrication, microstructure and electrochemical characteristics of mSOFC.

COFFEE BREAK — 15:15 – 15:30

PAPER 53.4 — 15:30

THE DEVELOPMENT OF NICKEL AND COBALT OXIDE SUPERCAPACITORS.

E.A. MCNALLY, I. ZHITOMIRSKY and D.S. WILKINSON, McMaster University, Hamilton, Ontario, Canada

Electrochemical supercapacitors (ES) are urgently needed as components in advanced power systems requiring high power and energy densities. The development of electric and fuel cell vehicles has led to a new wave of interest in ES. The discovery of high electrochemical capacitance in nickel and cobalt oxides has led to investigation of these materials as alternatives to expensive and toxic ruthenium oxide. A new avenue to the development of advanced ES is based on our recent developments in technology of cathodic electrolytic deposition of oxide films. Experimental data will be presented illustrating novel electrochemical strategies and properties of advanced nickel and cobalt oxide films for applications in ES.

PAPER 53.5 — 15:55

PERFORMANCE AND CHARACTERIZATION OF SOME COMMERCIAL AUTOMOTIVE UNDERCOATING AGENTS.

V.S. SASTRI, Consultant, Ottawa, Ontario, Canada, and  
M. ELBOUJDAÏNI, CANMET, Ottawa, Ontario, Canada

Automotive undercoatings are commonly used in North America to combat corrosion caused by deicing salt used on roads. The two types of undercoatings are: permanent type consisting of tars, waxes or gelled dispersions and the second type are oils applied annually. The commercial oil types of coating have been tested for corrosion resistance and also are characterized by UV-vis, IR and NMR spectroscopy. The results of the tests are discussed.

PAPER 53.6 — 16:20

DEVELOPMENT OF GLASS/NANO-CERAMIC COMPOSITES FOR SOFC SEALING

M. BROCHU, B.D. GAUNTT, R. SAHA, D. ZSCHIESCHE and R.E. LOEHMAN, Sandia National Laboratories, Albuquerque, New Mexico, U.S.A.

The development of durable seals for Solid Oxide Fuel Cells (SOFC) is now becoming one of the main limitations for the fabrication of reliable stacks. The sealing issue is really challenging, as the SOFC operation conditions are really severe. In particular, the following seal characteristics must be accurately adjusted: flow and viscosity, glass transition temperature and crystallization, coefficient of thermal expansion mismatch and interfacial reactions during sealing and service conditions. This presentation will focus on the control achieved on borate-glass properties by the addition of various nano-additives. Results on the modification of viscosity, wetting, adhesion, thermal expansion and interfacial reactions will be presented.