MONDAY, AUGUST 22, 2005, P.M.

SESSION 3A: INTERNATIONAL SYMPOSIUM ON FUEL CELL AND HYDROGEN TECHNOLOGIES

SOFC - CATHODE
Sponsor(s): Materials Science and Engineering Section, The Metallurgical Society of CIM
Room: Imperial Ballroom 2
Chairmen: E. TANG, Versa-Power Systems, Canada and
R. HUI, NRC Institute for Fuel Cell Innovation, Canada

PAPER 3A.1 — 14:00 – 3.6
OXYGEN REDUCTION KINETICS AT SOL-GEL DERIVED LSM/YSZ CATHODES.
J. FOURNIER and V.I. BIRSS, University of Calgary, Canada

A novel sol – gel (SG) synthesis procedure utilizing varying ratios of glycine and ethylene glycol to total metal cations has been developed to create high purity nanometer sized $La_{0.65}Sr_{3.5}MnO_3$ powders. X-ray powder diffraction (XRD), transmission and scanning electron microscopy (TEM, SEM), and dynamic light scattering (DLS) have confirmed that the crystallite sizes of such powders are ~ 20 nm, and the aggregate particle sizes vary between 100 to 300 nm. Mixing varying weight percents of SG LSM powders with commercially available Praxair LSM in a composite LSM/YSZ functionally graded cathode has been shown, through the use of electrochemical impedance spectroscopy (EIS) and cyclic voltammetry (CV), to exhibit enhanced oxygen reduction kinetics vs. at conventional cathode materials.

PAPER 3A.2 — 14:20
DEPOSITION OF POROUS CATHODES USING PLASMA SPRAY TECHNIQUE FOR REDUCED-TEMPERATURE SOFCS.
J. JANKOVIC, R. HUI, J. ROLLER, R. MARIC, D. GHOSH, NRC International Fuel Cell Innovation, Canada and
O. KESLER, University of British Columbia, Canada

Numerous advantages have been recognized for solid oxide fuel cells (SOFCs) operating at temperatures of 500-700°C. However, there are several issues related to low temperature SOFCs, such as high electrolyte resistance and high electrode polarization. One of the routes to enhance the electrode performance, particularly for the cathode, is to use new materials with optimized microstructure. In this work, plasma-spraying technique, recognized to have several advantages over presently used deposition techniques, was used to deposit cathode materials onto ceramic and stainless steel substrates to obtain a highly porous structures. Cathode materials with composition of $La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_3$ (LSCF) were employed in the powder form. The LSCF was either prepared from powder precursors, with different pore formers and binder levels, or from already produced, single-phase LSCF. The $(La_{0.8}Sr_{0.2})_{0.98}MnO_3$ (LSM) cathode material was also processed for comparison purposes. The deposition process was optimized in terms of bond strength, porosity, film thickness and residual stresses. The phase and microstructure of deposited materials were characterized using XRD and SEM.

PAPER 3A.3 — 14:40
FABRICATION AND CHARACTERIZATION OF THE $GD_{0.8}SR_{0.2}COO_{3-\delta}$-$CE_{0.9}GD_{0.1}O_{2-\delta}$ COMPOSITE CATHODE CERAMICS FOR USE IN INTERMEDIATE TEMPERATURE SOFCS.
L. KILIUS, M.D. VLAJIC and V.D. KRSTIC, Queens University, Canada

Due to its excellent thermal expansion match to the electrolyte $Ce_{0.9}Gd_{0.1}O_{2-\delta}$ (<6% in TEC), high electrical conductivity (115 S cm^{-1} at 700°C) and low activation energy for oxygen reduction (99 KJ/mol), doped $GdCoO_{3-\delta}$ has a great potential as cathode materials in intermediate temperature SOFCs. In this study, the cell was fabricated by co-pressing the cathode and electrolyte ceramics and sintered at various temperatures in order to achieve desirable densities. The symmetrical cells consisting of cathode-electrolyte-cathode has been successfully fabricated. The AC Impedance technique was used to determine the oxygen reduction catalyzation losses of the cathode operating at 700°C in air. Optimal performance has been achieved in the cathode material with the characteristics of a porosity level of ~40%, good adhesion to the electrolyte and low catalyzation losses of only 0.25 cm^2 when sintered at 1000°C.

PAPER 3A.4 — 15:00
STRONTIUM DOPED LANTHANUM FERRITE COMPOSITE CATHODES FOR INTERMEDIATE TEMPERATURE SOLID OXIDE FUEL CELLS.
L. SUN, University of Calgary, Canada

G. BRISSARD, University of Sherbrooke, Canada

In this work, strontium doped lanthanum ferrite (LSF) and their composite cathodes were fabricated by screen printing on yttria-stabilized zirconia (YSZ) electrolytes. Their electrochemical properties were evaluated by using electrochemical impedance spectroscopy and steady-state polarization methods. The improved LSF composite cathodes were also screen printed on YSZ/NiO half cells to fabricate solid oxide fuel cells (SOFC), which have reached the output power densities of 170 mW/cm^2 at 650ºC, 230 mW/cm^2 at 700ºC, 304 mW/cm^2 at 750ºC and 388 mW/cm^2 at 800ºC.

PAPER 3A.5 — 15:20

ELECTROCHEMICAL PROPERTIES OF PEROVSKITE CATHODES FOR MICRO TUBULAR SOLID OXIDE FUEL CELLS.

L SUN and V.I. BIRSS, University of Calgary, Canada

Recently, micro-tubular solid oxide fuel cells (SOFCs) have attracted the attention of many researchers because of their numerous advantages over larger tubular and planar SOFCs. These include excellent thermal shock properties giving rapid startup/shutdown capability, a high volumetric power density compared to larger tubular SOFCs, and reduced sealing problem compared to planar SOFCs. In order to screen cathode materials for micro-tubular SOFCs, the perovskite cathodes were deposited, using a variety of methods, on 10.5 mol % yttria-stabilized zirconia (YSZ) tubes. Their electrochemical properties were then evaluated by using electrochemical impedance spectroscopy and steady-state polarization methods, based on a three electrode configuration, and with the reference electrode position carefully optimized. The oxygen reduction reaction kinetics at the cathode/electrolyte half cell were then investigated in detail.

COFFEE BREAK — 15:40 – 16:00