

fuel at 80°C. Those with higher Pd concentrations have reduced coverage by CO. ECN have demonstrated 20 cell stacks with up to 500 hours of stable operation in reformat gas without an air bleed.

Considerable work has been carried out to develop direct oxidation fuel cells. In his talk 'Direct 2-propanol fuel cells', Zhigang Qi (H-Power Corporation, U.S.A.) described their work on fuel cells that operate on various fuels, including methanol, ethanol, 1-propanol, 2-propanol and ethylene glycol. Fuel concentrations of 0.5–2.0 molar and temperatures of 70–100°C are typically used. The use of 2-propanol in conjunction with a polymer electrolyte membrane reduces some of the problems due to organic crossover to the air cathode encountered with more volatile organic fuels. In small (25 cm²) cell tests, current densities up to 200 mA cm⁻² have been obtained at 0.5 V, compared to the 0.3 V typical of direct methanol cells. Voltage decay, caused by impurities adsorbed on the catalysts during operation on the organic fuel, recovers on standing at open circuit voltage or on reversing the polarity of the cells.

A different approach that is being adopted at the University of Newcastle, U.K., was described by Professor Keith Scott in his talk 'Direct methanol fuel cells: solutions to the problem of crossover'. When using 2 mg cm⁻² pgm (Pt-Ru) anode catalysts and 2 mg cm⁻² Pt cathode catalysts in conjunction with Nafion polymer membrane (60–120 μm thick) at 100°C, substantial methanol oxidation occurs at the air cathode. Various cathode catalysts which exhibit selective oxidation properties towards methanol have been assessed. These include cathode catalysts of iron tetramethoxyphenylporphyrins, (Fe TMPP) and Ru-based compounds, such as Ru-Se. To reduce methanol crossover, techniques such as using low methanol concentrations can be used combined with lower-permeability radiation-grafted polymer materials.

Modelling and Engineering

The importance of optimising fuel cell systems in areas such as thermal balance was emphasised in the final session. Advanced studies are being carried out on hybrids of high temperature fuel cells (such as solid oxide and molten carbonate cells) in

combination with gas turbines to produce systems having almost 70% overall efficiency. This is achieved by using the fuel cell as the combustion stage of gas turbines, with the compressor supplying high pressure oxidant, and utilising the waste heat from the fuel cells to drive the compressor. The main applications for these are as stationary generators providing combined heat and power.

The conference was concluded by the award of four prizes. The best submitted oral presentation was won by Klaus-Dieter Kreuer (Max-Planck-Institut, Germany) and the best poster prize by Adi Aharon (Tel Aviv University, Israel). The prize for the most original contribution was won by Eric Middleman (Nedstack, The Netherlands) for a talk on self-organising nanostructures in PEM fuel cell electrodes that incorporated strings of catalyst and wetproofing agent. Whitney Collella (University of Oxford, U.K.) won the best student contribution.

Conclusion

The variety of presentations, diverse range of science and high quality of work, demonstrate the wide support that is helping to bring fuel cell technology to the consumer.

Reference

- 1 W. R. Grove, *Phil. Mag.*, 1839, 14, 127; *ibid.*, 1842, 21, 417

The Author

Don Cameron is an independent consultant on the technology of fuel cells and electrolyzers. As well as the scientific aspects, his interests include the standardisation and commercialisation of these systems.

Eighth Grove Fuel Cell Symposium

The Eighth Grove Fuel Cell Symposium will be held at ExCeL in London, from 24th to 26th September, 2003. The theme of the meeting will be 'Building Fuel Cell Industries' to reflect the rapidly growing infrastructure needed to support the technology as commercialisation proceeds. The venue was chosen so that displays of stationary generators, vehicles and the refuelling techniques being developed could be viewed in comfort.

Details of the symposium can be obtained from <http://www.grovetfuelcell.com> or from Sarah Wilkinson: Tel: +44 (0)1865 843691.