# Fuel Cells at the Hannover Industrial Fair

## COMMERCIAL PRODUCTS DEMONSTRATING FUEL CELL AND HYDROGEN TECHNOLOGY

The huge annual Hannover Messe took place as usual in April, profiling many areas of industrial products and developments (1). At this fair, energy systems, in particular fuel cells and hydrogen, were a major theme (2). Despite the difficult economic climate, around one hundred fuel cell exhibitors from some twenty countries displayed the hardware of their latest advances in fuel cell and hydrogen technology. Actual demonstrations of the new technology captured the imagination of the many visitors to the stands.

Among criticisms aimed at the fuel cell industry are the lack of progress towards producing sellable products and towards answering energy questions. Therefore, the positive aspect of this year's fair was the clear message that units are now being integrated into real products, besides being in their traditional format as power sources. Indeed, perhaps the most impressive examples of a fuel cell in use were shown by the Fraunhofer Institute for Solar Energy Systems (ISE), Germany. ISE displayed a professional video camera and a handheld camcorder, both powered by neat, integrated, multiwatt fuel cells running directly on hydrogen stored as a metal hydride. With a run-time of up to eight hours for the larger video camera, it was easy to imagine a commercial product being developed.

On a larger scale, Proton Motor (Germany) gave details of its upcoming fork-lift truck powered by a proton exchange membrane fuel cell (PEMFC). In common with all PEMFC systems, this system utilises platinum-based electrodes. Lower noise and emissions, together with much faster refuelling/recharging times make this an interesting use for the fuel cell.

Proton Motor is also planning to manufacture a number of fuel cell buses intended for various European projects. These will contribute significantly to demonstrating the suitability of fuel cell vehicles for public transport. Buses from DaimlerChrysler have already been announced for the Clean Urban Transport for Europe (CUTE) project. This public transport programme is one of the first opportunities in Europe for the introduction of fuel cells.

Even though fuel cell products are still not fully competitive due to high costs related to components, manufacturing and materials, it is encouraging to see the industry moving away from pure research and demonstration models towards practical applications. This trend is not only in integrated uses of fuel cells, but also in single primary power sources; and several fuel cell power sources were on display. As a power source, the fuel cell can take the place of an electrical grid connection, a generator or even a battery.

In a typical example, Axane, a subsidiary of the French industrial gas supplier Air Liquide, demonstrated a new prototype PEMFC system: the 'Roller Pac'. This can generate 2 kW of power for back-up systems for computers, and other uses. New fuel cell systems were also presented by PlugPower (U.S.A.), Roen Est (Italy) and the newly founded direct methanol fuel cell company Bee Power Systems (The Netherlands). Small (educational) fuel cells were on sale at the h-tec (Germany) stand.

### The Fuel for Fuel Cells

Many products offered ways of providing the hydrogen fuel for fuel cells. Although there is no clear leading technology in this area, ten or more companies demonstrated solutions to this challenging question. The electrolysis of water was proposed by Norsk Hydro (Norway) and others, while hydrocarbon reforming by fuel processors (very much analogous to the processes going on in commercial oil refining) was demonstrated by, for example, HydrogenSource (U.S.A.) in their sleek 5 kW fuel processor. A third way is to use metal hydrides, and Millennium Cell (U.S.A.) exhibited its metal hydride hydrogen storage system – using it to power a model radio-controlled car.

As expected, the larger transport applications of fuel cells stole the show. No new cars were on display, but visitors engulfed DaimlerChrysler's A Class-based F-Cell car, and General Motors'

conventionally-styled HydroGen 3 and the quite outrageous AUTOnomy concept vehicle.

In another hall, politicians scrambled for photo opportunities with a new fuel-cell-powered motor scooter. Jointly developed by Aprilia (Italy) and MES-DEA (Switzerland), the scooter carries a 3 kW PEMFC – effectively supplying its environmental credentials to a young 'fashion' vehicle.

However, perhaps the most creative concept of all came from the British company, Intelligent Energy. Again, using platinum-based PEMFC technology, their compact units could be used for many different power applications. One of them, a 50 kW system composed of two 25 kW stacks, is to be used to power a lightweight single engine Boeing aeroplane (3). Although fuel cells will not be powering the world's airplanes in the foreseeable future, the first flight of this fuel cell plane is planned for December 2003, the one hundredth anniversary of the first powered flight. As a symbol, it allows us to consider where the fuel cell might be in another hundred years, although signs are that we will be using fuel cells in our daily lives much sooner than that. D. M. JOLLIE

## References


1 http://www.hannovermesse.de/

2 http://www.fair-pr.com/

3 W. Knight, 'Fuel cell-propelled aircraft preparing to fly', http://www.newscientist.com/, 12th May, 2003



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# Polymeric Platinum-Containing Anticancer Drugs

There have been many reviews over the past 30 years on platinum anticancer drugs. Usually, these have described the structure/activity relationships which have been established for platinum complexes. Few, if any, have dealt with polymeric species containing platinum, which is now the subject of the following review of a chapter written by Deborah W. Siegmann-Louda and Charles E. Carraher (Florida Atlantic University) entitled 'Polymeric platinum-containing drugs in the treatment of cancer'. This well informed chapter comes from the future Volume 3 in the book series on polymer science entitled "Macromolecules Containing Metal and Metal-Like Elements", which will be published by John Wiley & Son (http://www.wiley.com/), in late 2003 or at the beginning of 2004, tentatively priced at U.S. $125.

The polymer-platinum conjugate can act as a drug itself or as a prodrug. For the polymer to act as a prodrug requires a non-toxic polymer backbone containing solubilising entities to make it water-soluble and functional groups capable of reversible binding to the drug species with, ideally, some targeting specificity to enhance accumulation in the tumour. The binding of platinum drugs through oxygen-donor leaving groups, either carboxylate or hydroxyl species, provides a ready means of realising this model. Where the polymer-conjugate acts as a drug itself, the binding of the platinum to the polymer may reduce the elimination of the drug by the kidneys and reduce toxicity by reduction in the amount of hydrolysis products formed. Additionally, the polymer conjugate may circumvent resistance due to reduced cellular influx/enhanced cellular efflux mechanisms that affect small molecules. Finally, the activity may be modified by multiple bonding at a given site. Binding the platinum through nitrogen donors, such as amines, gives materials which exemplify this approach. The active species may be released by chain degradation, where monomeric units are released from the ends of the polymer, or chain scission, where macromolecular units are produced by breaks at random points in the polymer chain.

Examples of each of the above approaches are given in the review. Structural information on the polymer-platinum conjugate is given where this is available along with cytotoxicity data for many samples. Although some materials were found to be more cytotoxic than cisplatin there has been no attempt to date at the commercial introduction of any polymeric platinum drug. C. F. J. BARNARD


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