CMR Fuel Cells

In order to address the Carbon Trust Fuel Cell Challenge, a consortium formed by CMR Fuel Cells, University of Surrey and Imperial College London are proposing a project to further develop Pt-free alkaline polymer MEAs to achieve a performance on a par with state of the art PEFC MEAs but at a fraction of the cost. Once MEAs have reached sufficient levels of robustness, stacks and systems will be developed taking advantage of cheaper materials, proven developments and cost savings in other components and larger scale manufacturing techniques, so demonstrating the real commercial viability of alkaline membrane fuel cells.

Early indications are that, given further development, 66% cost savings can be achieved in the catalyst, and membranes will achieve sufficient conductivity and robustness to enable this cost saving to be directly translated to an MEA. Further savings in stacks and systems could result in overall savings at system level of above 25%. The technology is applicable to any hydrogen PEFC systems but is specifically aimed at the transport sector where savings of this magnitude would be an enabler to fuel cells becoming a commercial reality.

During the project the team intends to work closely with both customers, system integrators and commercial supply chain such that up-scaling, system integration, certification and testing can occur quickly to enable real commercial advantage to be realised at the earliest possible time.

Imperial College, London

The *FLEXI-PLANAR STACK* is a new type of polymer fuel cell stack that circumvents many of the problems associated with the conventional *bipolar* fuel cell configuration:

- bipolar plates are expensive because of machining/forming costs and sealing;
- the electric series configuration amplifies electrode failure to stack failure;
- water and thermal management is difficult and the systems typically impose a high back-pressure resulting in system efficiency degradation due to parasitic power loses, and limiting transient response;
- the electrical output of the entire stack must undergo electrical modulation using expensive monolithic power electronics (>£100 kW^{-1}). Point failure of the power electronics will lead to catastrophic failure of the fuel cell system.

The Flexi-Planar stack allows substantial reductions in cost at both the stack and system level. The approach is MEA agnostic and can be applied to both proton- and hydroxide conducting polymer electrolyte fuel cells. Crucially, the approach requires no seals and contains internal manifolding, and is fault tolerant: the system should continue working under extreme events (e.g. failure of a fuel cell electrode or entire layers of the stack).

ACAL

This 24 month, directed research project is focused on delivery of new non precious metal based cathode systems, based on ACAL Energy's novel, patented liquid regenerating fuel cell technology, FlowCath®. ACAL Energy's core technical approach to addressing the cost issues of PEM fuel cells is to replace the conventional fixed platinum based cathode, with a liquid regenerating catalyst system. The technology reduces platinum content by up to 80% and simplifies the overall fuel cell system balance of plant and therefore leading to further reduced cost. The company has to date made substantial progress in the development of the first generation of the technology, with peak power density performance of above 0. 75 W/cm2, and 40% cost savings in the 1-10kW stationary power generation range. If successful this research has the potential to give cost savings that could halve system level costs for automotive applications, over the best envisaged, scaled estimates for conventional PEM technology. ACAL has demonstrated the principle of a range new material types that could give improved power density (targeted to be above 1.2W/cm^2), which within this project be explored, optimised and tested for feasibility in fuel cell applications, along with the development of cost effective and practical routes for scaled synthesis. For phase 1 of the project, Endeavour Speciality Chemicals Ltd has been selected as a collaborative partner to provide knowledge and experience of practical organic synthesis scale up.

ITM Power

ITM Power has been working in electrolyser/fuel cell development for over 10 years, at the core of our work is the development and optimisation of a suite of novel membrane materials, both anionic and cationic. Our worldwide patented hydrophilic ionic polymers are a fraction of the cost of conventional fluorinated materials, lend themselves to mass production techniques, enable catalyst recovery and have shown world beating power densities in laboratory testing. ITMs materials are inherently different from traditional fuel cell membrane materials, their mechanical properties, hydration characteristics, ionic conductivities and manufacture methods offer many advantages, and also pose new challenges to the design and development of the complete fuel cell system. It is proposed that optimisation of the surrounding components to suit our membranes, such as GDL, catalyst layers, cell and stack geometries will result in further improvements in power density, cost reduction and operational life-time.

ITM propose a development project to optimise the fuel cell for these novel materials, the following areas require input from ITM and project partners.

i) Scale up of membrane manufacture,
ii) Optimisation of catalyst/GDL with ITM materials,
iii) Catalyst deposition optimisation,
iv) MEA testing,
v) Cell and stack design,
vi) Catalyst recovery, and
vii) System integration.

The successful market placement of the low cost high power fuel cell will depend on an economic review, planned in phase 2. However it has been identified that the greatest carbon saving is likely to be attained from deployment in automotive applications. Systems which are stationary would be well suited to utilising hydrogen and oxygen produced from an electrolyser, a complimentary technology produced by ITM, which is currently the subject of field trials and demonstration projects.

Ionic Polymer Solutions

During this programme, Ionic Polymer Solutions proposes to develop their innovative iCON^{TM} proton exchange membranes (PEM) and ionomers to enable a step-change in polymer fuel cell performance, durability and cost. The project brings together expertise in PEMs, chemical synthesis, polymer manufacture and fuel cell prototyping through a consortium of SMEs. By the end of phase 1, the team seeks to deliver low cost, robust materials suitable for volume production and to have demonstrated a fuel cell stack capable of start-up from sub-freezing temperatures, operational above 120°C and resistant to cycling between extremes of humidity and temperature.