Technology Strategy Board
Driving Innovation

Innovation **results**

AN R&D CASE STUDY #015

Longer lasting fuel cells

Developing long-lasting membranes for fuel cells has improved the technology's ability to satisfy the growing demand for clean energy.

The need

The Government is committed to reducing UK carbon emissions by 80% by 2050 in comparsion to 1990 levels. Power generation, using proton exchange membrane fuel cells (PEMFCs) in automotive (cars, light vans and buses) and other applications (forklift trucks, portable and back-up power) offers scope for significant carbon reductions, zero local emission of pollutants and competitively priced electricity. But to compete commercially with existing technologies and deliver environmental benefits, fuel cells need to offer a sufficiently long minimum operating life, and comparable cost and performance.

The results

The lifetime of PEMFCs in automotive and stationary power applications is limited by the tendency of the membranes, which act as an electrolyte between the cathode and anode, to degrade under the typically harsh operating conditions.

New analytical techniques developed by Johnson Matthey and the University of Surrey were used to:

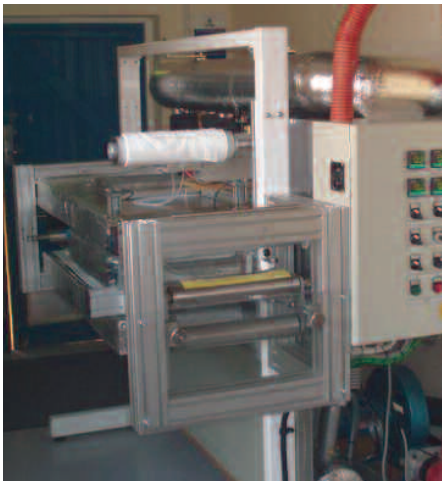
- Measure the behaviour of different membrane designs
- Understand more about the mechanisms that contribute to, or cause, membrane failure.

This knowledge was applied to the selection of materials, designs and manufacturing processes used to develop new membranes that incorporate tailored additives. A prototype coating system was built by ICI Imagedata to produce sample lengths for use in a fuel cell, followed by durability testing under accelerated ageing conditions.

State-of-the-art membranes available at the start of the project had a predicted service life of between 1,000 and 2,000 hours under automotive application conditions compared with a minimum target for a commercial PEMFC engine of 5,000 hours. The project partners succeeded in their aim of developing a novel membrane that lasted over 3,000 hours, even under an accelerated durability test condition. The new membrane design had minimum impact on fuel-cell performance.

Therefore, the increased durability of the membrane developed in this project will contribute to an acceleration of the adoption of fuel-cell technologies in a number of applications where limited lifetime is inhibiting commercialisation.

What is a proton exchange membrane fuel cell?



Prototype coating line

Fuel cells use hydrogen and oxygen (the reactants) to generate electricity and produce water as a by-product. They are similar in principle to batteries, except that the reactants are stored externally. This enables fuel cells to continue operating as long as reactants are supplied. Compared with other types of fuel cell, PEMFCs generate more power for a given volume or weight and operate at less than 100°C. Their high-power-density characteristic makes them compact and lightweight, while the ability to change power output rapidly means they are excellent for automotive power applications.

Market potential

The new analytical tools and methods developed during the project give the UK a leading edge in the development of advanced membranes for fuel cells. Other developers in the US and Japan are starting to report similar operating lives for their membranes, but not necessarily under such demanding test conditions.

The technology developed in this project will enhance the opportunity for a UK-based membrane electrode assembly product (MEA – an assembled stacked of PEMFCs) to be manufactured, for the growing PEMFC market worldwide. This will positively impact on the prospects for PEMFCs to satisfy the growing demand for improved efficiency (lower carbon emissions) energy technologies.

The market opportunities for this technology range from portable and back-up power, in the near-term, through niche transport (eg fork-lift trucks) to residential and commercial-scale stationary applications and, ultimately, to mainstream transport (eg buses, trucks and cars).

The scale of these markets is large. For the stationary and niche transport applications alone, the value of the MEA market is estimated to be more than £150 million by 2015. In the EU and North America, there are about

300,000 new fork-lift trucks deployed per year.

In large-scale indoor distribution centres, there is a requirement for large numbers of battery-powered trucks to operate 24 hours per day. Each truck will typically require three battery sets. The changeover in batteries can result in downtime and increased safety risks. The use of fuel cells will eliminate battery changes leading to improved productivity and safety. The economics of fuel cells in this application are closely linked to the lifetime of the fuel-cell stack, which is limited by the durability of the membrane.

The project has also helped activate a supply chain for the UK's emerging fuel-cell industry, including suppliers of additives and polymers, formulators/processors of membrane devices, component assemblers and characterisation equipment.

Future activities

The project partners are considering options for further process development, scaling up and manufacture of the new, more-durable membranes. Key to this will be the development of a plan to enable cost-competitive membrane products to be manufactured in the UK.

HOW THE TECHNOLOGY STRATEGY BOARD MADE A DIFFERENCE:

‘Our combined expertise and facilities enabled significant advancement of fuel-cell membrane durability.’

Project F_00288

Project partners
Johnson Matthey Fuels Cells Ltd, ICI Imagedata and University of Surrey

Technology Strategy Board investment
£450,900

Total project investment
£905,600

Project contact details
David Barnwell
Johnson Matthey Fuel Cells Ltd
Lydiard Fields, Great Western Way
Swindon SN5 8AT

E **barnwd@matthey.com**
T **01793 755600**

Technology Strategy Board
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Collaborative research and development projects are one of the tools that the Technology Strategy Board uses to drive innovation in the UK. The Technology Strategy Board is a business-led executive non-departmental public body, established by the Government. Its role is to promote and support research into, and development and exploitation of, technology and innovation for the benefit of UK business, in order to increase economic growth and improve the quality of life. It is sponsored by the Department for Business, Innovation and Skills (BIS).

Tel: **01793 442700** **www.innovateuk.org**

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