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Fuel cells show potential

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New measurements made inside working fuel cells will help increase the commercial uptake of fuel cell technologies. Credit: iStockphoto

National Physical Laboratory scientists have developed an innovative fuel cell reference electrode that has been used to map changes in electrode potential inside a working polymer electrolyte membrane (PEM) fuel cell for the first time.

Fuel cells are an efficient, low carbon energy technology that could enable hydrogen fuel to replace the petrol and diesel we currently use to power our cars and other vehicles. However, the commercial uptake of fuel cell technologies has been hampered by high costs, a lack of specialised refuelling infrastructure and the limited durability of the fuel cells themselves.

One problem with PEM fuel cell durability is corrosion. This is particularly severe when the fuel cell is turned on or off and is caused by changes in electrode potential at the cathode, associated with the movement of the air/fuel boundary as hydrogen flows into or out from the anode. With repeated start-up/shutdown of the fuel cell, corrosion of the high surface area carbon material on which the platinum catalyst is supported causes a gradual decrease in available catalyst surface area and consequently a decrease in performance.

In NPL research explained in Electrochemistry Communications, the novel reference electrodes were used to measure the variation in electrode potential across the active area of a 50cm2 fuel cell supplied by Johnson Matthey. What makes the new reference electrodes special is the way that they connect to the fuel cell. Conventional reference electrodes are connected at the sides of the cell, meaning that they can only really measure what's going on around the edges, but the NPL reference electrode connects through holes drilled into the end plates, allowing a measurement of potential to be made at numerous points along the cell anode or cathode.

The electrodes are numbered with respect to the flow of hydrogen through the cell and measurements are taken at each point during operation. The movement of the air/fuel boundary through the cell can be detected by spikes in electrode potential and this can be mapped from the measurements taken by the electrodes. From this data, researchers can determine where and when corrosion is most likely to take place and investigate ways to reduce it.

NPL's Gareth Hinds, who led the project, said: "We are confident that this technique can be successfully applied to a wide range of fuel cell performance and durability issues, enhancing fundamental understanding of the underlying mechanisms and facilitating significant improvements in fuel cell design."

This provides fuel cell researchers and manufacturers with a powerful new diagnostic tool in the drive towards improved fuel cell performance and durability, which is critical for commercialisation of this energy technology.

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More information: In situ mapping of electrode potential in a PEM fuel cell, *Electrochemistry Communications* 17, 26-29.

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