FuelCellToday
The leading authority on fuel cells

analyst view

A Turning Point for High-Temperature PEM Fuel Cells

28 AUGUST 2013

Advent Technologies exhibiting at the 2013 Hannover Messe (Source: Fuel Cell Today)

BASF recently announced that it was exiting its high-temperature proton exchange membrane fuel cell business to focus on supplying catalysts and adsorbants to the industry. The company had previously been positioning itself as a leader in HT-PEMFC technology, supplying membrane electrode assemblies (MEA) alongside its more traditional offering of catalysts and adsorbants. So in effect the company is repositioning itself as a raw material supplier instead of a technology provider.

Also moving away from HT-PEMFC technology, ClearEdge Power has converted its 5 kW stationary fuel cell product over to phosphoric acid fuel cell (PAFC) technology since its acquisition of UTC Power; this product is now offered by ClearEdge alongside the ex-UTC 400 kW fuel cell system unified under the PureCell® brand. But what does this turnaround by two of the major HT-PEMFC players imply for the future of the technology?

HT-PEMFC technology emerged from the research stage within the last ten years[1] and during that short time considerable progress has been made towards commercialisation. The appeal of HT-PEMFC cannot be denied: higher temperature fuel cells can better tolerate CO in hydrogen feeds meaning reformed natural gas can be used instead of purified hydrogen. Heat and water management can also be simplified and reaction kinetics are faster at higher temperatures, potentially allowing cheaper catalyst materials to be used. Operating at elevated temperatures is not solely beneficial however, because higher temperatures result in more rapid degradation, including corrosion of bipolar plates and catalyst support, alongside degradation of seals, membranes, etc. As a result, durability of HT-PEMFC is still a primary focus of all companies involved with the technology.

[1] Shao et al., 2007. http://dx.doi.org/10.1016/j.jpowsour.2007.02.065

Far from being a technology on the decline, HT-PEMFC is the focus of development for a wide range of applications by a number of companies including Truma (250 W, auxiliary power unit), Elcore (300 W, micro-CHP) and Serenergy (350 W – 6 kW, transportation and backup power). With the exit of BASF from HT-PEMFC MEA manufacture, the market opens up for smaller companies to service the market and Fuel Cell Today spoke to Dr Vasilis Gregoriou, CEO of US-based Advent Technologies, to learn more about its novel membrane technology and the markets it is targeting for HT-PEMFC.

The Company is headquartered in East Hartford, Connecticut with R&D and pilot production facilities in Patras Greece and affiliated laboratories at the University of Connecticut and Northeastern University. To date Advent's funding has come from institutional and industrial investors such as Connecticut Innovations, Piraeus Bank Venture Capital, Systems Sunlight and Velti. Advent holds a very strong IP portfolio on high temperature PEM fuel cell technology with a number of US and world patents already granted and a stream of patent applications in the pipeline. The Company is a global supplier with distribution partnerships in place in India, China, Taiwan, and Japan.

Advent sees four main markets suiting HT-PEMFC technology: micro-CHP, power production, portable power and hydrogen separation. It has developed a proprietary membrane material for its HT-PEMFC based upon pyridine, as opposed to the polybenzimidazole-based systems used by other companies. Its technology also has cross-linking, which provides greater mechanical strength. These improvements allow Advent's MEA to operate at higher temperatures than conventional HT-PEMFC MEA, in some cases above 200° C and with greater stability. Pressures inside the MEA can also approach those used in PAFC– a well-proven fuel cell type.

In terms of its target markets, Advent views portable applications and the potential for use in telecommunications backup power applications as the nearest to market. These markets for fuel cells are already successful globally for low temperature (LT) PEMFC and direct methanol fuel cells, and if HT-PEMFC systems can offer comparable durability and stability to existing products, its benefits in terms of fuel flexibility could prove decisive.

Longer term, micro-CHP is another application where reformed natural gas could be used in HT-PEMFC with minimal purification to offer a cheaper alternative to LT-PEMFC. Currently this market is heavily dependent upon subsidies, including net metering and feed-in tariffs. Getting legislative support will be critical to facilitate demonstration projects, but this support is available and projects such as Ene-Farm in Japan and ene.field in Europe are testament to this. Fuel cell micro-CHP outsold conventional micro-CHP for the first time in 2013, and the global potential for domestic heat and power systems makes this a very appealing goal for HT-PEMFC.

The final application Advent discussed for its technology was in hydrogen purification. This might not be the first use for HT-PEMFC that springs to mind, but this technology is somewhat uniquely positioned to do this. Reformed natural gas can be fed into the anode side of the fuel cell, containing hydrogen, carbon monoxide, methane, carbon dioxide, etc., and if no oxygen is introduced to the other electrode, the hydrogen ions can pass through the membrane and form pure hydrogen gas at the cathode. The additional strength of Advent's membrane allows for differential pressure operation.

Unlike BASF, which offered its products in standardised dimensions, Advent has adopted the model of working closely with its customers to develop bespoke products and ensure the needs of its customers are met. For a technology still in its infancy, this is most likely the right approach and while Fuel Cell Today believes that standardisation is vital to the future of the fuel cell industry as a whole, there first needs to be an established market for the products before the additional cost reduction benefits of standardisation can be enjoyed. This market is apparent for LT-PEMFC today, but not yet for HT-PEMFC.

Overall, like Advent, we believe there is a future for HT-PEMFC, but like all new technologies there will be hurdles to overcome, such as increasing system durability, before it reaches commercial deployment.

Dan Carter Manager
dancarter@fuelcelltoday.com
www.fuelcelltoday.com