

Katie S. Howe BA (Hons)

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DTC Project - Development and application of Micro Tubular Solid Oxide Fuel Cell stacks for Unmanned Aerial Vehicles (UAVs)

Supervisors: [Professor Kevin Kendall](#) (staff/profiles/chemical-engineering/kendall-kevin.aspx), Professor Stephen Decent & Dr Sarah Barley

Sponsor: [EADS Innovation Works](http://www.cassidian.co.uk/innovation-works) (<http://www.cassidian.co.uk/innovation-works>)

Start Date: September 2009

Finish Date: September 2013

About

Katie graduated from Cambridge University with a first class Natural Sciences (Physical) degree in 2008. She then worked as a financial analyst for a year before returning to academia. She started her PhD with integrated study in hydrogen and fuel cell applications at the University of Birmingham in September 2009.

Katie's PhD within the Doctoral Training Centre is funded by RCUK and sponsored by EADS Innovation Works. It focuses on solid oxide fuel cell (SOFC) and stack development for unmanned aerial vehicles (UAVs). SOFCs show promise for a number of possible applications due to their high efficiency and ability to cope with fuels that are not pure hydrogen. This fuel tolerance is important as high-purity hydrogen is not widely available at present.

Project Details

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UAVs provide a niche market where energy capabilities matter more than price. This is an ideal platform for a new, so expensive, but potentially very beneficial, technology. Working in partnership with EADS IW provides aerospace engineering experience and an insight into customer requirements.

The process of making the individual mSOFCs is being considered in detail, with various changes to the "in-house" techniques previously used being suggested. Dip-coating was tested as an alternative to hand-painting the cathode layer for the cells; the results show proof-of-concept, although more work is needed to make this a viable alternative.

The power output and transient performance of the cells was also investigated, with promising results. It was shown that the hand-painted cells take less than half a second to adjust to a change in demanded current, without any overshooting of voltage.

The performance of individual cells on various hydrocarbon fuel compositions is being investigated, with humidification of the fuel and use of an inert buffer gas being considered. It has been concluded that a buffer gas will be needed, as the performance shows strong positive correlation with total gas flow rate. A small, six-cell module was made following the same design used previously in-house. This was tested for both power density and transient performance. The intention is to build up to a larger stack of around 100W, using a modular approach.

Papers

- Howe, K. S.; Kendall, K. In Microtubular SOFCs - Review of Properties and Performance, 9th European Solid Oxide Fuel Cell Forum, Lucerne, 2010.
- Howe, K. S.; Thompson, G. J.; Kendall, K., Micro-tubular solid oxide fuel cells and stacks. *Journal of Power Sources* **2011**, 196, (4), 1677-1686. - [Link](http://www.sciencedirect.com/science/article/pii/S0378775310016496) (<http://www.sciencedirect.com/science/article/pii/S0378775310016496>)
- Howe, K. S.; Kendall, K., Transient Performance of Micro-Tubular Solid Oxide Fuel Cells. *Journal of Fuel Cell Science and Technology* **2011**, 8, (3), 034502. - [Link](http://scitation.aip.org/getabs/servlet/GetabsServlet?prog=normal&id=JFCSAU000008000003034502000001&idtype=cvips&gifs=yes) (<http://scitation.aip.org/getabs/servlet/GetabsServlet?prog=normal&id=JFCSAU000008000003034502000001&idtype=cvips&gifs=yes>)
- Howe, K. S.; Kendall, K., Transient Performance of Micro-Tubular Solid Oxide Fuel Cells and Stacks. *ECS Transactions* **2011**, 35, (1), 419-423. - [Link](http://www.ecsdl.org/getabs/servlet/GetabsServlet?prog=normal&id=ECSTF8000035000001000419000001&idtype=cvips&gifs=yes&ref=no) (<http://www.ecsdl.org/getabs/servlet/GetabsServlet?prog=normal&id=ECSTF8000035000001000419000001&idtype=cvips&gifs=yes&ref=no>)
- Patent pending: UK Patent Application Number **1107672.6**

Presentations

- 1st Annual DTC Conference, 2010 (Birmingham, UK)
- MEGS Christmas Event, 2010 (Birmingham, UK)
- 219th Meeting of the Electrochemical Society, SOFC XII – 2011 (Montreal, Canada)

Posters Presented

- 6th International Hydrogen and Fuel Cell Conference, 2010 (NEC, Birmingham)
- IMA; Fluid Problems in Process Engineering, 2010 (Leeds, UK)
- 9th European Solid Oxide Fuel Cell Forum, 2010. (Lucerne, Switzerland)
- 7th International Hydrogen and Fuel Cell Conference, 2011 (NEC, Birmingham)

Other Events

- 11th Grove Fuel Cell Symposium, 2009 (London, UK)
- Innovative Future Conference, 2009 (Coventry, UK)
- Sustainability Live, 2010 (Birmingham, UK)
- Sustainability Live, 2011 (Birmingham, UK)

Responsibilities

- DTC student representative to the teaching committee
- Outreach – laboratory tours and presentation to school children

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