

## **Newsletter – Winter 2016**

The Centre for Power Electronics (CPE) Hub and our national team of researchers have been busier than ever delivering top quality research and networking with industrialists and the general public to showcase their latest findings. It's been a while since our last newsletter so here are just a few of the highlights of the last 6 months.

### **Next Generation Integrated Drive**

Kicking off in February this year the primary aim of this project is to investigate, design, build and test a technology demonstrator industrial drive which pushes the boundaries of existing integration technology and know-how. We are now working towards a drive, operating at 30,000 RPM, with a liquid cooled stator, air cooled rotor and inboard, winding-mounted power electronics and control hardware. The drive specification is ambitious and includes world-leading miniaturised, hierarchical drive power systems and control systems with electronic electromagnetic design of the electric machine yielding >96% efficiency.

### **Packaging & Application of High Press-Pack SiC Modules**

The cross-theme project funded by the CPE, under the "operational management and control" theme, has almost reached completion after meeting all of its major objectives. The project has demonstrated the UK's first SiC power devices in pressure-contact packages and has demonstrated power cycling results. The project also investigated the impact of design parameters like thermal contacts and contact force. Results have been presented at international conferences including the ESREF 2016 (European Symposium on the Reliability of Electron Devices, Failure physics and Analysis) conference held in Germany and the IEEE ECCE conference held in Milwaukee. The results have been published as Journal articles in Microelectronics Reliability and the IEEE Transactions on Industrial Electronics.

### **Doctoral Scheme**

The PE doctoral scheme provides PhD studentships in Power Electronics. Talented doctoral engineers will be funded to conduct cutting edge research in close collaboration with industry. Within the UK there is an acute shortage of skilled power electronics engineers, with a very high demand for doctoral graduates to work in industry and academia. This initiative brings together world leading research groups and leading industry to address the issue, through fees and a scholarship jointly funded by industry and universities.

**For further information about applying for a studentship or to find out how your organisation could get involved please contact: Professor Barrie Mecrow, E-mail: [Barrie.Mecrow@ncl.ac.uk](mailto:Barrie.Mecrow@ncl.ac.uk)**

## Annual Conference

Our third annual conference was held at the National College, Nottingham from the 5<sup>th</sup> – 6<sup>th</sup> July 2016. The conference featured presentations showcasing research from across the four CPE themes and the three cross-cutting topics. We were lucky to have as keynote speakers Dr Alex Lidow, CEO and co-founder of EPC and Prof Braham Ferreira, Professor of Power Electronics and Electrical Machines at TU Delft. It was great to see so many of you there and we hope you can make it to next year's conference, which will be held from 3-5<sup>th</sup> July 2017 in Warwick. If you didn't make it or want to see them again, copies of presentations can be downloaded from our webpage.

[www.powerelectronics.ac.uk/power-electronics/events/pastevents](http://www.powerelectronics.ac.uk/power-electronics/events/pastevents)



## Post-graduate Summer School

Organised by the post-grads themselves and therefore tailored to their interests, the event included guest speakers talking about the future of Power electronics and gave students the chance to present their own work. Congratulations to the poster winners and thanks to everyone who took part!



## New Scientist Live

On 22<sup>nd</sup>-25<sup>th</sup> September CPE showcased exciting Power Electronics technology applications from across the UK at the New Scientist Live event in London. Exhibits included the electric superbike, the Green taxi aircraft wheel, demonstrations of wireless energy transfer and a fuel cell car.

The Centre collaborated with Robert Llewellyn in a panel discussion about Cars of the Future.

## UPCOMING EVENTS

**24<sup>th</sup> January 2017**

***Can we put the 'Z' in EV's?  
The Royal Institution Venue, London***

**15<sup>th</sup> March 2017**

***Driving into the Digital Age  
The Royal Institution Venue, London***

Further details of all of our events can be found at [www.powerelectronics.ac.uk/events](http://www.powerelectronics.ac.uk/events)

## Theme Updates

**CONVERTERS** – Two papers were presented at the IEEE ECCE Conference in Milwaukee describing the development of a design optimization tool for compact DC-DC converter and the control and experimental performance of a back-to-back, four-level ‘pi-type’ inverter configuration. Work is now examining new architectures for very high voltage, modular multi-level converters (MMC) that offer greater redundancy in switching states than does the conventional MMC. A paper on thyristor-based, forced-commutated switching modules for high voltage MMC converters was presented at the IEEE COMPEL conference.

**COMPONENTS** – Significant progress has been made in the components theme in the initial phase of developing a condition monitoring technique for silicon carbide based power electronic devices. This is important for the reliability of fast and efficient power converters for applications like automotive traction. We presented this work at the IEEE ECCE conference held in Milwaukee as well as the Applied Power Electronics Conference earlier this year. The extended version of the paper has also recently been accepted in the IEEE Transactions on Power Electronics.

**DEVICES** - Investigations into roadblocks affecting Silicon Carbide device performance, such as poor channel mobility and defect density, have been completed. Fabrication of 1.2-3.3 kV and 1-5 A devices is well underway with preliminary results expected at the beginning of 2017. Results from devices affected by the carbon concentration have been used to improve GaN epitaxy, reducing trapping mechanisms in the epi-layers and dynamic-Ron recovery time. Failure analysis of 600V-1.2 kV silicon Super-Junction devices during blocking operation continues. Termination designs of >700V Si IGBTs and >1000V Si LDMOSFETs have been compared and, so far, all pass reliability testing.

**DRIVES** – Within the Drives theme we have moved into an exciting phase in which we are creating several demonstrators. These include a very high temperature motor, operating at over 350 degrees; new concepts for fault tolerant drives and failure detection; new types of drive architectures, combining silicon and silicon carbide technology; integrated drives with varying degrees of integration, ranging from proof of concept through to fully operational systems. We are also continuing to develop control systems which enable real time optimal operation of single and multi-drive systems. Our work has been presented at a series of conferences, including VPPC and PEMD.



*Christmas wishes from the CPE team*

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