

# CENTRE FOR POWER ELECTRONICS NEWS

## Newsletter Spring 2019

### CPE Annual Conference 2019

Our Annual Conference is always very popular, and tickets are already selling fast!

This is your opportunity to hear from experts in the field, find out more about the work of the Centre, to learn about our latest research and to network with colleagues.

With international speakers, workshops, exhibitors, a poster competition not to mention our popular networking BBQ in the evening, this event is not to be missed!

### International Speakers

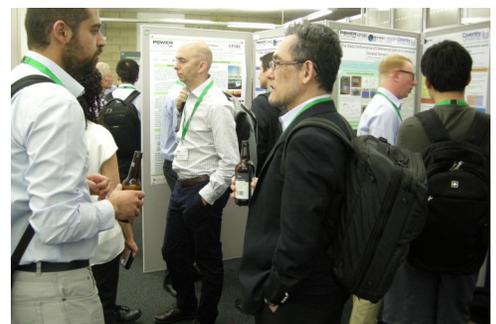
- Professor Johann W. Kolar, ETH Zurich, Switzerland
- Professor Leon Tolbert, University of Tennessee, USA
- Professor Annette Muetze, Graz University of Technology, Austria
- Professor Frede Blaabjerg, Aalborg University, Denmark
- Dr Galina Mirzaeva, University of Newcastle, Australia
- Professor Alex Huang, University of Texas at Austin, USA

### Exhibitors



### [Book your place](#)

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- Dates for your diary*



CPE Annual Conference 2018

## University Research Group of the Year



Dr Jose Gonzalez (University of Warwick) with Peter Davies (Thales) on the right.

At Techworks' Grand Gala Dinner and Awards ceremony held in November last year, the **University Research Group of the Year Award** sponsored by Thales, was presented to the Power Electronics Technologies in Energy Research Group at the University of Warwick.

Well done to our colleagues at Warwick!

## New Centre for Doctoral Training in Power Electronics for Sustainable Electric Propulsion

The universities of Nottingham and Newcastle are delivering an EPSRC Centre for Doctoral Training (CDT) in Power Electronics for Sustainable Electric Propulsion.

This is a collaboration between two of the UK's largest and most forward thinking research groups. It will train a new generation of power electronics specialists to meet the future demands of society and industry for clean, electric propulsion systems. The CDT will also benefit from the involvement of more than 20 industrial partners.

The new CDT is led by Professor Volker Pickert, an expert in Power Electronics and lead for the Electrical Power research group at Newcastle University.

[Find out more about Power Electronics for Sustainable Electric Propulsion CDT](#)

## Greenpower Challenge 2019

Once again the Centre for Power Electronics is supporting the Greenpower Challenge. This competition gives primary school pupils the chance to get a taste of the exciting world of engineering. The children build, then design the bodywork for a Green Goblin electric kit car, before taking part in races over the summer. A team of researchers from the University of Nottingham is supporting the students with the project.

"Bramcote Hills Primary School, Nottingham was the winning entry this year, and the project is progressing well," Professor Lee Empringham explained. "So far, three groups of 10 children have been working hard at their after-school club on the construction of the car. The chassis, wheels, steering, breaking system and drive system have all been completed and planning for the exciting designs for the bodywork has already started in anticipation of the racing season."

## Automotive Power Electronics Symposium 2018

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### Automotive Challenge

The EPSRC Challenge Network in Automotive Power Electronics held a Symposium on 14 and 15 November 2018 at Austin Court, IET Birmingham. Keynote speakers included Professor Neville Jackson, Chair, Advanced Propulsion Centre Advisory Group and Professor Phil Blythe, Newcastle University and Chief Scientific Adviser, Department for Transport.

This two-day event provided delegates with the opportunity to explore the challenges facing the automotive sector in power electronics machines and drives, as well as exploring cross cutting elements of relevance to the wider power electronics community.

Our workshops explored the following topics in depth:

- Wide Band Gap Power Devices for Automotive Applications led by Professor Phil Mawby, University of Warwick.
- Materials for Electrical Machines led by Professor Allan Walton, University of Birmingham and Dr Philip Anderson, Senior Lecturer, University of Cardiff.
- Integrated Drives led by Dr Judith Apsley, University of Manchester.
- Converter in Package/On chip led by Professor Merlyne De Souza, University of Sheffield.
- Machine Architectures led by Dr Rafal Wrobel, Newcastle University.
- Thermal Management led by Professor Chris Bailey, University of Greenwich.



“

*Overall a very informative event that has prompted a lot of new ideas .*

”

## PEMD Roadmap and Future Strategy Workshop



This workshop provided a forum for delegates to identify and discuss key cross-sector and cross-disciplinary challenges and opportunities. Representatives from the rail, energy and aerospace sectors gave their perspective on the challenges facing their industries. The event also provided delegates with the opportunity to contribute their views on intersections between the Automotive Council roadmaps and in particular opportunities for cross-sector and cross-discipline working.

Outputs from the workshop will be used to influence future policy and research agendas in power electronics, machines and drives.



“

*It was great to bring the various sectors together and it was a very good networking opportunity.*

”

**PI - [Professor Olayiwola Alatise](#) University of Warwick**

The Reliability and Health Management theme held a successful workshop on reliability and condition monitoring in SiC power modules on the 5 December 2018 with over 75 attendees, half of whom were from UK industrial organisations. The project team presented its latest research findings on SiC and GaN device reliability together with gate drivers and new packaging materials. The University of Warwick team has presented research results on gate oxide reliability at the IEEE Energy Conversion Congress and

Exposition 2018 in Portland, Oregon. Representatives from the University of Bristol presented results on their high speed gate driver for temperature sensing in GaN power devices at the same conference. The team from Newcastle University presented their current source gate driver at the Applied Power Electronics Conference (APEC). The University of Warwick team will be holding a tutorial on condition monitoring for SiC power devices at the upcoming IEEE EPE conference in Genova, Italy later this year.

**Switch Optimisation****PI – [Dr Peter Gammon](#) University of Warwick**

The Switch Optimisation theme is conducting research into a high voltage power device - a silicon carbide (SiC) IGBT - which could be used in future grid applications. The initial year of the programme has focussed on the optimisation of an initial 10 kV IGBT structure, to be developed alongside a 10 kV MOSFET.

Simulation studies, carried out at the universities of Cambridge and Coventry, have resulted in an optimised IGBT layout that includes an innovative 'retrograde P-well' that was presented by the team at the European SiC Conference held in Birmingham in September 2018. The design takes into account the characteristics of a novel SiC substrate featuring a high carrier lifetime ( $>5 \mu\text{s}$ ) that is necessary to reduce the on-state losses of the thick 100  $\mu\text{m}$  layer of SiC epitaxy, so reducing on-state losses.

The design also exploits the diverse, state-of-the-art processing capabilities available to the team, with a gate design that will be developed using an industry standard high temperature N<sub>2</sub>O treated process at the University of Warwick, and an innovative low temperature ALD process at Newcastle University. The comparison of the two processes and the comparisons between the unipolar MOSFETs and bipolar IGBTs will be world firsts, with the benchmarking shedding light on the gains of each device at such high voltages.

The project has now entered the first phase of device fabrication, with the first generation of SiC IGBTs and MOSFETs expected in the summer of 2019.

## Multi- Domain Virtual Prototyping Techniques for WBG Power Electronics

PI - [Dr Paul Evans](#) University of Nottingham

Dr Arnauld Videt has just returned to the University of Lille after a three week stay in Nottingham working with Dr Ke Li. They have been developing measurement techniques and device models for GaN power devices so that detailed switching waveforms, and device losses, can be predicted under both hard- and soft-switching conditions. Two publications describing this work are currently being prepared and the models developed will ultimately be imported into the project's virtual prototyping software.

Elsewhere in the project, the University of the Nottingham and University of Greenwich now have a coupled electro-thermal-mechanical modelling framework that is capable of predicting how electrical operating cycles induce mechanical stresses in power electronic components. Work is now underway to link this model with lifetime models being developed in the reliability and health management project. A validation exercise that will model how power cycling tests under different conditions affect package lifetime will take place later this year.

## Converter Architecture

PI – [Professor Xibo Yuan](#) University of Bristol

In the Converter Architecture theme, we have completed defining the high-profile demonstrator, aiming to extend the frequency/power/voltage envelop using wide-bandgap devices. Medium-voltage DC/DC and DC/AC converter topologies have been identified with minimum number of components required, low dv/dt and low current ripple. Modulation and control strategies aiming to balance dc-link capacitors' voltages and reduce passive components requirement are being developed. Mechanical structures are being designed for the demonstrator system, integrating power modules, planar

bus-bars, high-frequencies inductors and capacitors, etc. Supplying the gate power of high-voltage wide-bandgap devices through wireless link is also being explored. The consortium is holding a panel discussion session on the [Future of Wide-bandgap Devices in Power Processing and Wireless Power](#) during Wireless Power Week on 19 June 2019 in London.

## Heterogeneous Integration

PI - [Professor Lee Empringham](#) University of Nottingham

The Heterogeneous Integration theme continues to drive research into the creation of compact embedded power converters. This includes investigating the implementation and characterisation of magnetic ferrite structures using the Gelcasting method. The main advantage of this method is that magnetic objects, suitable for integration into power converter structures, can be manufactured with differing shapes. Research onto the precise production methods and sintering temperatures is ongoing in order to achieve the desired permeability and loss profile for differing applications. Another key area is that of

the creation of high current interconnects for both semiconductor and inter-layer conductors. Good results have been achieved using plating methods which will now be subjected to reliability analysis to determine the effect of these structures when they are embedded in insulators with significantly different Coefficient of Thermal Expansions. The creation of integrated structures (including inductive) using a 2.5D 'PCB' lamination methodology is also under development and showing good progress.

## “Driving the Electric Revolution” Challenge

As part of the third wave of the government’s Industrial Strategy Challenge Fund, the Stephenson Challenge was originally announced in the November 2018 budget. Now known as **Driving the Electric Revolution**, its focus is on power electronics machines and drives (PEMD), targeting electrification and decarbonisation across the transport, industrial and energy industries.

The aim of this cross-sector challenge is to lead the world in electrification by enhancing the UK’s strengths in PEMD through activities targeting:

- Cross-sector working
- Driving innovation in materials to manufacturing
- Supply chain development
- Developing world-leading facilities
- Workforce development.

The proposed delivery is through:

- Establishment of three Industrialisation Centres utilising existing clusters of UK expertise and infrastructure.
- Development of high efficiency, high volume supply chains to develop innovative and differentiated production methods, optimising productivity.
- Support for low volume, high value supply chains and tier N development.

It is proposed that the delivery of the Challenge will be through a virtual centre, with a hub and spoke model. The Spokes will cover the following topics:

- Materials, components
- Motors and drives
- Prototyping and scale-up.

Matt Boyle, OBE formerly CEO of Sevcon, has been appointed the senior industry lead for the Driving the Electric Revolution Challenge and work is now underway to develop a business plan for the challenge to be submitted in early May 2019.

“Driving the Electric Revolution will accelerate the development of supply chains, workforce and differentiated technological solutions, positioning the UK as a global leader in PEMD” said Professor Mark Johnson, Director of the Centre for Power Electronics. “CPE was involved throughout the bid development process and will continue to support the development of the delivery mechanisms, in particular in relation to engagement with the UK academic PEMD community.”

## Dates for your diary

15 May 2019	<a href="#"><u>Post Graduate Summer School 2019</u></a> Austin Court, IET, Birmingham
19 June 2019	<a href="#"><u>The Future of WBG devices in power processing and wireless power</u></a> IET London: Savoy Place
3 & 4 July 2019	<a href="#"><u>Centre for Power Electronics Annual Conference 2019</u></a> Holywell Park Conference Centre, Loughborough University

## GDPR - GENERAL DATA PROTECTION REGULATION

The General Data Protection Regulation came into law across the EU last year. Under the new regulations, organisations must keep a record of how and when an individual gives consent to store and use their personal data. With this in mind, the Centre for Power Electronics is asking you to confirm that you still want to receive information from the Centre and will allow us to keep your contact details on our database.

Please follow the link below to confirm that you want to stay in touch with the Centre for Power Electronics.

[Yes I want to continue to receive communications from CPE](#)

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