

CENTRE FOR POWER ELECTRONICS NEWS

Newsletter Spring 2018

Annual Conference 2018

Our Annual Conference this year will be held on 4 and 5 July at Holywell Park Conference Centre, Loughborough.

With a focus on international working, we have secured inspirational keynote speakers from Germany, Japan, China, and USA. Professor Rik De Doncker from Aachen University will open proceedings. The event will also provide insights into the work of the Centre's new research themes, and a case study in knowledge transfer in Wide Band Gap Power Electronics from our first tranche of research .

There will be the opportunity to browse our exhibition, featuring industrial and Centre activity, take part in our poster competition and network at our barbecue at the end of Day One. Our Annual Conference is always very popular, so we would advise early booking to secure your place.

[Book your place](#)

[Find out more](#)



Discussions at our Annual Conference last year

Inside this issue:

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"A good spread of academic and industrial presentations."

"A good forum for further discussions and meeting people."

"Some interesting ideas being presented. Everyone was very enthusiastic."

"The CPE theme updates were excellent ."

POWER

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Automotive Challenge

The EPSRC Challenge Network in Automotive Power Electronics held a Feasibility Study sandpit at the end of March 2018. The focus of this two day event was to explore opportunities for long term research with a focus on components, converter architectures and enablers. Over 30 delegates attended the event, with 19 institutions represented. The delegates worked in small groups to develop ideas that would lead to research clustering and the generation of feasibility projects. Seven proposals were chosen by the group to be presented to the CN Steering Group. All of these were supported by the Steering Group and will now be developed to proposals for submission in early May. The successful feasibility projects will be announced in June 2018.

Professor Lee Empringham said: "It was good to see some great ideas being generated. The sandpit provided those taking part with the opportunity to build consortia and develop their ideas into proposals. By the end of the event, we had identified projects that could be taken forward to the next stage of the funding process."

BUSINESS DEVELOPMENT NEWS



In December 2017, our business development team piloted a "Tech Talk" at the University of Warwick. This informal lunchtime workshop brought together local businesses and the research community, so that industrialists could find out what Power Electronics research is going on at their local university.

"There was lively discussion on how universities can disseminate their work and keep industry informed," said Business Development Manager, Steve Earl. "We generated interest from a number of companies which we are now following up."

Steve has also been making connections with key organisations in the field of Power Electronics, including MTC, PES and Warwick Manufacturing Group. He is supporting the development of a sustainability strategy for the Centre for Power Electronics.

Meanwhile our Business Champion, Geoff Haynes represented the Centre at the IESSES 2018 tutorial program at the University of Waikato. The tutorial program was developed by the University of Cambridge and explores the relative attributes of Si, GaN and SiC power switches, addresses the challenges of using the higher speed parts and identifies the application areas that benefit most.

"I am keen to help any company interested in exploring the potential of compound semi-conductors," said Geoff.

If you would like find out more about how we can put researchers and businesses in touch with each other, then email us: correspondence@powerelectronics.ac.uk

KIT CAR TAKES SHAPE



The winning team of the CPE-sponsored Goblin kit car project met for their first after-school car building session in January. A small excited group of pupils from Abbey Road Primary School, West Bridgford, were thrilled to finally get to see the car and get started on the project.

Engineers from the University of Nottingham joined the youngsters to guide them through the process and answer any questions about the car.

In the first session, the group identified the key parts of the car, organised the hundreds of nuts, bolts, and washers required for the build and put together the basic framework of the car. The group have progressed so well that the car is now nearly finished!

Professor Lee Empringham from the University of Nottingham said: "The Abbey Road team are getting on really well. They've had a great time grappling with the instruction manual and keeping track of all the little nuts and bolts! They have made great progress and they've almost finished the assembly. The car was brought back to our labs over Easter for checking and tightening of the nuts and bolts where necessary. The team are now working on designs for the car's bodywork."

The next step of the process is to get the car ready for racing in July!

GDPR - GENERAL DATA PROTECTION REGULATION

The General Data Protection Regulation came into law across the EU in May. 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 data base.

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

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Winner Zhe Zhang (right) with Judge, Geoff Haynes

The final of the Future Power Challenge was held on 14 May 2018, at Austin Court, Birmingham. Five candidates were invited to present their work to the judges, as well as present a summary of their research to CPE’s Post Graduate Summer School the following day.

“The quality of the finalists’ work was outstanding,” said Geoff Haynes, one of the Future Power Challenge judges. “We were impressed by the high level of innovation and quality of the work presented – selecting a winner proved to be really difficult.”

First prize of £2,000 was awarded to Zhe Zhang from the University of Nottingham for his presentation on Silent Switching- EMI suppression without EMI filters

Second prize of £750 was awarded to Yichen Cai, from the University of Manchester.

Commendations of £250 were awarded to:

- Juan Manuel Arteaga from Imperial College London.
- Nikita Hari from University of Cambridge .
- Stewart Marchant from University of Nottingham.



Runner up, Yichen Cai (right) with Geoff Haynes



Geoff Haynes with Highly Commended Nikita Hari and Juan Manuel Arteaga

The Future Power Challenge was supported by the Centre for Power Electronics.

With thanks to sponsors

EPC, GaN Systems, Infineon, and p Semi

The theme of this year's Post Graduate Summer School was "Your Career the Next Steps". Led by a steering group of Post Graduates, the school this year offered talks from representatives from both industry and academia.

There was a poster display, presentations from the Future Power Challenge finalists, and an exhibition featuring Power Electronics companies. Delegates also had the chance to meet other PhD students from around the country with a similar research interest, and to build links with potential employers.

Keynote speaker Dr Dave Cook from TMD Technologies Ltd started off the day, giving a talk about his career path from academia through to industry. Dr Steve Earl, CPE's Business Development Manager gave a talk about communicating your research and knowledge exchange strategies for academia and industry.

After presentations by the Future Power Challenge finalists, delegates had plenty of opportunities to network and browse the exhibition. After lunch, Dr Peter Gammon gave a presentation on what its really like to follow an academic career. Amanda Miller and Dr Helena Cartwright from CPE then offered some practical tips on how to network.



Keynote speaker David Cooke

"It's a fantastic event, and helps a lot with my career after PhD." Zhenyu Wang



Poster discussions

NEW RESEARCH THEMES UPDATES

Our new themes are investigating different aspects of Wide Band Gap technologies. All the projects are just getting underway, but over the next couple of pages we report what has been achieved so far.

Reliability Condition Monitoring & Health Management Technologies for WBG Power Modules



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

Understanding the reliability of WBG semiconductors is becoming increasingly important as these new devices are being used more widely in industrial settings. Electrothermal characterisation of the latest SiC MOSFETs (planar and trench) has been carried out as have initial studies on BTI of SiC MOSFETs and its impact on the Temperature Sensitive Electrical Parameter (TSEPs) which is used for condition monitoring to determine system health. A review on active gate driver topologies and TSEPs was carried out at Newcastle University and an active gate driver topology selected.

Heterogeneous Integration



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

The Heterogeneous Integration project topic will address aspects related to the inclusion of components more traditionally seen at a system level, within new and innovative power module structures. Work will develop manufacturing techniques and design methodologies using a layered manufacturing approach to produce the next of generation power modules. Key aims are to:

- Understand how the design of layered, 3D-integrated structures can maximise the electromagnetic, thermal and mechanical performance of power modules.
- Understand how new materials and interconnection techniques (can be best used in the design of power modules to improve their performance.
- Investigate new, cost-effective manufacturing processes that will allow these new modules to be brought to market.
- Produce proof-of-concept demonstrators.

A new electroplating system has been installed at the University of Nottingham to support work which will develop a new packaging that low inductance, planar-style power device packaging with integrated EMI filtering, effective thermal management and coefficient-of-thermal-expansion mitigating interface layers. A literature review and preliminary CAD and multi-domain simulation exercise has begun as part work that will develop possible designs for manufacture. This review is also being used to steer software development activities in the Virtual Prototyping topic.

Converter Architecture



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

The Converter Architecture project brings together academic and industrial expertise to investigate optimal converter architectures, advanced passive components design methods, fast speed control techniques and holistic optimisation. It aims to realise the full potential of WBG devices in achieving higher efficiency, high power density with extended voltage, frequency and power handling capability.

The teams working on Topology carried out a literature review and market search on high voltage (HV) device availability and performance , converter topologies, HV capacitors and HV magnetics.

The teams at the Universities of Bristol and Manchester are responsible for design optimisation. They have been working on a design optimisation tool junction temperature case study. Volume optimisation was performed on a DC to 3-phase AC converter using SiC BJTs (GA50JT12-247). This found that:

- Increasing junction temperature from 125°C to 150°C, only decreased the heatsink volume.
- Increasing from 150°C to 175°C increased the heatsink but reduced the passive component volumes since the optimal switching frequency changes.

They also started experimental tests of the DC-DC converter in boost mode: 190 V-500 V, 25 kW at 115 kHz per phase.

Multi- Domain Virtual Prototyping Techniques for WBG Power Electronics



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

This research project will develop the software tools that power electronic system designers need to be able to design optimal WBG systems, right-first-time, on a computer. The project builds on previous CPE-funded work that developed software that could make fast electro-thermal predictions for power devices and their packaging, taking into account design geometry and construction materials. This project will investigate fast numerical methods for making EMI/EMC predictions, look at magnetic component modelling, develop fast models for fluid cooling loop modelling and produce methods for lifetime prediction. Ultimately all of this work will be integrated into design software under development.

Work on EMI/EMC predictions started in March. Dr Paul Evans and the team at Nottingham have been evaluating the capability of existing code for electromagnetic modelling using GaN HEMT based examples for experimental verification. This work, combined with an ongoing literature review, will lead to the development of new modelling techniques in the coming months. Dr Tim Tilford at the University of Greenwich has begun developing fast CFD-type code for localised modelling of fluid flows in power electronic heatsinks. Dr Hua Lu has been working on lifetime modelling and has produced a simplified Finite Element code that can predict mechanical stresses in power electronic systems based on thermal simulation results. This code has already been integrated into the design software and will form the basis of lifetime modelling efforts later in the project. Researchers are currently being recruited at the University of Bristol to work on magnetic material modelling and system-wide cooling loop models.

Switch Optimisation



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

Silicon carbide insulated-gate bipolar transistors (IGBTs) have the potential to enable new and highly efficient ultrahigh voltage applications enabling a low carbon society. This multidisciplinary project aims to be among the first in the world to develop these devices, and to push the boundaries of what has been achieved so far.

The project team held its first meeting in January 2018. To date, work has progressed on optimising a device design and developing the fabrication processes. At the Universities of Cambridge and Coventry, simulation work of the 3D design of SiC IGBT has started. A concise literature review has been carried out and the device architectures obtained through these publications have been used to inform the initial device simulation. The team at Newcastle University have performed grinding tests, which are necessary to remove the original substrate from the backside of the wafer. At the University of Warwick, 10kV 4H-SiC MOSFET devices, designed and started in CPE's Tranche One themes, have been successfully fabricated with breakdown voltages reaching 13.6kV. These results inform the IGBT development to come.

DATES FOR YOUR DIARY

July 2018

4 & 5 July

The EPSRC Centre for Power Electronics **Annual Conference 2018**, Holywell Park Conference Centre, Loughborough University. This year, our Annual Conference has an international focus with keynote speakers from Germany, China, Japan and the USA. This event is always very popular, so we would urge you to book early to avoid disappointment.

[Book your place](#)

November 2018

The EPSRC Automotive Challenge Network Symposium, IET, Austin Court, Birmingham.

This two day event will bring together industrialists and academics in an event where industrialists can challenge academics to come up with solutions to the problems faced by the Industrial sector. It will explore themes of the Automotive Council Roadmaps and provide plenty of networking opportunities for delegates. Further information will be available on our website soon.

Centre for Power Electronics

The University of Nottingham

Tower Building

University Park

Nottingham NG7 2RD

t: +44 (0) 115 951 5545

w: powerelectronics.ac.uk

E: correspondence@powerelectronics.ac.uk

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