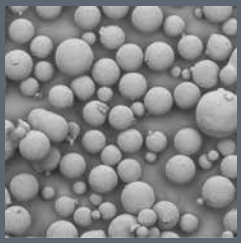
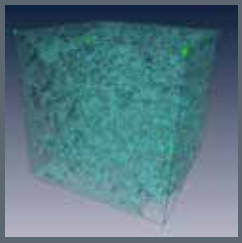
OXFORD BROOKES UNIVERSITY

SUSTAINABLE ENGINEERING AND INNOVATION RESEARCH

Industry leading research in creating innovative solutions for a more sustainable future





SUSTAINABLE ENGINEERING AND INNOVATION RESEARCH

Sustainable Engineering and Innovation (SEI) at Oxford Brookes University draws together a collective of many different technological disciplines, highly successful research groups and individuals.

"We are a strong multi-disciplinary team that is able to deliver innovative and sustainable engineering solutions that impact upon national and international issues concerning current and future environmental, social and economic needs." ***James Broughton***

Dr James G Broughton
Theme Lead for SEI

The key focus areas of SEI include:

- Intelligent and integrated solutions for sustainable mobility.
- Closed-loop manufacturing through the development of smart materials, efficient processes and innovative design.
- Advanced sustainable materials and joining processes.
- Whole life energy analysis and low carbon solutions.
- Expertise in the use, manufacture and performance of carbon materials.

Examples of some of our most recent and exciting developments and how this ground-breaking work has already impacted upon society, are showcased in the following sections.

Siew Yan Goh, Oxford Brooke's KTP Associate with YASA Motors

ENGINEERING FOR THE FUTURE

In 2011 SEI entered into a Knowledge Transfer Partnership (KTP) with YASA motors. YASA are the creators of a revolutionary electric motor which first made an appearance in the Morgan LIFECar. SEI have helped to prepare it for mass production, to a market predicted to be worth £15bn by 2020. By the end of the KTP production time had been reduced from seven days to two. Material use had been reduced, the defect rate was down ten-fold and the cost of a key component was reduced from £95 to £10.

SEI are currently engaging in a second KTP with YASA to address the challenge of motor cooling. Previously an oil coolant was used but in the high-speed applications the amount of generated heat was still limiting the output power. YASA aim to find a solution which will cool the motor more efficiently as well as reducing the amount of material and the cost of ownership.

SUSTAINABLE VEHICLE ENGINEERING AND E-MOBILITY

SEI has undertaken pioneering research in electric vehicles and e-mobility, since 2009. The research in these areas has been as a result of prestigious projects, consultancy work and public engagement.

As BMW's academic partner in the £6m TSB-supported, (Technology Strategy Board), MINI E project the group was able to engage in cross-university research to approach not only the technical issues behind electric vehicles but also to understand the social and psychological aspects of e-mobility.

Professor **Allan Hutchinson** of SEI was recently appointed to the board of directors of the Low Carbon Vehicle Partnership (LowCVP). Established in 2003 LowCVP is a public-private partnership with the mission to accelerate a sustainable shift to low carbon vehicles and fuels in the UK.

Professor Hutchinson believes that: *"We should have a direct opportunity to put forward thinking and findings into the partnership's activities, benefit from information generated by LowCVP very quickly, and link with potential research partners directly."*

MINI E car developed as part of a project with BMW

PUBLIC TRANSPORT INNOVATION AND ENGAGEMENT

SEI is one of seven partners in the EU REPUTE project (Renewable Public Transport Enterprise). The aim is to promote innovation and engagement in the efficient use of energy in public transport by means of information provision, enterprise stimulation, and policy change recommendations.

The Oxford Transport Laboratory is led by Preston Racing and comprises of the University of Oxford, Oxford Brookes University, Oxford City Council and Zeta Group. The output of this work will be a feasibility study to provide a viable and costed roadmap to an integrated transport system within the constraints of the historic Oxford city centre. This work is to coincide with a major redevelopment of the city centre.

Brookes Bus uses Gyrodrive technology

CLOSED-LOOP, RECYCLABLE, LOW CARBON VEHICLES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A 4-year EPSRC major programme of research involving nine universities will aim to lay down solid scientific and technological foundations for future low carbon vehicle development. The project called TARF-LCV (Towards Affordable, Closed-Loop, Recyclable Future Low Carbon Vehicle Structures) will focus on the strategic areas of advanced materials, low carbon manufacturing technologies, holistic mass-optimised vehicle structure design and closed-loop recycling.

SEI's role in this project is to further research in areas of advanced disassembly technologies for bonded structures, structure/joint design concepts and the life cycle analysis of new materials, processes and manufacturing routes.

IMPROVING BATTERIES FOR ELECTRIC VEHICLES

To make electric vehicles appealing to the average customer, their range and lifetime need to be improved. In order to achieve this, improvements to the energy density and lifetime of Li-ion batteries are crucial. Current Li-ion batteries have relatively high energy density, *ie* 150 Wh/kg, but they still require further development to enhance this and the service life on both an individual cell and battery level.

Electric car charging in Amsterdam

To achieve these goals the MARS-EV FP7 project will focus on the development and sustainable scaled-up synthesis of high-energy electrode materials (250 Wh/kg at the cell level) and safe electrolyte systems for Li-ion cells. Another aspect of the MARS-EV involves improving the cycle of life of the cells (>3,000 cycles). This will be achieved via the use of new and modified cell materials, prototype cell testing and modelling to help improve the understanding of the ageing behaviour at the electrode and system levels.

Development of an optimised recycling system and construction of a full life cycle assessment (LCA) of the developed technology is being undertaken by SEI researchers at Oxford Brookes University. The results of the MARS-EV will be fed back into the development phases to ensure the new Li-ion battery designs will provide a superior product which is cost-effective and sustainable.

BROOKES COLLABORATES WITH DALLARA ON NEW ELECTRIC RACING SERIES

Image courtesy of Dallara

In January 2014, Oxford Brookes University announced a dynamic and ground-breaking collaboration between the University and Dallara, world-leading race car manufacturer. SEI staff and students on the Motorsports Engineering MSc programme are developing a production, entry-level electric race car with Dallara as well as playing a major role in specifying the regulations for the formula and how the race will be run.

AIRCHARGE - INNOVATIVE PRODUCT FOR THE 21ST CENTURY


Aircharge: Look, no cables!

SEI engineering academics have teamed up with CMS - a local SME in a Knowledge Transfer Partnership (KTP) - that has resulted in both a step change in the company's design capabilities and real world application of the University's knowledge and research; the outcome, a two-year project in engineering design that is reaping spectacular rewards. Added in the mix is KTP Associate, Glen Le Faou, the talent recruited by the partnership as a product designer. Guided and supervised by Dr Shpend Gerguri and Dr James Broughton he has established the design function at CMS while working on its products.

"Seeing Aircharge through from conception to a new brand and product range has been an insightful and rewarding experience, particularly as I want to help create products that people can use in day-to-day life. It has taught me about the process of harmonising technology, ergonomics and manufacturing methods cost effectively to make something worthwhile." ***Glen Le Faou***

For CMS, Brookes brought fresh thinking and support that generated the confidence to expand into a new market and develop a product unlike others in its portfolio.

Sales Director **Barry Grant** commented: *"Finding Glen has proved to be one of the most invigorating moments in our 24-year history. With backing of Oxford Brookes we had a great deal of confidence in the high-level design input from the experienced individuals behind him. He and the KTP have given us benefits over and above our expectations."*

GROWING OUR OWN BIKES

Dr Shpend Geguri and Dr James Broughton with the Bamboo Bike they developed

Dr Shpend Gerguri and Dr James Broughton, along with undergraduate and postgraduate engineering students developed a bicycle frame made from bamboo and bonded with flax fibre.

The bike frame is made with bamboo tubes and advanced joining technology using flax fibre that exploits the specific strength and stiffness of bamboo (taking its own weight into consideration the strength and stiffness of bamboo can be superior to that of steel and aluminium).

"Bamboo is one of the most sustainable materials on the planet. It is extremely fast growing, requires very little water for growth and can absorb up to five times more CO2 and release 35% more oxygen than other equivalents." ***Shpend Gerguri***

The bamboo is held together by a flax fibre developed with the Joining Technology Research Centre at Oxford Brookes. The flax fibre supports the frame whilst a patent-pending bonded joining technology enables the strength and stiffness of the bamboo to be fully utilised. The bicycle is built to a high specification, and after 18 months in development has now been certified to European standards and has gone into production by RAW Bamboo Bikes.


Dr James Broughton testing the Bamboo Bike on an eight-day 640km TransAlp Challenge race

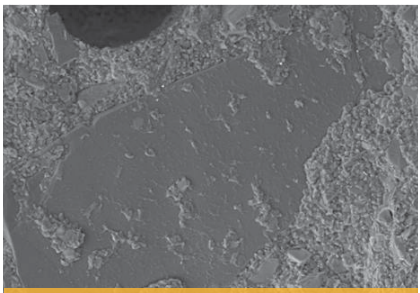

Close up of the Bamboo Bike and flax joining technology

CARBON AND GRAPHITE MATERIALS

SEI research into materials and process performance is broad and covers a range from integrated management systems to fracture mechanics and fundamental structure-property relationships of porous engineering materials, particularly carbon materials and the generation of heavily oxidised graphites in service. At present the main thrust of work remains the effectiveness of UK gas-cooled nuclear reactor core designs, particularly materials performance and the functionality of core components to support life extension using various modelling and analytical techniques.

SEI member Gareth Neighbour is currently the longest serving chair of the UK's Graphite Core Committee: *"The committee seeks to peer review the science and engineering used to underwrite the safety and thus operational aspects of the civil nuclear fleet. With each reactor resulting in income in excess of £1m per day, and with 16 AGRs, the impact is significant."* ***Gareth Neighbour***

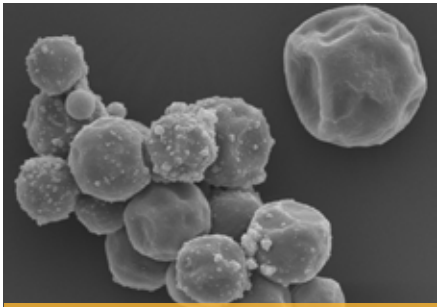
ORGANOSILANE TREATMENT OF BORON CARBIDE



STEM Micrograph of the PMC failure surface, showing enhanced adhesion to BC particle.

Extensive research within SEI has been undertaken on the surface modification of different materials to develop new polymeric matrix composites (PMC). Recently, high boron carbide (BC) content PMC was obtained through a modified moulding process. The BC PMC exhibited improved strength and durability providing lower cost parts whilst accommodating increased complexity of geometry and size for radiation shielding applications in the nuclear industry and satellite technology.

DISBOND ON DEMAND



STEM Micrograph illustrating a mixture of grafted and non-grafted TEMs

SEI has been investigating novel ways to enable structural adhesives to disbond on demand, since 2008. Two approaches being investigated currently include the addition of either thermally expandable microspheres (TEM) or chemical foaming agents (CFA).

The former of these approaches has focused upon incorporating a range of TEM grades into a commercially available adhesive matrix. Experimental work is now exploring surface initiated atom transfer radical polymerisation (SI-ATRP) to improve the TEM/resin matrix compatibility, which if successful should enhance the adhesive's in-service performance.

Cover images, clockwise from top left: close up of the bamboo bike with Dr James Broughton and Dr Shpend Gerguri; Brookes Bus with Gyrodrive technology; materials and processes composite; building in which SEI is located; electric car charging in Amsterdam; STEM micrograph.

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