The Energy Materials Group is an interdisciplinary special interest group of the Institute of Materials, Minerals and Mining.
EMG Newsletter Lead

With challenges arising from global warming mounting worldwide it is encouraging to see that there are many initiatives in place to meet this green challenge. Some of these have been considered recently in a specific issue of the Physics World Focus devoted to Energy Technologies. These illustrate some of the ways that industrial and applied research are addressing challenges for renewable energy generation, distribution and transportation. It is recognised that within these areas there are many materials challenges that need new and innovative solutions. Some of this work is undertaken under the umbrella of the Faraday Institution which is the UK’s virtual national laboratory for energy storage science and technology. Workers within this framework are addressing a range of issues including energy storage for vehicles. In this context lithium-ion battery development requires many technology inputs and there is potential that these will evolve into what is referred to as ‘the solid state battery’. Such a battery should be lighter in weight and more efficient in operation and charging than currently available. To achieve this requires a step change in materials selection and understanding to provide new electrode chemistries and architectures that have higher energy densities together with electrolytes that can deliver the necessary high electrical conductivity. In general the electrolyte in most of these batteries is a liquid allowing space between the electrodes to be filled and thereby providing as much contact as possible. A porous membrane is introduced to prevent finger-like growths of lithium that short circuit the battery. By introducing a solid alternative, some limitations would be removed. An example of a new method being explored comprises a nano-porous oxide mixed with ionic compounds and additives combined with a lithium salt. When linked with standard electrodes of LiFePO₄ (cathode) and Li₄Ti₅O₁₂ (anode) an experimental cell has shown a capability of being charged to 80% capacity within an hour. There are many such examples where materials science is offering a major impact in delivering these new technologies.

However we must not forget the need remains to operate coal fired plants worldwide and it is necessary to decrease release of pollutants such as SO₂, NOx, Hg and of course CO₂. For the latter a one percent increase in plant efficiency for an 800 MW system would yield just under a 3% reduction in emissions. This is equivalent to a reduction in CO₂ emissions from such a plant over the service life of nearly five million tonnes. To achieve this, a major challenge is to increase the operating temperature of the steam cycle which requires suitable materials. Research and development is ongoing in the USA, Japan and Europe to develop materials suitable for higher temperature operation. For example fine-grained 347 HFG and Super304 H steels have been developed for boilers operating in the temperature range 650 to 700°C. Of course the UK has sought to remove such coal fired plant and replace with nuclear and renewable power. However it is clear that within the worldwide energy mix, to meet the green challenge, there remain many broader materials demands.

May I take this opportunity of wishing you all a happy and prosperous new year.

Prof Peter Flewitt
EMG Committee Vice Chairman
Energy Materials Information Streams

The EMG microsite is a mine of information relating to Energy Materials with links to various sources of information, including funding sources for collaborative research/development.

The EMG microsite is actively managed and regularly updated; the link to the appropriate location on the microsite is given below


Editor’s Note:
Sorry there was no December edition, unfortunately work priorities over took my time so missed the allocated slot for putting to bed, so this edition is a combined Dec/Jan issue. May I take this opportunity to wish you a prosperous and happy 2019.

Front Cover

So have you decided what the picture on the front cover is? It’s a pollen grain believed to be from the Flame lily. The grain, circa 1mm in length, has a highly sculptured outer wall (exine), which may assist in their dispersal by improving their adherence to pollinating insects. Each pollen grain contains a male gamete (reproductive cell) that is intended to fertilise an egg or ovule (female gamete), and initiate the formation of a seed for a new plant.

Materials at High Temperatures, Issue 1, Volume 36, 2019

- Modification of the reactive synthesis of porous FeAl with addition of Si
- Stress and crack propagation in the surface layer of carburized stable austenitic alloys during cooling
- Rejuvenation of the microstructure and mechanical properties of a service-exposed IN939 superalloy by heat treatments
- Research on hardness variation for P92 notched specimen creep experiment
- Effect of TiC and NbC carbides on creep life of stainless steels
- High temperature tensile properties of 316LN stainless steel investigated using automated ball indentation technique
- High temperature deformation of IN718 superalloy: use of basic creep modelling in the study of nickel and single-phase Ni-based superalloys
- Microstructural evolution analysis of grains and tensile properties of tin bronze in hot extrusion at different temperatures
- An improvement in creep strength of thermo-mechanical treated modified 9Cr-1Mo steel weld joint
- High temperature oxidation of Fe–Ni-base alloy HR120 and Ni-base alloy HAYNES 282 in steam
The Faraday Institution, FI, founded in October 2017 is the UK’s independent institute for electrochemical energy storage science and technology, supporting research, training, and analysis. FI is a new, virtual research institute comprising a headquarters at the Harwell Science and Innovation Campus, to co-ordinate a series of research projects carried out in UK universities to accelerate fundamental science and its translation directly related to batteries; namely to reduce battery cost, weight, and volume; to improve performance and reliability; and to develop whole-life strategies from mining to recycling to second use.

The Faraday Institution’s seven founding partner universities are University of Cambridge, Imperial College London, University College London, Newcastle University, University of Oxford, University of Southampton and University of Warwick. Their aim is to bring together scientists, industry partners, and government funding with a common goal to reduce battery cost, weight, and volume; to improve performance and reliability; to develop scalable designs; to improve our manufacturing; to develop whole-life strategies from mining to recycling to second use; and to accelerate commercialisation.

Currently four main research strands include

- **Battery Degradation.** Led by the University of Cambridge with eight other university and 10 industry partners, this project is examining how environmental and internal battery stresses (such as high temperatures, charging and discharging rates) damage electric vehicle (EV) batteries over time.

- **Multi-Scale Modelling.** Imperial College London (ICL) is leading a consortium of seven other universities and 17 industry partners to equip industry and academia with new software tools to understand and predict battery performance, by connecting understanding of battery materials at the atomic level all the way up to an assembled battery pack.

- **Recycling and Reuse.** A project led by the University of Birmingham, including seven other academic institutions and 14 industrial partners, is determining the ways in which spent lithium batteries can be recycled. With the aim to recycle 100% of the battery, the project is looking at how to reuse the batteries and their materials, to make better use of global resources.

- **Next Generation Solid State Batteries.** The University of Oxford is leading an effort with six other university partners and nine industrial partners to break down the barriers that are preventing the progression to market of solid-state batteries, which should be lighter and safer, meaning cost savings and less reliance on cooling systems.

FI aims to sponsor a national curriculum in energy storage science and provide technology education opportunities to invigorate regional and national workforce development. This will provide new models of education and training for skilled workers while creating new and expanded employment.

For more information on the activities of FI please visit [https://faraday.ac.uk/](https://faraday.ac.uk/)
Editor’s Titbits Section

An electric bicycle from General Motors

General Motors has unveiled a new electric bike brand it says will offer revolutionary and flexible electrification technologies. The company has already announced two innovative, integrated and connected eBikes – one folding and one compact – that are designed to provide a low carbon alternative to cars for commuting purposes. The bikes use a small battery-powered electric motor to assist in pedalling, enabling easy riding up hills and over flat terrain.

London and Edinburgh to trial self-driving buses and taxis

London and Edinburgh are to be the first cities to experience self-driving vehicle services in the UK by 2021. The government has announced three public trials, which will include an autonomous bus service on a 14-mile route across the Forth Bridge from Fife to Edinburgh and self-driving taxi services in London. They will assess technical performance as well as explore how driverless technology can seamlessly integrate into society, with the findings applied to the development for future autonomous service models.

- Project CAV Forth. Five single-decker buses will be converted into autonomous vehicles, providing a service capable of carrying up to 42 passengers across the Forth Bridge to Edinburgh Park Train and Tram interchange.
- Project Apollo. Addison Lee, which is leading the project, is working to develop and deploy four autonomous taxi pilot services in Greenwich, London.
- ServCity. A mobility service based in London will be developed using six autonomous Land Rover Discovery vehicles. Led by Jaguar Land Rover (JLR) a consortium will test and further develop existing JLR sensing and autonomy systems in Coventry and the Midlands before deploying a pilot of a premium mobility service across four Greater London boroughs. The project will also develop analytical models to understand and demonstrate the wider positive impacts of connected and autonomous vehicles on cities – from reduced air pollution to easing congestion.

Cement is responsible for 8% of global emissions

Cement is the source of around 8% of the world’s carbon dioxide emissions, according to a new report from Chatham House, which shows that if the cement industry were a country, it would be the third largest emitter in the world, following China and the US – it contributes more carbon dioxide to the atmosphere than the aviation sector (2.5%) and nearly as much as the agricultural industry (12%).

Editor’s Note: The source of many of these titbits is Energy Live News.
Could air pollution be causing childhood obesity?

Exposing children to nitrogen dioxide air pollution from vehicles in the early stages of their life could increase the risk of them becoming obese. The new research led by a team from the University of Southern California and published in the Environmental Health journal, studied 2,318 children across the region to see whether there was a link.

It appears that children living on or near busy main roads in the first year of their life were almost a kilogramme heavier by the age of 10 than those with low exposure. The scientists were not able to examine how the harmful chemicals increased weight gain in the children but said inflammation of the brain could have caused anxiety-induced overeating and changes in fat metabolism. A recent report suggested spending a long weekend in some of Europe's famous cities could have the same health impacts as smoking up to four cigarettes.

Capacity Market suspension

The European Court of Justice has suspended the UK’s Capacity Market scheme. Clean technology company Tempus Energy had brought forward a legal challenge, arguing the scheme gave an unfair advantage to fossil fuel generators over demand side response (DSR) technologies. The government said the decision “poses no issues for our security of supply” and it is working closely with the European Commission so the scheme can be reinstated “as soon as possible”.

Under the Capacity Market scheme, generators are offered financial incentives for ensuring power plants are kept on standby and are ready to provide emergency back-up electricity when demand is at its peak. The Capacity Market will now enter a “standstill period”, preventing the government from holding any capacity auctions, making any capacity payments under existing agreements or undertaking any other action which could be seen as granting state aid until it has been approved again.

National Grid, which administers the scheme, said it is still able to continue with activities which do not involve granted state aid, including completing the prequalification process for 2019, in case it is required for future Capacity Market auctions. The Commission is required to undertake a formal investigation before providing approval for state aid under the scheme and as part of the process, BEIS will consider if any changes to the design of the Capacity Market are required.
Editor’s Titbits Section

Are organic groceries damaging the environment?

A new international study involving the Chalmers University of Technology in Sweden seems to suggest so – it says the greater land-use required by organic farming compared to conventional techniques leads to higher carbon dioxide emissions. As a result of organic yields per hectare being much lower because fertilisers are not used, to produce the same amount of food, a much larger area of land is needed. In turn, this requires more deforestation to clear space for fields – as trees are cut down, carbon stored in forests is released as carbon dioxide. Many biofuels are also harmful as they are made up of wheat, sugar cane and corn. Researchers suggest conscientious consumers should not simply switch to buying non-organic food but instead shift dietary choices, claiming organic beans or organic chicken are much better for the climate than conventionally produced beef. The study shows that organic peas, farmed in Sweden, have around a 50% bigger climate impact than conventionally farmed peas and for winter wheat the difference is closer to 70%.

Climate change is causing more storms – but could trees adapt?

Ecologists at the Baruch Institute of Coastal Ecology and Forest Science in South Carolina have conducted tests following Hurricane Maria hitting Puerto Rico last year which shows some trees are able to heal from hurricane damage by growing replacement leaves optimised for greater efficiency.

The storm stripped trees of their leaves, leaving them unable to absorb the light needed for photosynthesis – however, many were seen to compensate for this by creating new leaves able to generate increased amounts of resources. The scientists’ findings suggest 11 of 13 species studied were taking in carbon dioxide at much higher rates immediately following the storm, with many also improving the shape and structure of their leaves in order to capture the same amount of light while using a smaller number of leaves.

Robotic ants to clean solar panels

Osoji Solar has created a fleet of robots to clean dust off solar panels. It says the devices work together ‘like a colony of ants’ to solve the problem of reduced solar efficiency as a result of layers of dirt blocking sunlight.

The firm suggests most of the world’s ideal environments for solar generation are in places like deserts and are often accompanied by an extremely dusty environment – when dust settles on panels it can reduce efficiency by 50%. Its robots can clean without depleting valuable resources such as water and have been designed to function without human input, meaning people don’t need to work in hostile environments.
Editor’s Titbits Section

Solar and wind keep getting cheaper

Solar and wind are now the cheapest new sources of generation in all major economies, except Japan. That’s according to Bloomberg New Energy Finance’s (BNEF) Levelised Cost of Electricity (LCOE) analysis for the second half of 2018, which assesses the cost competitiveness of various generation and energy storage technologies. It shows wind and solar have taken the lead even in countries such as China and India, where until relatively recently, coal was the predominant energy source. BNEF claims in India, these forms of renewable capacity are now available at half the cost of building new coal plants.

The organisation says that China’s utility-scale solar market domestic demand has contracted by around 33% resulting in a “global wave” of cheaper equipment, driving the benchmark LCOE of new solar down to $60/MWh (£46.8), more than a tenth lower than during the first half of 2018. The cost for onshore wind is around $52/MWh (£40.5), down 6% from the first half of the year, as turbines become more affordable and the US dollar strengthens. The report suggests higher interest rates in China and the US in the past two years have put upward pressure on financing costs for solar and wind energy, although this has been more than offset by the price of equipment falling. The cost of batteries is expected to fall by approximately a third before 2030, which BNEF predicts will lower the cost of peak power and flexible capacity to levels cheaper than any conventional fossil-fuel peaking plants in history.

Global coal generation on steep decline

That’s the verdict from environmental think-tank Carbon Tracker, which has published a new report suggesting 42% of the world’s operating coal fleets are already unprofitable due to high fuel costs.

The statistics cover around 95% (1,900GW) of global operating capacity and 90% (220GW) of capacity being built – the predictions assume fuel costs will fall by more than a tenth after 2018 and only include existing climate and air pollution policies, meaning they are likely to prove conservative estimates. Carbon Tracker claims 35% of existing coal capacity already costs more to run than building new renewable infrastructure, potentially increasing to 96% by 2030. The think-tank believes renewables will be cheaper than coal in all markets by 2025 and warns coal owners that they could avoid $267 billion (£211bn) in stranded assets by phasing-out the fossil fuel resource sooner rather than later.

If you’re interested in EMG activities and/or interested in joining the EMG committee please Contact: Prof Stuart Irvine, s.j.c.irvine@swansea.ac.uk

Items Relating to Newsletter Contact: Dr Peter Barnard, peter.barnard@doosan.com
Upcoming Events

**NEXT COMMITTEE MEETINGS**
11:00 6 February, IOM3, 297 Euston Road

**EMG WORKSHOPS/CONFERENCES**
Parsons 2019, 16–18 September 2019, Cranfield University, UK

**OTHER WORKSHOPS/CONFERENCES/COURSES OF INTEREST**
High Temperature Materials Degradation Workshop 2019, 29 Jan 2019, Grantham, UK
Hume-Rothery Seminar, Computational Materials Chemistry, 12–13 Feb 2019, Derby, UK
Gordon Conference, Nanomaterials for Applications in Energy Technology, 24 Feb–1 March 2019, Ventura, USA
1st EPERC International Conference, 1-3 April 2019, Rome, IT
PVSAT 15 Photovoltaic Science, Applications and Technology Conference, 10-12 April 2019, Warwick, UK
29th Journées des Actinides, 14-18 April 2019, Erice, IT
2019 MRS Spring Meeting, 22-26 April 2019, Phoenix, Arizona, USA
Baltica XI - International Conference on Life Management and Maintenance for Power Plants, 11-13 June 2019, Baltic Sea, FI/SE
CCT2019 The International Conference on Clean Coal Technologies, 3-7 June 2019, Houston, USA
NECEM International Conference on Energy Materials & Interfaces, 29 July–1 Aug 2019 Newcastle, UK
Environmental Degradation of Materials in Nuclear Power Systems - Water Reactors, 8-22 Aug 2019, Boston, USA
24th International Conference on Advanced Materials and Nanotechnology, 19 – 20 Sept 2019, Brussels, BE
ECCC2020, 14–16 Sept 2020, Edinburgh, UK