Front Cover Image – Compression Test Specimen

A scanning electron image of a micro-pillar compression sample prepared using ion beam milling. Gallium ion beam milling can be performed on most materials, so when you need mechanical property information at the micro-metre length-scale this technique is one of the main ways of specimen manufacture.
EMG newsletter lead

Materials Making a Difference

To meet the challenges of climate change within the United Kingdom there is an increasingly diverse approach being supported by Government. Hence there are a variety of initiatives in the areas of electrical power generation, distribution, storage and usage, the latter includes the drive to increase use of electric vehicles. Each has specific material challenges. The field of nuclear power generation certainly remains high on the agenda, both fission and fusion.

Each year there is a Nuclear Academics meeting which was held during September this year at the University of Bangor. Several messages emerged to support this view. Here just two are selected.

The first is that the UK has formally joined the Generation IV International Forum (GIF). This is an international collaboration to develop and demonstrate advanced fission nuclear energy systems. This international collaboration Forum has an objective to support and undertake research and development needed to establish the feasibility and performance capabilities for next generation systems; certainly post the current designs such as Hinkley C power station. Professor James Marrow of the Department of Materials, Oxford University, is the UK representative. Within the considerations and material challenges is a drive to higher temperatures to achieve greater efficiency and links to the hydrogen economy.

www.world-nuclear-news.org/Articles/UK-joins-Generation-IV-International-Forum

In addition, the National Nuclear User Facility (NNUF), which is part of the Governments nuclear industry strategy, has been provided with further funding to develop the UK infrastructure. Via this route EPSRC are funding an initiative to evaluate the need for a National archive of long-term neutron irradiated materials of high pedigree currently in store at many locations around the country. The UKAEA, the University of Bristol and the National Nuclear Laboratory made a submission for a detailed options study that has been funded. This provides the opportunity to consult a wide range of stakeholders. The output will be a report in March 2021 with recommendations for consideration by EPSRC, the NNUF Management team and owners of the materials. A decision will then be made on whether to proceed with one of the options.

The work will establish what suitable samples are available and which are of interest to UK researchers now, and in the future. NNL will lead discussions with owners and consider issues such as ownership, liability, conditions of use, transport and eventual disposal. However, an essential task is consultation with the academic community. To do this staff at the University of Bristol will run a series of workshops around the country. NNL and the UKAEA will produce costed concept designs for archive stores. The options for an archive will be considered and how they would work in practice addressing advantages and disadvantages. Certainly this offers the opportunity to retain unique neutron irradiated material, steels and other metals and alloys, ceramics and concretes, for future researchers.

Professor Peter Flewitt

Vice Chair EMG
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


Materials Today Energy, Volume 12, Issue June, 2019

- Asymmetric supercapacitors: An alternative to activated carbon negative electrodes based on earth abundant elements
- Polysulfide diffusion controlled, non-shrinkable, porous, PAN/PES electrospun membrane for high energy Li-S battery application
- Hierarchically nanostructured ZnCo$_2$O$_4$ particles in 3D graphene networks for high-rate and long-life lithium ion batteries
- Metal–organic framework derived porous hollow ternary sulfide as robust anode material for sodium ion batteries
- Nitrogen-doped braided-looking mesoporous carbonaceous nanotubes as an advanced oxygen reduction electrocatalyst
- Electronic structure and transport properties of TlInSe$_2$ and Tl$_{0.5}$Li$_{0.5}$InSe$_2$
- Ultralow thermal conductivity and low charge carrier scattering potential in Zn$_{1-x}$Cd$_x$Sb solid solutions for thermoelectric application
- Incorporation of gold nanocages into electrospun nanofibers for efficient water evaporation through photothermal heating
- Interfacial electronic properties of ferroelectric nanocomposites for energy storage application
- Synergistic catalysis in monodispersed transition metal oxide nanoparticles anchored on amorphous carbon for excellent low-temperature dehydrogenation of magnesium hydride
- Using easily prepared carbon nanodots to improve hole transport capacity of perovskite solar cells
- Safe and green Li-ion batteries based on LiFePO$_4$ and Li$_4$Ti$_5$O$_12$ sprayed as aqueous slurries with xanthan gum as common binder
- Amorphous nickel boride membrane coated PdCuCo dendrites as high-efficiency catalyst for oxygen reduction and methanol oxidation reaction
- Defining the composition and electronic structure of large-scale and single-crystalline like Cs$_2$AgBiBr$_6$ films fabricated by capillary-assisted dip-coating method
- High performance hybrid supercapacitor based on doped zucchini-derived carbon dots and graphene
Organisation Profile

Birmingham Energy Institute

The Birmingham Energy Institute, BEI, is the focal point for the University and its national partners, to create change in the way we deliver, consume and think about energy. The Institute harnesses expertise from the fundamental sciences and engineering through to business and economics to deliver co-ordinated research, education and the development of global partnerships. By creating technology and guiding policy today, we aim to help shape energy solutions tomorrow.

BEI is based around 4 nationally recognised centres of excellence, Energy Storage, Nuclear Education and Research, Strategic Elements and Critical Materials and Fuel Cell and Hydrogen Research.

The Birmingham Centre for Energy Storage consists of two components: the Birmingham Centre for Cryogenic Energy Storage and the Birmingham Centre for Thermal Energy Storage; both of which draw on capacity in materials, thermodynamic processes, application development, smart grid and policy economics.

The Birmingham Centre for Nuclear Education and Research was launched in 2010 and is making a significant new investment in the area of Nuclear Engineering, Waste Management and Decommissioning. This is timed to support the UK’s investment in new construction in the Nuclear Power sector, the need to manage the legacy waste, the decommissioning of the current generation power stations and the tremendous challenges in developing the next generation nuclear facilities. The demand for highly skilled graduates and postgraduates is set to rise, which will be met by increasing provision at both levels.

Experts within the Centre for Strategic Elements & Critical Materials are working on the development of new recycling processes to enable the recovery of critical materials from end of life products, mining wastes and even road dust. We are looking at ways to re-use components containing strategic and critical elements, and developing new processing techniques to use these materials more efficiently. An important focus of the centre is also on the substitution of either the technology or the critical elements contained within a wide range of products.

The Birmingham Centre for Fuel Cell and Hydrogen Research was formed in early 2000 for Doctoral Training in Hydrogen, Fuel Cells and their Applications. The Centre is nationally and internationally recognised for its expertise in fuel cell technologies and continues to develop sustainable solutions to the designing of future cities, energy and transportation.

Cross Centre cutting technologies include “the cold economy” where effective cooling is essential to preserve food and medicine. It underpins industry and economic growth, is key to sustainable urbanisation but is energy intensive. Research in this area explores the technology and the societal, business and financial models needed to deliver sustainable cooling for all. Also “transport systems” because the transport sector is one of the world’s largest consumers of energy and at present is heavily reliant on fossil fuels. Engineering and environmental scientists are researching alternative energy sources and optimising efficiency whilst investigating the resilience of the UK transport network to climate change.

For more information on the activities of BEI please visit

https://www.birmingham.ac.uk/research/energy/index.aspx
Editor's Titbits Section

Final turbine installed at ‘world's largest’ offshore wind farm

Work on what is claimed will be the largest offshore wind farm in the world is nearing completion with the installation of the final turbine. Developer Ørsted said each 7MW Siemens Gamesa turbine at the Hornsea One offshore wind farm, located in Yorkshire, will be able to power a UK home for more than a day with a single rotation.

The blades are 75 metres long and handcrafted in Hull, with each set of three picked for the closest match in characteristics to avoid any being out of balance. A total of 174 turbines have now been installed and once completed, the wind farm will be able to generate enough electricity to power more than a million homes in the UK.

Located around 120km off the coast, it is said to be the furthest offshore wind farm every built from the shore. The last turbine being installed is only nine months after the first one was erected is just one small part of this record-breaking project.

Urban trees are good for air conditioning

Planting more trees in urban areas could cool surrounding areas and slash energy consumption from air conditioning. That’s according to new research released by the Forestry Commission, which says green spaces and plants within towns and cities can significantly reduce air temperatures – its data shows areas with lots of vegetation were up to 4°C cooler than areas in the same city without any trees.

The researchers found air conditioning usage could be reduced by up to 13% in some cities, saving £22 million a year on energy and significantly reducing related emissions. The cooling is largely a result of evapotranspiration, which is the process of water evaporating from leaves through plant transpiration during photosynthesis – larger trees with greater leaf areas, dense foliage and high transpiration rates have the best cooling properties.

Along with the University of Reading, researchers found the London Plane Tree, the Sessile Oak and the Cherry Tree were some of the best types in London for cooling the air. The report notes: “In light of climate change, the need for cooling by trees and green spaces is expected to increase even in temperate climates such as that of the UK”. Infrastructure planning and development should embrace green space design and tree placement that facilitate such cooling, as well as include tree species with high cooling ability and ensure they are provided with enough space and resource to grow and function.

Record low price for offshore wind in clean energy auction

The UK's offshore wind industry has smashed price records for delivering electricity in the government's latest Contracts for Difference (CfD) auction. Around 6GW of clean energy projects have been awarded contracts, with offshore wind projects set to be delivered for as low as £39.65/MWh – around 30% lower than the second auction held in 2017.

BEIS says it is the first time renewables are expected to come online below market prices and without additional subsidy on energy bills. CfDs are 15-year contracts, under which a `strike
price’ is agreed with developers before projects are built. If the wholesale electricity price falls below the agreed price when the projects are operational, the government pays the difference.

The 12 chosen projects are expected to generate enough green electricity to power around seven million homes in the UK and create around 8,000 jobs. They include six offshore wind farms, four remote island onshore wind farms and two advanced conversion technologies, i.e. converting waste which would otherwise go to landfill into energy. The results follow a £250 million sector deal with the offshore wind industry signed earlier this year and committing to sourcing up to a third of electricity from the renewable energy source by 2030. Energy and

According to BEIS, the UK has the largest installed capacity of offshore wind in the world, with around 8GW installed at the end of 2018. The figure is expected to rise to 10GW by next year and even further as more projects start contributing power to the grid into the 2020s.

**Study finds tea bags shed billions of microplastic particles**

One plastic tea bag can release billions of particles of microplastics, according to new research. Researchers from Canada’s McGill University found a single plastic tea bag at brewing temperature could release around 11.6 billion microplastic and 3.1 billion nanoplastic particles into a cup. Using electron microscopy, they found the levels of microplastic and nanoplastic particles were “thousands of times higher” than those reported previously in other foods.

**NASA unveils experimental all-electric aircraft**

NASA has unveiled an experimental all-electric aircraft, called the X-57 Maxwell. The new plane has arrived at the space agency’s Armstrong Flight Research Center in California – it was delivered by prime contractor Empirical Systems Aerospace (ESAero). The plane is the first of three configurations in the development pipeline and is known as Modification II. It takes the form of an altered Tecnam P2006T, with the original aircraft’s combustion engines having been replaced with electric cruise motors. NASA engineers say they will now begin putting the aircraft through ground testing, which will be followed by taxi tests and flight tests in the future.

The project ultimately aims to help develop certification standards for emerging electric aircraft markets, including urban air mobility vehicles or ‘flying cars’. NASA plans to share its findings from the design and testing process with regulators and industry to help develop the sector.

**Solid Oxide Fuel Cells Could Cut Emissions from Shipping by 45%**

Fuel cell firm Bloom Energy and shipbuilder Samsung Heavy Industries (SHI) have announced a partnership to design and develop ships powered by solid oxide fuel cell technology. Solid oxide fuel cells generate power through an electrochemical reaction, using natural gas, biogas or hydrogen as fuel – however, no combustion takes place, slashing the amount of emissions produced. The companies say the innovation will play a key role in helping to reach the 50% emissions reduction target that the International Maritime Organization (IMO) has called for all shipbuilders to achieve by 2050, compared to 2008 levels. The marine transport industry currently produces between 2% and 3% of global carbon dioxide emissions and if it was a country, would be the sixth largest global producer of greenhouse gases. Bloom Energy and SHI estimate replacing oil-based power generation with electrochemical conversion of liquid natural gas through fuel cells could reduce annual greenhouse gas emissions from shipping by as much as 45%. They note the equipment can be deployed in increments as small as 200
kilowatts, allowing power sources to be distributed in separate areas throughout a ship to optimise usage of space.

(Source: Energy Sector Update Report 30/09/19)

**Seaweed plaguing Mexico’s beaches ‘could provide energy opportunity’**

Seaweed plaguing Mexico’s beaches could provide a clean energy opportunity. That’s according to University of Exeter scientists, who say Sargassum seaweed can be turned into biofuel and high-quality, low-cost fertiliser through a process called hydrothermal liquefaction.

The fuel produced could be used to power the liquefaction process, with any excess fuel able to be sold. The seaweed blooms, which are said to be caused by farming fertilisers washing into the sea, blight beaches and harm tourism and fisheries. The plan to collect and process the seaweed is among the Exeter projects boosted today by a £615,572 grant from UK Research and Innovation (UKRI).

**The launch of the UK’s first large-scale cryogenic energy storage plant**

Highview Power has announced it is to launch the long-duration 'liquid air' energy storage plant located at a decommissioned thermal power station in the North of England. The 50MW facility can play an important role in helping the UK achieve its goal of decarbonising the industrial, power, heat and transport sectors. The business is also developing a wider portfolio of projects in the UK and says it is currently in the process of securing sites.

The technology could enable an immediate shift from thermal and nuclear power to renewables – it uses low temperature liquids such as liquid air or liquid nitrogen to store surplus power by using electricity to freeze them. When power is needed the liquids are then rapidly heated back into a gas, expanding and turning a turbine.

Grid operators are turning to long duration energy storage to help improve power generation economics, balance the grid and increase reliability – unlike several other forms of energy storage, cryogenic storage can hold weeks’ worth of power at a time.

**As its Xmas how about biodegradable seaweed-encased whisky shot capsules**

Whisky-maker Glenlivet has partnered with sustainable packaging startup Notpla to create biodegradable and edible capsules of Scotch whisky. The so-called “Capsule Collection,” which debuted last month, is composed of a material, also called Notpla, that is a combination of seaweed and other plants. Together with Glenlivet, Notpla filled the capsules with 23 mL, roughly a shot’s worth, of whisky. Each of the three reserves citrus, wood and spice can be consumed entirely or punctured to reach the whisky contained inside. If discarded, the tablet will biodegrade in an estimated four to six weeks, leaving behind no sign of waste.

(Source: marie.donlon@ieeeglobalspec.com, Oct 10th 2019 Engineering 360 website)

Editor’s Note: Unless mentioned the source of many of these titbits is *Energy Live News.*
Mini Feature

ECO FLETTNER Rotary Wind sail

After a 100-year pause, wind, an inexhaustible but somewhat unpredictable natural energy form, has grabbed the attention of ship designers again as a potential auxiliary energy source. Wind-assisted propulsion is permissible under existing international regulations, including SOLAS. The most mature wind propulsion technology currently available for commercial shipping is the Flettner or rotor sail, a tall, rotating cylinder which takes advantage of the so-called Magnus effect in the presence of side wind to produce additional thrust forward.

At the end of June 2018, the 4,250-tonne coaster Fehn Pollux left the port of Leer, Germany, for the first sea trial of its newly installed ECO FLETTNER rotor sail. It was the culmination point of a long-term joint project involving several partners from the shipping industry, the University of Applied Sciences Emden/Leer and DNV GL. The MariGreen project is supported by the EU’s Interreg programme for the German–Dutch border region, and coordinated by MARIKO, with the Dutch industry association FME as a co-partner.

The ECO FLETTNER developed for Fehn Pollux is 18 metres tall and 3 metres in diameter, it rotates around a stationary mast with bearings at two critical heights. It has many innovative design features, such as lightweight materials, high-performance bearings and the ability to rotate at high speeds.

During the first six months of operation the ECO FLETTNER withstood all kinds of stress tests in heavy weather, showing no weaknesses. Fehn Pollux has been able to fully perform her commercial activities without any limitations or delays. As an added benefit, the gyroscopic forces resulting from the spinning rotor sail reduce the ship’s rolling action significantly.

The rotor sail can be controlled manually or automatically in response to sensor readings. The crew can choose to utilize the extra thrust generated by the sail to reduce engine power and fuel consumption, or to increase the ship’s speed. For example, at Beaufort force 7, the crew found that the rotor sail boosted the cruising speed by 2 knots. The unit also passed its first storm test with flying colours: an inspection following exposure to wind speeds around Beaufort 9 revealed no damage. According to the applicable rules the system must be designed to be safe under all environmental and operational conditions the vessel may experience.
During a scheduled port stay in Rotterdam, dynamic balancing to minimize vibration and bearing wear was undertaken by attaching balancing weights along the entire length of the rotor based on a proprietary method developed by design engineer Siegfried Lais, achieving a rotor balance improvement of 50 per cent, expressed in terms of vibration amplitudes.

After the six months of operation, enough operational data was available to draw some key conclusions regarding the effectiveness of the rotor sail. All performance data exceed the predictions made by the Emden/Leer University based on wind tunnel measurements and calculations by a wide margin: at Beaufort 4 to 5, the rotor sail is 20 per cent more effective than calculated; at Beaufort 7.5 to 8, its efficiency is as much as 40 per cent better than predicted. In medium wind conditions the unit produces the equivalent of 2 kilowatts of propulsion power per square metre of projected area (H × D) on average per day in addition to the main engine output.

Savings in the range of 10–20% can be expected, depending on the speed of the ship and main engine performance. The vessel’s rotor sail has a projected area of 54 square metres. Multiplied by 2 kilowatts, the ship saves an annual average of 108 kW at sea beyond its main engine output, equivalent to a 15 per cent saving in energy and emissions for the ship’s 650 kW main engine (Eco speed). This applies to medium wind conditions. In good wind conditions, such as on trade wind routes, the rotor sail produces 2.5 kilowatts per square metre of surface area, and in very good wind conditions the yield exceeds 3 kilowatts.

The German schooner Buckau was the world’s first ship equipped with a Flettner or rotor sail. The trials were technically successful but for decades cheap fossil fuels and the absence of environmental concerns made the technology unattractive to shipowners. Now the tide has changed, and advanced technology further enhances the efficiency of rotor sails.
NEXT COMMITTEE MEETINGS
11:00 Feb 2020, IOM3, 297 Euston Rd, London
11:00 July 2020, location TBA

EMG SPONSORED WORKSHOPS/CONFERENCES
PVSAT - 16, 15–17 Apr, 2020, Salford, UK
ECC2020, 14–16 Sept, 2020, Edinburgh, UK

OTHER WORKSHOPS/CONFERENCES/COURSES OF INTEREST
Novel Materials and Engineering Solutions for High Temperature Power Generation Plant, 23 Jan, 2020, Bristol, UK
Int. Conference on Energy, Materials and Sustainability, 13 – 14 Feb, 2020, Dubai, UE
International Conference on Energy, Materials and Systems, 23 – 24 Mar, 2020, Tokyo, JP
Tackling Low Temperature Superalloy Degradation, Spring, 2020, Rotherham, UK
Structural Integrity Developments for a Competitive UK Nuclear Industry, 30 April, 2020, Cambridge, UK
ICEMR 2020 International Conference on Energy Materials and Research, 04 – 05 May, 2020, Rome, Italy
36th World Congress on Materials Science and Nanotechnology, 13-14 May, 2020, Tokyo, JP
International Conference and Exhibition on Advanced Energy Materials, 21 – 22 May, 2020, Athens, GR
The 11TH THERMEC'2020 International Conference, 31 May–5 Jun, 2020, Vienna, AU