ISSUE 80 • WINTER 2016

THE JOURNAL FOR SCIENCE, ENGINEERING AND TECHNOLOGY

advances WALES

Preventing climate-changing carbon loss from mangroves

How research from Welsh scientists indicates the release of dangerous amounts of greenhouse gases from mangrove swamps could be stopped

Llywodraeth Cymru
Welsh Government

THE JOURNAL FOR SCIENCE, ENGINEERING AND TECHNOLOGY

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Contents & Editorial

"Innovation distinguishes between a leader and a follower."

Steve Jobs

Through innovative science, research and engineering, Wales is developing world-leading technologies.

Wales' scientists are working to create a better, more sustainable future with research into preventing the loss of greenhouse gases from damaged mangroves (page 18) and removing environmental toxins with date seeds (page 20). A Welsh team has become the first to study on the ground how climate change has affected Antarctica's Larsen C ice shelf (pages 6-7).

The steel industry contributes significantly to the Welsh economy and is also a key part of the innovation landscape. The Active Classroom demonstrates how a high steel content building can help reduce carbon through generating its own energy (page 4) and Swansea University has developed a new environmentally friendly coating to inhibit corrosion in steel (page 10).

Welsh engineers are also developing an app to tackle the global food waste epidemic (page 14) and an agricultural device to encourage hydroponic growing of plants, which is a more efficient, eco-friendly alternative to traditional soil farming (pages 12-13).

As well as these environmental innovations, this edition covers the growth and new developments in the North Wales photonics industry (page 11) and space sector (page 8). Other cutting-edge technologies featured include a system that detects leaks in water network pipes (page 15) and a tool that mines the internet for data using artificial intelligence (page 17).

Advances Wales is also available online, where you can find previous editions that feature key developments in research and innovation from Wales.

Sophie Davies
Editor

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Advances Wales is a high-quality, quarterly 'transfer of technology' journal produced by Welsh Government to showcase new developments in science, engineering and technology from Wales. Devoted to concise reports and commentary, it provides a broad overview of the current technology research and development scene in Wales. Advances raises the profile of the technologies and expertise available from Wales in order to facilitate collaborative relationships between organisations and individuals interested in new technologies and innovation.

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MATERIALS	FOOD	ELECTRONICS	PHYSICS
AGRICULTURE	ENGINEERING	COMMUNICATIONS	CHEMISTRY
ENVIRONMENT	MANUFACTURING	INFORMATION TECHNOLOGY	MEDICINE
ENERGY	EARTH SCIENCES	OPTO-ELECTRONICS	BIOTECHNOLOGY

PHOTOGRAPHY Sourced from organisations featured, their representatives, and istock.

Wild mango could be answer to cocoa crisis

Researchers at Bangor University have identified wild mango butter as a new, high-quality alternative to cocoa butter.

Cocoa butter (the pure butter extracted from cocoa beans) is the only commercial available natural fat that is rich in saturated and monounsaturated fatty acids. It is in high demand from the food, pharmaceutical and cosmetic industries and serves as a particularly vital ingredient in the production of chocolate.

Demand for cocoa is predicted to rise 30% by 2020, yet global production of cocoa is in decline due to a combination of factors. These include crop failure, disease and ageing plantations, leading to price fluctuations and a shortfall in supply.

The industry is seeking a viable cocoa butter alternative and Bangor University researchers may have found it. Wild mango is an underutilised fruit species from south-east Asia which is not farmed in any formal sense. Studies have now shown that wild mango butter, made from the fruit's stone, has a very similar chemical, physical and thermal profile to cocoa butter as well as several superior properties.

For instance wild mango butter has a higher solid triglyceride content, which means it can be used to improve soft cocoa butters and make a temperature resistant hard chocolate. It also has a higher moisture content than cocoa butter and there is growing evidence that more moist butters produce low-fat chocolate.

Wild mango is under threat in its native Bangladesh due to habitat loss and deforestation, but a lack of research into its value means that no conservation efforts have been made. It is hoped that this new research will convince the food industry that the wild mango is worth saving.

"Wild mango is one of the so-called 'Cinderella' species whose real potential is unrealised. The identification of real added value as we have shown in this study could pluck it from obscurity into mainstream production."

Sayma Akhter
PhD Researcher, Bangor University

www.bangor.ac.uk

CO_2 emissions drop for Sainsbury's delivery vehicles

Perpetual V2G Systems are helping Sainsbury's supermarkets to drop CO_2 emissions from click & collect with an innovative fuel and carbon reduction system.

The Lampeter-based company's Lithium Power Supply, which featured in Advances Issue 74, is currently cutting hundreds of thousands of pounds in fuel costs and over a million kilograms of CO_2 in Sainsbury's Online Home Delivery Vehicles.

Drivers of food delivery vehicles often keep their engines running when stopped, so that the refrigeration stays on and the food does not spoil. However, a running idle van will typically burn two litres of diesel per hour and emit around four tonnes of CO_2 annually.

With Perpetual V2G's technology in place, the driver can turn the engine off as soon as the vehicle is stationary and immediately the battery system kicks in to power the on-board refrigeration. This means that food remains chilled and frozen to meet the customer's requirements.

The simple, non-intrusive system harnesses otherwise lost electrical energy from the vehicle's standard alternator and stores it inside a small, powerful lithium ion battery. Once the vehicle has stopped, either to deliver goods or replenish its load, the battery allows the refrigeration unit to be powered for six hours at a consistent temperature.

This 'start stop' system is providing increased fuel economy and vital CO_2 reductions for the automotive industry.

www.perpetualv2g.com

Energy positive classroom is switched on

Built by Swansea University's SPECIFIC Innovation and Knowledge Centre, the Active Classroom generates, stores and releases its own solar energy.

Electricity is generated by a steel roof with solar cells integrated into the panels, supplied by Flintshire-based BIPVco. The roof is connected to two saltwater batteries and can store 40 kWh – enough energy to power the building for at least two days.

The building also generates solar heat energy through its perforated steel cladding. Warm air is drawn in through tiny holes in the steel using a fan, so during winter warm air can be drawn in at peak hours to help heat the building. A novel electric underfloor heating system powered by the sun provides the primary source of heat inside the classroom.

In addition to its use of solar energy, the classroom has been built without plasterboard or concrete, steel screw piles have been used instead of traditional foundations and there is a 'living wall' of plants – all of which reduces the carbon footprint.

The team plans to develop an app which will enable teachers to control the classroom, programming in the number of students due to be there each day, so the classroom will be at an ideal temperature when they arrive. It provides teaching space and a laboratory for Swansea University students, as well as a building-scale development facility for SPECIFIC and its industry partners.

www.specific.eu.com

IN BRIEF

Work begins on Menai Science Park

Construction company Willmott Dixon has been appointed to build Wales' first dedicated science park. The £20 million Menai Science Park (M-SParc) development, which is the brainchild of Bangor University, will be located on the outskirts of Gaerwen in Anglesey. M-SParc will focus on the low carbon and renewable energy sectors, and aims to bring economic, scientific and technological benefits to North Wales. It will help deepen hi-tech business and scientific research partnerships in the region, as well as creating a bridge between innovative companies and Bangor University. Construction of the park is expected to be complete in 2017/18.

Zip World boosts Welsh economy

The adventure sports company behind Europe's longest zipwire has attracted £121 million to the Welsh economy since opening its first attraction three years ago. New research from North Wales Tourism has found that in this time, Zip World has brought thousands of new visitors to the region and also created 218 jobs. It currently has three adventure sites in North Wales, with more activities due to open next year as part of a £5.5 million investment. Sean Taylor, a founder of Zip World, said: "We approached North Wales Tourism to carry out the research because we wanted to quantify exactly what we have brought to the economy of North Wales. The figures are pretty amazing – and a lot more than we anticipated. The research will allow us to plan for the future."

Award for health tech collaboration

The ADEPT project - a collaboration involving engineering/scientific technology company Renishaw, design consultancy/research centre PDR and Abertawe Bro Morgannwg University Health Board - has won the Health and Wellbeing category at The Engineer's national Collaborate to Innovate Awards. The project is about enabling the widespread use of 3D printing to produce bespoke, patient-specific maxillofacial (jaw and face) implants. It stood out among the other nominees because of its ability to revolutionise the way design and 3D printing are used in bespoke implant production by creating a new software product, which increases the level of automation in implant design.

US investment for life sciences firm

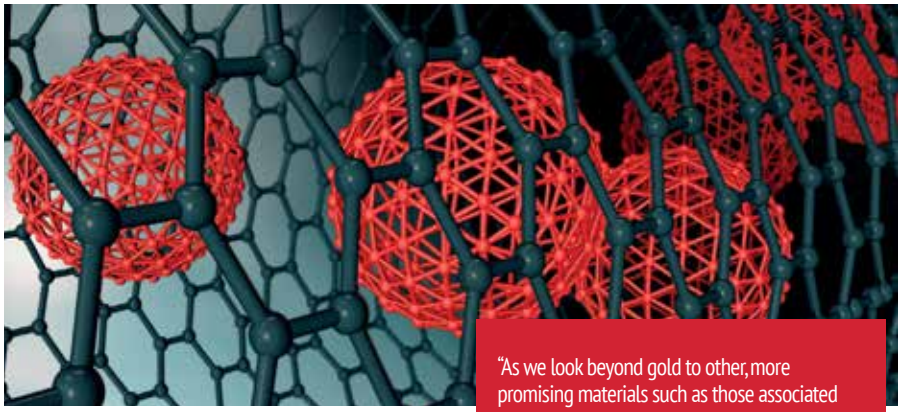
Cardiff-based TrakCel has received a multi-million dollar investment from San Francisco private equity firm Telegraph Hill Partners to support global growth activities and enhancement of its technology platform. This follows a series of significant new contract wins in the US and the opening of a new TrakCel office in Newport Beach, California. Matt Mackowski, Chairman of Telegraph Hill Partners, said: "Bringing decades of expertise in pharmaceutical supply chain and information technologies, TrakCel's team is in the process of scaling up the most advanced cell therapy management system in the field." The company's technology efficiently records, tracks and reports all aspects of the cell therapy supply chain from patient registration and collection of cells, through logistics, storage, processing of the cells in manufacturing and delivery back to the cell donor.

Cyber security academy launched

The University of South Wales has launched a project to help address the shortage of cyber security skills and develop the next generation of cyber security experts. The pilot National Cyber Security Academy, which is the first of its kind in Wales and a major UK initiative, took its first students in October. By 2019 it is forecast that an additional 4.5 million personnel will be needed worldwide to deal with cyber security issues and the academy will work to close this expected skills gap. Industry partners are involved, so that new challenges in the cyber security environment can be identified and inform the syllabus.

Improved catalysis method discovered

Research by scientists at Cardiff University's Catalysis Institute has discovered a more cost-effective, efficient way to produce a promising new catalyst.



Since its discovery in 2004, 'wonder material' graphene has been of interest to researchers all over the world due to its remarkable properties. This has led to the exploration of graphene-related materials in the field of catalysis, which involves developing materials to speed up chemical reactions with a long-term aim of making products cheaper, cleaner and more efficient.

Scientists have now found a better way of producing graphitic oxide, which is used in reactions to produce epoxide – a widely used material in electronics, cosmetics, pharmaceuticals and more.

Graphitic oxides are commonly prepared using the Hummers method, but the new research shows that a less conventional method, known as the Hofmann method, actually leads to improved catalysis.

This research is part of a wider project building on the success of research into gold catalysis by the Catalysis Institute, which featured in Advances Issue 73, and aims at replacing gold catalysts with cheaper and more sustainable alternatives.

"As we look beyond gold to other, more promising materials such as those associated with graphene, this paper is a significant first step along that path."

Professor Graham Hutchings
Director
Cardiff Catalysis Institute

www.cardiff.ac.uk

Cardiff Innovation Campus approved

The latest phase of Cardiff University's £300m Innovation Campus has been approved by city planners. Two new buildings will bring together researchers, businesses, public sector backers and students to unlock ideas that drive economic growth. The Innovation Campus will host a range of facilities including: The Institute for Compound Semiconductors, a translational research centre in compound semiconductors; Cardiff Catalysis Institute, with a state-of-the-art catalysis facility to support research in chemical sciences; SPARK, the world's first social science research park where academics work with private, public and third sectors to design and test solutions to societal problems; and The Innovation Centre, a creative base for start-ups working in partnership with clinical innovation incubator the Medicentre.

AerFin wins award for fast growth

Following growth of over 1000 per cent between 2013 and 2015, generating over £17 million of additional turnover, AerFin was named the fastest growing business in Wales at the Fast Growth 50 Awards 2016. The Caerphilly-based company is a market-leading civil aviation parts distributor and lessor, supplying quality used aircraft parts to the global aviation market. It does this through innovative supply chain solutions, aimed at reducing airline maintenance and operational costs. The company's fast growth can be attributed to recruitment of high quality aviation professionals, excellent staff retention levels and significant financial support and investment. AerFin currently sells 60 per cent of its business internationally and aims to achieve further global growth in the future.

30 years of Techniquest

Cardiff Bay's popular attraction Techniquest has just celebrated its 30th birthday. The science and technology discovery centre has welcomed five million visitors since it opened in 1986 and engages with thousands of children every year from schools across Wales. In its anniversary year, Techniquest received a visit from astronaut Tim Peake and secured funding from the UK Space Agency to develop a school and family programme related to space. The centre also recently hosted a party for corporate guests who heard from Virgin Galactic's commercial director Stephen Attenborough and collaborated with food artist Nathan Wyburn to make a unique portrait of Einstein from Smarties. The venue's plans for the future include extending opening hours, appealing to an even wider audience and being hired for more business events and private functions.

Welsh contribution to new rugby head guard

Cardiff-based Thread Design, which specialises in materials and textiles, has been working on an innovative rugby head guard with the aim of preventing concussion and medical issues arising from collisions. The design consultancy was approached by Contego Sports to develop a head guard using newly tested material layering technology, which is able to reduce the energy transferred to a rugby player's head during impact - one of the main factors in sports-induced brain injuries. Thread Design worked to make the head guard slimmer, lighter, simpler and cheaper to manufacture using their technical expertise and knowledge of materials. Prototypes were made in their studio and they created five sizes from small child to large adult. The N-Pro head guard is the first piece of head gear for rugby players that has been built within the European Union's legal framework for medical devices and the next step is more rigorous testing before it can be widely used.

CastAlum achievement award

Welshpool-based CastAlum, a supplier of aluminium diecast parts for the global automotive and truck industries, has been awarded Company of the Year at the annual Cast Metals Industry Awards Dinner. They won based on their move from five to six day working, investment in new equipment and in staff training, growth in manpower and sales and improvement of quality and uptime through technical developments. The company's production is 80 per cent for export, with its components going into vehicles around the world produced by some of the biggest automotive manufacturers. Today, one in ten vehicles produced in Europe has a steering gear housing manufactured by CastAlum.

Welsh team make Antarctic discovery

Fieldwork led by an Aberystwyth University academic has made an important breakthrough in understanding the effects of climate change on ice shelves

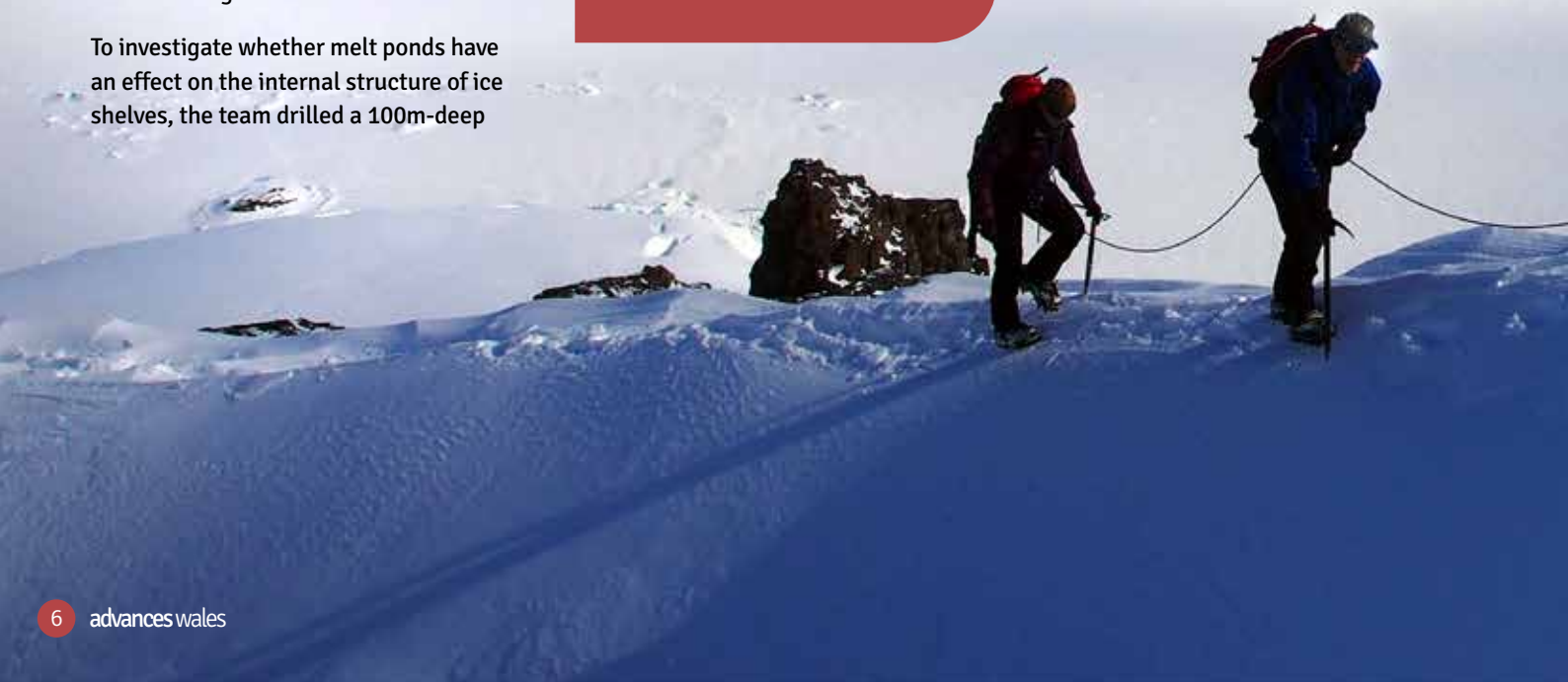
The team went on a drilling expedition to one of the largest ice shelves in Antarctica known as Larsen C – a floating mass of ice with a surface area around two and a half times the size of Wales. After establishing a base on the shelf, where there were sub-zero temperatures and inhospitable conditions to overcome, the team carried out research over several months.

The Antarctic Peninsula is warming faster than many other places on Earth. Warm air, descending from the mountains as föhn winds, is causing the surface of the ice to melt, forming surface pools of water known as melt ponds. These melt ponds are thought to have contributed to the collapse of ice shelves including Larsen A and B in 1995 and 2002 respectively. The Welsh team started work on Larsen C after satellite images showed melt ponds forming regularly on the surface, becoming the first scientists to study them on the ground.

To investigate whether melt ponds have an effect on the internal structure of ice shelves, the team drilled a 100m-deep borehole into Larsen C and were surprised to strike a layer of solid ice after only 3m. It has long been thought that solid ice in such structures forms about 50-60 metres down, but the team's findings proved otherwise.

> "I think it's fair to say that we were all surprised when we hit the ice so quickly as it completely contradicted our previous conceptions of how ice forms within the shelf. We believe that climate change has played a role in this due to the particularly strong warming this part of Antarctica has experienced in recent decades."
>
> **Professor Bryn Hubbard**
> **Leader of the expedition (which is part of a wider project involving Aberystwyth and Swansea Universities)**

The icy layer was found to be warmer than the compacted snow it had replaced, due to the heat released when the filtering meltwater refreezes at depth. The team discovered temperatures of between -5 and -10°C, which was 10C above what



they had expected. As warm ice flows more readily than cold ice, the layer inside Larsen C could be speeding up ice flow to the ocean. Conversely the refrozen pond ice may be more resistant to fracturing, strengthening the shelf. The next phase of the project, which is based on computer modelling, aims to disentangle these effects.

This research into the formation of melt ponds and their impact on the internal structure of ice shelves has provided new and improved physical boundary conditions for computer-based models of ice shelf flow and fracture. The borehole drilling work demonstrated that the Larsen C ice shelf is internally denser and warmer than was thought before. Pre-existing computer models can now be revised with this new density and temperature data, resulting in their predictions for ice shelf flow and stability becoming more accurate.

The results of the expedition further suggest that the melt ponds on Larsen C are a relatively recent phenomenon. They have formed just over the last few decades because of climate change, despite extensive surface melting quite possibly for centuries.

For his work on Larsen C and more of the world's icy expanses, Professor Hubbard has been awarded the Polar Medal, joining the ranks of Captain Robert F Scott, Sir Edmund Hillary and Sir Ernest Shackleton.

Profile

Product
Ice shelf analysis

Applications
Exploring the effects of climate change on ice shelves

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Lift-off for North Wales space industry

The OpTIC Centre, the science and technology centre managed by Glyndŵr Innovations in St Asaph, has received grant funding to attract the space sector to its facilities

Companies succeeding in industries such as engineering, solar power, manufacturing, software engineering, electronic or mechanical systems, design or manufacture have the potential to work with the space sector but are not always aware of it.

The UK Space Agency has awarded £50,000 to the OpTIC Centre, which recently celebrated its tenth anniversary, so that it can nurture firms wanting to enter the UK space industry. It will act as an incubator, providing high-quality facilities, business and technical support, networking and knowledge transfer events. The initiative is part of the UK's ambition to achieve a 10% share of the global space market by 2030.

One tenant already achieving success in the space industry is CSER – Swansea University's Centre for Solar Energy Research.

> "North Wales has the potential to make a significant contribution to our thriving space sector. There are opportunities for a range of companies developing innovative products that can match the needs of the space industry."
>
> **Colin Baldwin**
> **UK Space Gateway Programme Manager**
> **UK Space Agency**

In Advances Issue 72, we featured the technology behind their innovative Thin Film Solar Cell, designed to meet emerging demands of new space applications such as space-based power and solar electric propulsion.

This cell is now orbiting the earth as part of the AlSat Nano CubeSat mission – a joint nanosatellite mission between the UK Space Agency and the Algerian Space Agency. The mission marks the world's first satellite mission of a thin film solar cell on space-qualified cover glass, as well as the world's first performance data obtained from this type of solar cell in space.

It measures the non-linear current-voltage response of four experimental thin film solar cells in orbit when under illumination by the Sun. It also measures the ambient temperature and sends all data to the AlSat Nano's on-board computer. As the satellite passes within range of the ground station in Oran, Algeria, the on-board computer's data is downloaded and then distributed to the various end users including the North Wales team.

The team will be able, over a series of measurements, to build up a picture of the solar cell's performance in space and its robustness to the space environment. By demonstrating the technology in space, the team aims to put thin film solar material on the map as a key power source for emerging large area solar array space applications. The successful launch, deployment and measurement of the cell's payload will inform the team's next mission, in which the cell's lightweight and flexible nature on cover glass will be demonstrated.

Profile

Product
Innovative products for the space industry

Applications
Meet the new and emerging needs of the space sector

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Brain stimulation help for moods

Swansea University brain scientists are developing a new technique to reduce the impact of stress on mood and help improve emotional wellbeing

Stressful situations can lead to irritability, agitation and moodiness. When we face stressful events, the frontal regions of our brains are particularly active and constantly appraise the positive or negative emotions that are generated, shaping how we react to situations. Over time the negative impact of stressors build up, which can compromise our physical and emotional wellbeing.

Dr Frederic Boy, an Associate Professor in Translational Neuroscience within Swansea University's School of Management, and his team of fellow academics Sian Roderick and Simon Newstead, have conducted research into whether it is possible to reduce the impact of stress on people who are not already suffering from clinical depression.

Their method involves employing weak electrical impulses to stimulate the frontal cortex by placing electrodes in precise locations on the top of the head. The stimulation is subtle and only lasts for a short period of time. It has been described as feeling like a weaker version of a TENS machine, which is commonly used to deliver pain relief for people suffering from sports injuries, arthritis and during pregnancy.

Past studies have shown that this method of brain stimulation can relieve depression, but the new research from Swansea University now provides the first evidence that it is capable of boosting the mood of a healthy person.

The research team has now studied hundreds of healthy young women with no history of psychiatric disorders or substance dependence. The volunteers filled in questionnaires and clinical scales to help assess different aspects of their current mood, before undergoing a course of short brain electrical stimulation sessions for several consecutive days. In all experiments, control groups received an ineffective but realistic placebo stimulation.

Over the duration of the research, the women who had received the real, active stimulation gradually reported experiencing less negative mood states. On the other hand, participants in the placebo group did not report any noticeable changes in mood.

The team envisions the development of an over-the-counter device delivering this treatment for bad moods and stress at home, which would empower people to take responsibility for their own emotional health and wellbeing. It could serve as a viable alternative to prescribed medication such as antidepressants.

Dr Boy added: "We are hopeful this research can assist in the treatment of mood without having to resort to medication. As well as the possible side effects that medication can have on the patient, prescribing drugs in the first instance is a huge drain on the NHS."

One of the leading causes of clinical depression is the gradual buildup of day-to-day negative emotions, so this treatment even has the potential to prevent the onset of depression in the first place.

Dr Boy and his team are also planning further research into whether this form of brain stimulation could provide relief in clinical conditions such as chronic pain or migraine and a new joint venture between Swansea University, University College London and the NHS has just been incorporated. They will explore how the electrical stimulation can be targeted to specific areas of the brain.

ARCH (A Regional Collaboration for Health), in which Swansea University is a partner, hopes that the new research could lead to creation of a complementary therapy with the potential to relieve pressure on GPs, reduce the cost of prescribing drugs and support people to take responsibility for their own health, wellness and wellbeing.

> "Advances in transcranial electrical stimulation techniques mean we are able to investigate different people and specific areas of the human brain to see how those regions regulate people's behaviour. It is clear that the way people behave results from a complex interaction between a number of genetic, social and environmental factors."
>
> **Dr Frederic Boy**
> **Associate Professor**
> **Swansea University's School of Management**

Profile

Product
Brain stimulation device

Applications
Reducing the impact of stress

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Steel gets anti-corrosive boost

Researchers from Swansea University's College of Engineering have made a breakthrough in preventing rust and corrosion in steel

Corrosion inhibitors are used to coat and protect steel in a wide range of sectors, including automotive, aerospace and construction. However, the steel industry's most widely used corrosion inhibitor, hexavalent chromate, is set to be banned across the EU from 2019.

Hexavalent chromate is an acknowledged carcinogen, which means it is a concern both for the environment and for human health. Chronic exposure has been linked to lung cancer. As such there is an urgent need to identify new corrosion inhibitive technologies showing equivalent, if not better protective capability.

Swansea University doctorate student Patrick Dodds has discovered a material and manufacturing process for a smart release coating, which outperforms hexavalent chromate in laboratory tests. The method involves a stored reservoir of corrosion inhibitor that is released on demand when activated. It works by channelling aggressive electrolyte anions into the coating, triggering the release of the inhibitor and thereby preventing corrosion.

The new technology has been tested with salt spray, the standard test for corrosion. The research team used a specially built scanning Kelvin probe, which detects the state of the metal beneath a coating without touching it. This allowed the team to test different products more quickly than usual, with each test taking around 24 hours, rather than 500 hours as was previously required.

Results of the tests show that by using the new smart release coating, the onset of corrosion can be prevented for over 24 hours, compared to less than two hours in the case of hexavalent chromate - the current market leader. They also demonstrate that the rate of corrosion can be slowed down significantly once the process has started.

For their work, the team was awarded the Armourers and Brasiers Venture Prize and their prize money will be used to buy a Jet Mill system - a tool needed to overcome the last technical barriers on the way to making the product available on the market. The system will help them to achieve the fine uniform particle size (5µm) that commercial grade inhibitors require.

The market for coated steel is worth £3 billion per year in Europe alone, and this newly developed corrosion inhibitor has the potential to take a significant slice of this market as hexavalent chromate is phased out.

"This is a significant breakthrough, showing a smarter and safer way of reducing corrosion. The new product is environmentally sound, economical and outperforms the market leader in laboratory tests."

Professor Geraint Williams
College of Engineering
Swansea University

Profile

Product
New corrosion inhibitive technology

Applications
Preventing rust and corrosion in steel

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Photonics innovation on the rise in North Wales

Five companies are set to develop innovative technologies after winning the North Wales photonics Launchpad competition

The Launchpad programme, funded by Innovate UK, aims to stimulate the hotspot of photonics, electro-optics and opto-electronics businesses in North Wales. The goal is to draw investment and people into the area, and to encourage networking and collaboration to strengthen the cluster.

The competition attracted entries from a range of small and early-stage companies in the areas of photonics, electro-optics and opto-electronics. Each of the five winning companies will receive up to 70% of their project costs as grant funding and will also have access to business support and expertise from partners.

ICAM Engineering is one of the more established companies among the winners. The Flintshire-based precision engineering company specialises in manufacturing bespoke mechanical equipment using both old and new techniques.

Their planned Launchpad project relates to MOCVD (Metal-Organic Chemical Vapour Deposition) - a complex process for growing crystalline layers, which is used in manufacturing LEDs, lasers, transistors, solar cells and other electronic and opto-electronic devices. Recently this production method has reached technological limitations, increasingly harming product profitability and hindering device progression.

Targeting the root cause of the issue, the company has developed concept hardware to work in conjunction with the MOCVD process that effectively resets the system between processes. By applying a novel innovative equipment and process to condition system components before every process, they have found that yield can be increased and material quality improved.

> "Our vision is to solve issues slowing solid state photonics progress, assist manufacturers to overcome current problems and become established in the solid state opto-industry, building a reputation for the North Wales cluster as a centre of excellence for manufacturing in this sector."
>
> **Ram Patel, Project Manager**
> **ICAM Engineering**

Denbighshire-based Zeeko's project lies in a key area of process optimisation. Polishing of precision surfaces such as lenses and mirrors requires a rubbing action, rather than cutting as with a grinding machine or lathe. Such surfaces are required for a huge range of modern products, including digital and phone cameras, LED lighting and advanced defence and space systems.

Modern computer-controlled polishing machines move a polishing tool over the surface of the component. The path is programmed to remove just the right amount of material at each place, to correct height-errors measured in the surface. This assumes that polishing is predictable, but in reality it falls well short of the ideal, meaning that several cycles of polish, measure, polish are needed to meet requirements. In order to improve overall predictability, the project proposes to measure key physical effects before and in real-time during the polishing process and also characterise the tooling itself.

> "The ultimate goal is to automate iterative surface-processing and metrology without human intervention, including decision-making before manufacture starts and between each process-step. This is highly adventurous and has huge potential to increase productivity and reduce wastage and manufacturing costs."
>
> **David Walker, Technical Director**
> **Zeeko**

The three other Launchpad competition winners are:

Camstech, which wants to improve the performance and reduce the cost of a Surface Plasmon Resonance instrument by developing a novel SPR sensor;

Mathcyf Cyf, which is creating a set of quantitative simulation tools to improve the processes used in polishing ultra-precision surfaces;

Compass Optics, which is developing instrumentation for the measurement of large optical surfaces that will make up the next generation of extremely large optical telescopes.

The Welsh photonics sector is made up of around 80 companies, with a strong innovation and manufacturing cluster in North Wales. The sector employs 5,000 people and steady ongoing growth of 8% per annum is expected as exports increase and Wales continues its take-up of photonic technologies. Businesses range from micro companies and SMEs to larger corporations and many have links to the automotive and space industries, which provide significant opportunities for market expansion and growth.

Profile

Product
New photonics, electro-optics and opto-electronics technologies

Applications
Bring more innovative products and services to the industry

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Accessible hydroponics in a sack

Cardiff-based Phytoponics want to bring hydroponics to the global agricultural mainstream by making it cheaper and easier to do

Hydroponics involves growing plants in a nutrient solution rather than in soil. This is possible because plants already take nutrients from soil as a solution, through capillary water networks, with hydroponics offering better supply.

Many advantages can be drawn from the use of hydroponics as an alternative to soil farming. First of all, it can be a more productive method of growing plants, offering 20 times the market returns of open field growing. It enables you to grow any plant in a greenhouse at any location and at any time, without being limited by climate or season. Food production is made possible all year round, aided in low light conditions with artificial lighting.

As hydroponically grown plants have their roots dipped directly into nutrient-rich solutions, they take up their food with very little effort, while plants grown in soil must use their energy to seek out nutrients and extract them. This means that hydroponically grown plants have no need for long root systems, so can devote more energy to leaf and stem growth. The result is they can grow larger and at a faster rate than soil grown plants.

Hydroponically grown plants require less extensive roots than in soil farming, so they can be grown closer together, which saves space with minimal competition for nutrients. In commercial agriculture, the use of hydroponics can result in ten times less land being needed to grow the same crop yield. Another environmental benefit of hydroponics is that it saves water. A lot of water is wasted in soil farming, as plants will only use a small percentage of what farmers pour into the soil. Hydroponic systems recycle water, so typically five times less is required overall, and very little water is lost during the whole process.

To further increase productivity in hydroponics, it is possible to control factors such as the strength and pH of the nutrient solution. This artificial environment can be adjusted and optimised to ensure that plants grow to yield as much produce as possible.

Plants grown indoors (or in a greenhouse) and without soil are less vulnerable to pests and diseases. Consequently fewer pesticides, which are toxic and a threat to the environment, are used in hydroponics than in traditional soil farming. With nutrient containment, fertiliser run-off is drastically reduced or even eliminated, helping sustainable agriculture reduce pollution.

Faster, better growth, increased control and reduced environmental impact are just some of the many reasons that hydroponics is being adapted around the world for commercial food production. However, a significant obstacle to overcome is all of the time and technologies needed to set up a hydroponic system.

Phytoponics has developed the Hydrosac in order to make hydroponic growing more accessible. As an inflatable sack made of recyclable, UV-resistant plastic, it can be mass-produced cheaply. It also takes just a few minutes to roll it out, inflate, connect and start growing. The system can scale to multiple sizes – a one-metre option that folds up to the size of a newspaper roll and a ten-metre long version that rolls up to the size of a beer keg for large farm installations. It is designed to be adaptable and can become longer or thicker to hold larger volumes of water for larger crops.

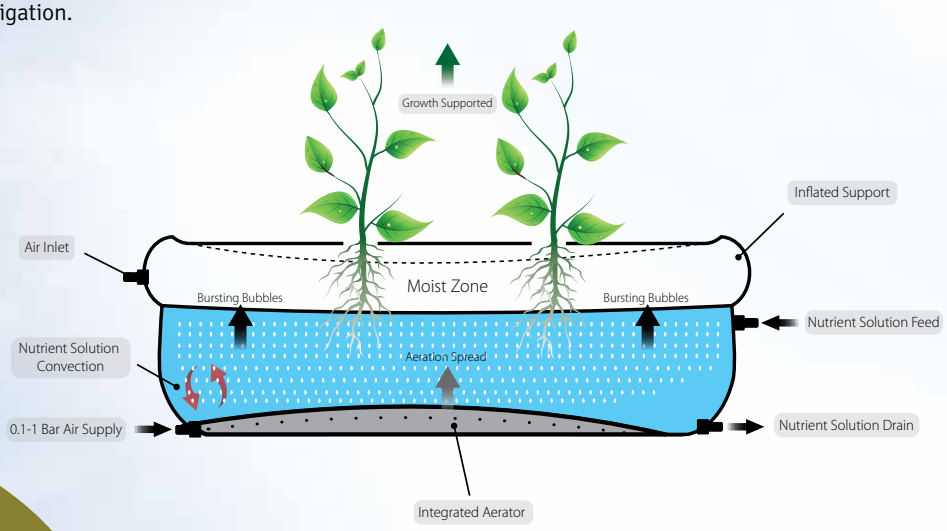
The platform offers several hydroponic growing methods and is capable of working horizontally, vertically or on a slope. The sack holds an internal water chamber with an integrated aerator inside. This means there is no need to worry about the placement of airstones or pipes. It is possible to connect the entire system to the air supply and aerate with a reliable spread. Adequate oxygenation is critical to plant root health, because without it plants respire anaerobically and generate ethylene, which can cause cell death and root rot.

Supporting the body of water are inflatable sections that hold a porous layer of netting above the water level. Plants enter through holes in the top and rest on the netting. Seeds can be planted from seed tape on the netting, for seed-to-crop growing with high germination rates. The aerator fed from a remote air compressor or pump maintains oxygen levels and encourages new plants and seeds to send their roots down. An oxygenated nutrient solution then feeds the plant roots entering deep into the water body. When the bubbles pop, a mist sprays upwards towards the bottom of the plant, creating a nourishing growth environment.

As water is contained inside the sack, the only points of evaporation are the small plant entry slits and the plant transpiration (evaporation of water from plant leaves) itself. The porous netting layer also adds a barrier to evaporation between the water body and the entry slits, minimising evaporation and resulting in a system 90% more water efficient than soil farming. When used in areas where there is drought or a general lack of water access, it can operate at different levels of fill, storing up to one week's worth of water to provide a buffer period until the next irrigation.

Through the creation of this device which is low-cost and easy to use, Phytoponics are aiming to accelerate the adoption of hydroponics in order to tackle issues such as food security, global warming, deforestation, water scarcity and land shortages. They hope to convert millions of farmers to hydroponics and bring a new era of more productive, sustainable agriculture. They also see potential for the Hydrosac in disaster relief, because a rolled up, rapid deployable farm could help people grow crucial food supplies in a short amount of time and in ruined, unfertile land.

Recently they have secured placement on Startupbootcamp's Foodtech accelerator in Rome, where they are installing a large multiple-polytunnel hydroponic system growing salad for a client and scaling up the business for international markets.



Profile

Product
Hydroponic growing device

Applications
Growing produce without any need for soil

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App eats into food waste problem

Engineers at Thaw Technology have developed an app to fight the food waste epidemic

It is estimated that £12.5 billion of avoidable household food waste is generated in the UK each year. We purchase too much food, which is then forgotten about and expires, leaving no other option than to throw it away. Many of us also prepare and cook too much food for meals, which then goes uneaten and ends up being discarded. This amounts to annual wastage of around £470 worth of food per UK household.

Wasting food doesn't just result in money lost. Food waste has a significant impact on the environment too. The energy that goes into the production, harvesting, transportation, packaging and storage of wasted food generates carbon dioxide – a greenhouse gas which contributes to climate change.

The 'Use By Mate' app has been designed to prevent food from being wasted, helping consumers to save money and reducing damage to the environment. It uses simple notifications to tackle the problem of people purchasing food and forgetting to use it before it expires. Once the consumer has the app on their smartphone, the food that they buy is logged at the point of purchase, along with the use-by dates. This data gets uploaded to servers and the app then sends the consumer reminders about their unused, soon to expire food.

The consumer also receives recipe suggestions from the app, based on items that it knows they already have in stock. This enables them to use up their expiring food without needing to do more shopping. Where appropriate, notifications to freeze food are given and the app assigns a new expiry date to these frozen items.

The issue of people cooking excess food is tackled by the app with built-in recipe planning and portion control tools. If the consumer supplies the app with their family demographic, it provides accurate portion measurements for recipes, so the correct amount of food can be bought and cooked. Hints and tips are provided by the app to aid re-use and correct storage methods, further reducing needless waste.

Analytics from the app educate consumers on how much food they are wasting, in order to make them more aware of their habits and motivate them to change their behaviour in the long term.

Thaw Technology is now working with Tesco and WRAP (the Waste and Resources Action Programme) to further develop the app. The aim is to integrate 'Use By Mate' into the supermarket's existing app, so that customers can benefit from it and the retailer itself can receive useful data. This data is similar to what retailers currently get through purchase loyalty schemes (for example Clubcard in the case of Tesco), but with an extra level of detail. They will be able to analyse information including how much food their customers really use and which combinations and recipes they like. This will allow for better pack sizing, linked promotions, targeted marketing and new product ranges.

A live trial for the app with Tesco is planned for later this year, and Thaw Technology are also hoping to use a similar app to combat medical and pharmaceutical waste in the future.

Profile

Product
Mobile app

Applications
Preventing avoidable household food waste

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Water network leak detection system goes on-screen

HWM's innovative system detects pipe leaks in water networks, allowing for time, money and water to be saved

The PermaNet+ system enables leakage teams to monitor water distribution networks from a number of different sensors that can be accessed through any internet device. It transmits leak data via low-cost GPRS or SMS telemetry, which is the same technology used by most mobile phones. This removes the requirement for expensive site visits and 'drive by' data retrieval.

The leak detection system sits underground, attached to network fittings, and automatically analyses sound presence on the pipeline. Unique algorithms are able to separate the consistent signature of a leak from the general noisy environment. The system also retrieves the 'Aqua log' detailed noise graphic, which can clearly indicate the presence of a leak. If the leak alarm is triggered, the operators are notified and they can listen to a transmitted audio file of the sound for confirmation.

The system works in conjunction with Google Map technology, providing a live on-screen tracking system that helps the operators to see where the leak is coming from. As they are able to pinpoint the location of the leak remotely, they can proceed straight there and avoid the time, expense and disruption of wide area surveys, which are particularly difficult in busy cities. The leakage team can respond immediately, inspect problem areas and bring them under control as quickly as possible.

As well as the ability to identify and localise leaks remotely, accurately and in a short of space of time, the system also gives operators the chance to view historical leak data. As a result, they can better identify trends, understand their network and plan improvements.

This technology has the potential to save the industry a huge amount of both money and water. It is able to detect even the smallest of leaks, preventing mass floods which are not only financially costly but also time-consuming to resolve. Long-term monitoring enables a reduction in both the frequency and impact of pollution events.

In early 2016, the technology was installed in the city of Copenhagen. Within just two weeks of the project beginning, the team identified a leak, monitored it and found it was causing water to run directly into a sewer. This quick discovery and analysis allowed damage and costs to be limited.

Profile

Product
Water pipe leak detection system

Applications
Identifying and localising leaks in water networks

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Bringing telephony into the digital world

Talkative's click-to-call technology allows customers to webcall companies through just one click on the company's website

As a customer, much of our contact with companies is now done through websites or apps, but to call a company, we still have to use a telephone. Everyone can relate to the frustration that comes from navigating an Interactive Voice Response system, being put through to the wrong person, having to repeat information and describe what you see on your screen, which the contact centre agent has no access to.

This common problem can be solved with website calling (or 'webcalling' via the internet rather than a telephone) which Talkative's technology enables. It brings real-time communication into websites, allowing voice and video webcalling between a website visitor and a contact centre agent.

The website visitor simply clicks a button and a voice call is initiated. In addition to this voice communication, webcalling also makes collaboration possible. Through co-browsing, the contact centre agent can view the customer's screen and guide them around the website, pointing them towards certain pages and helping them to fill in forms or work on documents.

The technology leverages a device's in-built microphones and speakers and can work through browsers and applications on desktops, tablets and smartphones. Webcalls can be free for the customer, as calls go over the internet as opposed to the PSTN (public switched telephone network).

Webcalling is still in its infancy, but presents a number of opportunities for the online sales and customer service industries. As well as no telephone being needed, the customer requires no additional downloads, plugins or separate applications for webcalling to work. It is also easy for companies to deploy webcalling and start offering it as a service.

Webcalls can integrate with existing telephony, so a contact centre agent is able to receive webcalls using the same phone from which they receive normal calls. This means that companies can also use their existing call recording, routing and reporting systems for webcalls. Transcoding, quality of service monitoring and media negotiation working behind the scenes allows this unique integration to be possible.

The world is becoming increasingly digitally connected and webcalling can help companies keep up to date with the fast-paced innovation of consumer technology. Customers also benefit from this new development, because it makes the process of speaking to a contact centre agent easier. As webcalling technology becomes more widely adopted, companies and customers will be able to communicate more effectively.

Profile

Product
Webcalling technology

Applications
Enabling customers to call companies over the internet

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Unlocking the Deep Web

Technology company AMPLYFI is using artificial intelligence (AI) to access and interpret vast amounts of previously untapped data from the internet

Imagine running a specific Google search, and being able to read and digest the content of every relevant site and page across all languages within just a few hours, or even minutes. This is essentially what AMPLYFI's DataVoyant technology enables businesses to do.

The 'Deep Web' is a term used to describe the area of the internet that cannot be accessed by standard search engines such as Google, Yahoo! or Bing. As the primary means of finding information on the internet, these search engines only access the 'Surface Web' which contains just a fraction of the content that is actually available online. The Deep Web is estimated to be at least 500 times larger than the Surface Web, and it is ever growing.

The tool harvests data from both the Surface Web and the Deep Web, which involves automatically finding and then mining webpages, databases, academic journals and more. While standard search engines only scrape the surface of information available online, DataVoyant digs further to extract the less easily accessed information hidden in the Deep Web. The harvested data is then analysed using AI methods to find underlying patterns and trends. This is undertaken across all modern languages, so a huge variety of sources from around the world are interpreted.

Following analysis, the results are used to create intuitive visualisations of the data, providing the deep insights needed for businesses to make more informed decisions. The presentation of Surface and Deep Web data in a comprehensible format enables businesses to digest all of the information they require in a short space of time.

This whole process requires very little human manual intervention, which allows results to be quick and unbiased. The tool uses AI to replicate what humans do but at a speed, volume, complexity and accuracy that is beyond the capability of individuals, teams or even large companies. The easy-to-use interface makes the technology accessible to non-experts, which allows businesses to keep their intelligence gathering projects in-house, saving money and providing increased security.

By harnessing the power of the internet's untapped data, the technology is able to support businesses in a range of activities such as competitor intelligence, investment optimisation, mergers and acquisitions, as well as portfolio and country risk assessments. It can also help them to better understand and monitor potentially disruptive market developments, which would otherwise be difficult to see on the horizon.

AMPLYFI's technology has been piloted with some of the world's biggest organisations in sectors including energy, insurance, pharmaceuticals, professional services, automotive, aerospace, defence and banking.

Profile

Product
Software that mines the Surface and Deep Web for data

Applications
Providing data and insights to inform business decisions

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Preventing climate-changing carbon loss from mangroves

Scientists from Bangor University claim that the release of dangerous amounts of greenhouse gases from mangrove swamps could be stopped

Mangrove swamps are coastal wetlands that exist across 118 countries in tropical and subtropical regions. They are often found in estuaries, where freshwater from rivers and streams meets saltwater from the ocean, and are home to many trees and other plants that have adapted to mangrove environments and can rarely be seen elsewhere.

Due to the high organic matter content of their soil, mangroves are among the most carbon-rich forests in the tropics. They sequester and store large quantities of 'blue' carbon (the name given to carbon stored in coastal and marine ecosystems) both in plants above the surface and in the underwater sediment.

When mangrove trees or plants are damaged or cut down, they release this stored carbon into the atmosphere and the soil they were growing in quickly starts to decompose, releasing even more carbon. Although they account for only 0.7% of the global tropical forest cover, destroyed mangroves contribute around 10% of tropical forest carbon emissions.

Despite the negative impact their destruction is capable of having on the environment, mangroves have actually been reduced by 30-50% during recent decades. This can be attributed to several factors. Human activity such as deforestation, overharvesting, urbanisation and pollution has contributed. One of the greatest threats is the shrimp aquaculture industry, for which mangroves have been cleared in order to make room for artificial ponds. Global warming and climate change have also played a part, as mangroves are sensitive to rising sea levels and require stability for long-term survival.

To explore a potential solution to the issue, wetland scientists Professor Christian Dunn from Bangor University and Professor Bill Mitsch from Florida Gulf Coast University have joined forces. Their new research has found that the key to preventing massive carbon loss from tropical mangroves may be found in the wetlands located right here in the UK.

The research team has identified the natural processes keeping the carbon locked away in some of the mangrove soils as being almost exactly the same as those found in other wetlands, such as the fens and bogs of North Wales. Knowing this will allow the scientists to transfer

> "It's wonderful to think that the work we've been doing on the bogs of Snowdonia could affect the management of mangrove swamps in Florida and Indonesia. If we could treat the soil using some of our tested techniques, then we could prevent this loss of greenhouse gases and allow the regrowth of the mangrove trees; preventing millions of tonnes of carbon from being emitted to the atmosphere."
>
> **Professor Christopher Freeman**
> **Head of School of Biological Sciences**
> **Bangor University**

considerable knowledge on the soils of these well-studied habitats to mangroves.

Tested techniques include manipulating the habitat's hydrology and vegetation, as well as the chemical characteristics of the soil, in order to suppress the decomposition of organic matter by enzymes and microbes.

This reduction in decomposition means that dead plant material stays locked up in the waterlogged mangrove soils and will not be ultimately broken down into greenhouse gases, such as carbon dioxide and methane.

Profile

Product
Soil treatment for wetlands

Applications
Preventing carbon loss from damaged mangroves

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Removing environmental toxins with date seeds

Scientists from the University of South Wales have been working with partners in Syria and France to combat deadly environmental toxins

Dioxins are a type of highly toxic pollutant produced mainly as an unintentional by-product of industrial processes, such as chemical and pesticide manufacturing. They're persistent and dangerous, causing birth defects, reproductive and developmental problems, damage to the immune system and even cancer. Humans are exposed to dioxins through meat, fish, seafood and dairy products due to contaminated soil and water.

Professor Denis Murphy from the University of South Wales is part of a team which has made a breakthrough in tackling dioxins with date palm seeds. Date palms grow throughout the Middle East and are especially common in Syria. The dates that come from these trees are an in-demand crop, but their seeds are inedible and end up being discarded. Professor Murphy's team has now found a way of using date seeds, that would otherwise be wasted, for good.

Date seeds are rich in an oil that has an affinity for dioxins, and although this richness in oil is not unique to date seeds, they have the advantage of being both abundant and of no commercial value. This made them an ideal target for the team's research. Within date seeds, there are droplets containing the oil, along with special proteins that help hold them together. Each droplet is surrounded by a membrane composed of phospholipid, a substance which can interact with both oil and water phases in a solution. This means that when the droplets are shaken up with water, they form a stable emulsion.

To extract these droplets, the date seeds were soaked in water for two weeks to soften them before being ground up into microparticles. Through this process, the droplets were separated from the rest of the mashed seed as a creamy emulsion. The emulsion's ability to remove dioxins from water was then tested and proved successful, with the droplets acting like little magnets for the dioxins. Once the dioxins were inside the droplets, the oil kept them trapped there. The droplets eventually rose to the top of the water and could then be safely destroyed.

Based on the team's findings, date palm seeds could be used to clean up some of the most polluted parts of the world, getting rid of toxic spills and other environmental contamination. A reduction in dioxins would mean less contaminated food and a lower risk to human health.

Scientists from the University of South Wales have been conducting this research with partners from France's University of Strasbourg and the Atomic Energy Commission of Syria in Damascus. The Syrian team carried out their work despite having to work in what amounted to a war zone.

> "We have been privileged to work with such a great team of researchers on this important project, that could lead to improved food safety and environmental protection."
>
> **Professor Denis Murphy**
> **University of South Wales**

Profile

Product
Date seeds

Applications
Removing dangerous environmental toxins

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