

THE JOURNAL FOR SCIENCE, ENGINEERING AND TECHNOLOGY

# advances

WALES



## Tea leaf nanoparticles fight cancer

Swansea University scientists have discovered that nanoparticles derived from tea leaves can destroy lung cancer cells



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Anti-biofilm technology to aid wound healing



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Advanced technology for immersive first aid training



Llywodraeth Cymru  
Welsh Government

## Guest Foreword

### Professor Peter Halligan, Chief Scientific Adviser for Wales

As Chief Scientific Adviser for Wales, I am delighted to introduce you to the Autumn 2018 edition of Advances Wales.

With only 2 per cent of the total UK spend on research and development (R&D), Wales's research base is a national asset, delivering economic, social, cultural and health benefits. Wales's universities contribute significantly to the world-leading UK research base, second only to the US in its share of global citations. Several of Wales's universities boast examples of outstanding science research – from Nobel Laureates in life sciences research at Cardiff University, to the award-winning Institute of Biological, Environmental and Rural Sciences at Aberystwyth, Swansea's innovative advances in materials research and testing, and Bangor's impressive work in the fields of environmental protection.

This edition features work from scientists who have discovered that nanoparticles derived from tea leaves can inhibit the growth of lung cancer cells (page 14) and have managed to recreate an antibiotic compound found in garlic for the very first time (page 16). Meanwhile, medical companies based in Wales have created an advanced wound dressing to combat biofilm (page 6) and a device for the management and prevention of foot ulcers (page 7).

Also a collaboration between industry and academia has resulted in the development of an innovative system to detect damage in military body armour (page 9).

Other innovations highlighted in this edition include new recycling technologies for waste MDF (page 17) and for disposable nappies (page 18), as well as mixed reality technology for immersive first aid training (page 10).



Advances Wales is also available online at: [www.businesswales.gov.wales/innovation/advances-wales](http://www.businesswales.gov.wales/innovation/advances-wales)

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Advances Wales showcases the latest news, research and developments in Welsh science, engineering and technology. This edition and past editions can all be viewed online.

Sophie Davies Editor

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Government to showcase new developments in science, engineering and technology from 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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## New technology to detect stress in guide dogs

**Researchers at Swansea University are developing a range of bespoke collar sensors to detect stress in guide dogs in training.**

Dr Sofia Teixeira from Swansea University's Centre for NanoHealth is working with researchers from the ICT for Health Programmes group at Tyndall National Institute, Cork, to translate technologies developed for human application into use for training and communicating with guide dogs.

The device in development makes use of a highly sensitive graphene-based Electrochemical Impedance Spectroscopy (EIS) sensor. This technology (which featured in Advances 84) enables rapid analysis, is compatible with miniaturisation and can be manufactured at an industrial scale.

A saliva sample is taken from the dog and placed on the EIS sensor, completing a circuit. A current is then run through this circuit and the resistance is measured. This value is compared to a bank of already defined biomarkers, which can identify if anything in the sample is a cause for concern. Multiple samples are taken for comparison to ensure accuracy.



Over the next few years, the project aims to develop bespoke sensor systems for detecting parameters such as motion, temperature, respiration and heart activity and to deploy them onto a dog's harness and/or collar. This wearable technology will leverage embedded artificial intelligence to provide

a better understanding of the dog's health and welfare, providing vital information that will inform decisions around breeding, training approaches and more.

 [www.swansea.ac.uk](http://www.swansea.ac.uk)

## Virtual reality for railway safety training

**A company based in Ebbw Vale is using VR technology to educate people about the potential dangers of railways.**

Working in partnership with the Centre of Excellence in Mobile and Emerging Technologies (CEMET) at the University of South Wales, Motion Rail has

produced a virtual reality system that enables users to learn about the hazards posed by railways via real-time scenarios in a safe environment.



The company initially developed the pioneering VR system, which is endorsed by Network Rail, for training railway workers to manage hazardous environments while working on or near the tracks. The technology is now also being taken into schools to teach children about the dangers they could face around railways.

In 2016/17 there were 39 fatalities, excluding suicides, on railways. 33 of these were public fatalities, mostly resulting from trespassing and incidents at level crossings, and 6 were railway workers. There were also 164 major and 5,676 minor injuries to railway workers during this period.

By engaging children early and educating them about the risks at a young age, it is hoped that the number of injuries and deaths on railways could be reduced. The system also aims to benefit railway workers by making them more aware of the appropriate amount of time needed to move out of the way when a train is approaching.

 [www.cemet.wales/motion-rail](http://www.cemet.wales/motion-rail)



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



## High-tech sensors for housing associations



*"Social housing providers are responsible for managing tens of thousands of properties, often with extremely small teams. Poor property conditions cause serious problems for the property and, more importantly, tenant health if they are not addressed quickly. It costs in the region of £25,000 to fully refit the average social housing property – a cost that our technology helps to avoid."*

**Mark Lowe**  
Business Development Director  
Pinacl Solutions

**Innovative sensor technology from a St Asaph-based company is helping housing associations to maintain their properties and improve tenant health.**

A growing number of social housing providers are using the sensors, developed by Pinacl Solutions, to reduce their maintenance bills by detecting

issues such as damp, fuel poverty and abandoned properties. Among early adopters of the technology are Newport City Homes and Halton Housing.

The sensors give social housing providers a real-time insight into the health of each of their properties. Alerts can be automatically generated if problems arise or are predicted to arise, ensuring that corrective action is taken to keep property and tenant healthy. Up to four sensors are installed

in homes, typically covering the bathroom, bedroom, living room and kitchen.

Pinacl's system includes sensors, an Internet of Things (IoT) network and an application dashboard. The sensors can monitor humidity, temperature, CO2 and movement and are able to provide hourly readings on the dashboard.

 [www.pinaclsolutions.com](http://www.pinaclsolutions.com)

## Developing disease-resistant red clovers

**Researchers at Aberystwyth University are working to ensure more Welsh livestock farmers could benefit from longer lasting, disease-resistant red clovers.**

Red clover plants are susceptible to treading, and they become vulnerable to disease when damaged. In contrast to white clover plants, which grow via

small roots that spread across the soil surface, red clover plants grow from a single point. This means that once the crown is damaged and the plant succumbs to disease, the remaining plants are not able to compensate and fill in the gaps, leading to a loss in yields.

To solve this problem, researchers led by Professor Leif Skot of Aberystwyth University's Institute

of Biology, Environmental and Rural Sciences (IBERS) are working to develop red clovers that are resistant to two major diseases – Stem Nematode and Sclerotinia. There is currently no recognised chemical way of controlling these two soil-borne pathogens, so the only option is to take a gap of several years in rotation to minimise the potential risk. The researchers are hoping to select material that is more resistant to each of the diseases, and then combine them in order to create resistance to both pathogens. As the crown of the red clover plant is susceptible to damage, the team is also looking at improving the structure of the crown.

By improving red clover production and persistency, the researchers are hoping to help farmers improve their silage crop value. In turn, this could help farmers reduce the need to use expensive concentrates.

The research is part of a three-year project exploring ways to improve protein production and utilisation on farms in Wales through improved forage crops. IBERS is leading the project in collaboration with Germinal Holdings, HCC and Farming Connect.

 [www.aber.ac.uk](http://www.aber.ac.uk)

Red clover is a widely used cover crop that offers many benefits including nitrogen production and weed suppression.



### IN BRIEF

#### Funding for organic pesticides

Swansea-based biotechnology company Bionema has received £500,000 equity investment to develop new organic pesticides. The company (featured in *Advances* 78) is specifically developing bio-insecticides, which kill harmful crop pests, but leave fruit and vegetable crops residue free and safe for consumption without heavy washing beforehand. Use of natural products is becoming increasingly crucial in areas where the practice of using chemical pesticides is banned. Founder and MD of Bionema, Dr Minshad Ali Ansari, commented: "We are really pleased that our backers recognise our potential and our achievements to date as we capitalise on the industry drive to reduce dependence on chemical pesticides with safe and sustainable solutions." It is hoped the products developed from this funding will be launched by 2021.

#### Drives for Sri Lankan tea industry

Welshpool-based Invertek Drives is helping to create efficiencies and savings in Sri Lanka as part of a project to reduce greenhouse gas emissions. The company is supplying 200 of its Optidrive Eco drives in the first phase of a project which aims to make the tea withering process of Sri Lanka's tea industry more efficient and reduce its impact on the environment. The drives from Wales provide optimised speed control of the fan motors used in the tea withering process, ensuring greater efficiency that minimises energy usage. This allows CO2 emissions to be cut both locally and throughout the energy chain. It is expected that implementing the drives will result in energy savings of 20 to 25 per cent for the world's fourth largest tea producing country.

#### Innovations in satellite and drone technology

Aberystwyth University is leading a major new initiative to put Wales at the forefront of the fast-growing spatial intelligence market. The Geographical Data and Earth Observation for Monitoring (GEOM) programme involves scientists from the Department of Geography and Earth Sciences at Aberystwyth University collaborating with QinetiQ to help Welsh companies exploit state-of-the-art satellite and drone technology. Data collected by this technology can provide vital information for a range of sectors, including agriculture, energy, security, environment, transport and infrastructure. For example, satellites can be used to monitor forest plantations and provide early warning signs of disease or stress. The £3m initiative aims to identify new and innovative ways of capturing and analysing spatial intelligence and geospatial data through satellite and drone technology, in order to develop market-ready products and services.

#### First cyber security centre of excellence in Wales

Cardiff University has been named as an Academic Centre of Excellence in Cyber Security Research by the UK's National Cyber Security Centre (NCSC), becoming the first institution in Wales to be given this status. Set up by GCHQ, the NCSC helps protect the UK's key services from cyber attacks, manage major incidents and improve the underlying security of the UK's internet through technological improvement and education. As a Centre of Excellence, the university will specifically focus on how artificial intelligence can be used to monitor, identify and eventually tackle cyber attacks in the UK, making networks more secure for business as well as personal use. The university will also nurture more young talent and foster a pipeline of the next generation of cyber security professionals.

#### Cancer treatment advances with trial

A North Wales cancer patient has become the world's first participant in a trial searching for a more effective myeloma treatment. This cancer of the bone marrow affects white blood cells that produce the antibodies needed by the body to fight infection. As myeloma can develop wherever there is bone marrow, there can be multiple locations of the cancerous cells in the body at any one time. This study, registered at Betsi Cadwaladr University Health Board's Research and Development department, is investigating and comparing two combinations of cancer medicines to see if one is more effective in patients whose disease is no longer responding to treatment or has reoccurred after more than two previous treatments. It is hoped that a new method of treatment will be found for those who have limited or no viable therapy options remaining, boosting cancer survival rates.

#### New research hub to support shellfish industry

Bangor University has secured a further £2.8m funding for the Shellfish Centre, a science and innovation hub intended to boost the Welsh shellfish industry. Based at the Marine Centre Wales, the Shellfish Centre will support improvements to coastal water quality, the adoption of new technology and production methods, and expansion into new markets, which are all priorities for shellfish industry in Wales. It is expected that over the next three years, 20 Welsh businesses will participate in scientific research programmes. Professor Lewis Le Vay from Bangor University said: "Our long-term aim is for the legacy of the Shellfish Centre to be a sustainable and growing shellfish production and processing sector in Wales. Supported by a science and innovation partnership, this initiative will help place Welsh shellfish producers in a leading position in the UK and internationally."

#### Research to develop bovine TB test

Aberystwyth University's Institute of Biological, Environmental and Rural Sciences (IBERS) is leading an international effort to develop a new test for bovine tuberculosis. In the UK, tens of thousands of cattle are destroyed every year because of the highly infectious disease. It is hoped that a more effective and less controversial method can be found to replace the current blood tests and wild animal culls currently in use. At present the most commonly used tests are relatively inaccurate, and the need to quarantine a TB-positive testing herd for 60 days before retesting puts farmers under economic and emotional strain. The consortium will collaborate to develop a new, cost-effective, rapid and accurate point-of-use test for farm stock and wildlife. Data gathered from tests will also be integrated into databases, leading to more accurate epidemiology monitoring and the development of a more informed disease strategy, potentially leading to total TB eradication.

#### Award for diagnostic cancer technology

A test that predicts the aggressiveness of common types of cancer and identifies patient responses to treatment won the Medical Innovation Award at the Cardiff University Innovation and Impact Awards. Working in partnership with Cardiff and Vale University Health Board, TeloNostiX (which featured in *Advances* 78) has developed a prognostic tool that helps clinicians and patients to understand the likely need for treatment and to choose the most appropriate treatment for cancer. It can forecast the outcome of common cancer types like breast cancer and Chronic Lymphocytic Leukaemia, and can also help identify patients who do and do not require early treatment. TeloNostiX is now working with major pharmaceutical companies and has developed its technology into a high-throughput system to allow for large-scale clinical testing.

#### Progress for hydroponic system

A hydroponic farming system developed by agricultural start-up Phytozonics (which featured in *Advances* 80) is currently being trialled in Wales. The system grows plants and crops without a need for water and is inflatable so that it can be easily transported and deployed. The company has teamed up with Aberystwyth University to put the system into practice, growing two tonnes of tomatoes in a 50m<sup>2</sup> greenhouse. The trial is designed to showcase the potential of the Phytozonics system, which produces high yields and uses 10 times less land and water than other agricultural processes with no use of pesticides and herbicides. The first harvest of tomatoes from the trial has been sold to local customers, and harvesting will continue into November with plans to then upscale to a commercial-size pilot farm.

#### Investment in smart energy

The Smart Energy Storage Solutions Hub (SESS) scheme, led by the University of South Wales, has received £3.5m funding to collaborate with businesses in sectors such as low carbon, energy and environment, advanced manufacturing and ICT. The hub, based at the university's state-of-the-art Centre for Automotive and Power Systems Engineering (CAPSE), will work with businesses to drive innovation and development of new energy-efficient products, technologies and processes for the commercial market. Businesses will have access to the university's specialist research facilities and academic expertise to help develop new products and processes, including in the automotive and energy fields. The scheme is based on CAPSE's expertise in the field of battery and energy storage research, and aims to help Wales become a major exporter of energy efficiency technology and know-how.

# Anti-biofilm technology to aid wound healing

ConvaTec has developed an innovative dressing to combat wound biofilm and aid healing.



**The NHS treats millions of wounds each year, and many of these are chronic wounds that do not heal as quickly or as simply as they should. There are various underlying causes, but significant contributors are microbiological colonisation and infection.**

Wounds can contain many different microbial species, which live in self-protective, surface-attached communities known as biofilm. Current research suggests that around 80 per cent of all chronic wounds contain biofilm. This blocks antibiotics and antiseptics by, among other strategies, providing a physical barrier to exposure, and it recovers very quickly from intermittent treatments. It also creates an environment where antibiotic-resistant microorganisms can thrive and is a potential source of pathogenic microorganisms that can result in clinical infection.

Deeside-based medical device company ConvaTec undertook research to identify ingredients, compatible with open wounds, that could assist in the disruption and removal of wound biofilm and therefore enhance the antimicrobial effectiveness of ionic silver in their AQUACEL Ag dressing. Nearly 250,000 chemical combinations were considered, and over a three-year period more than 60,000 of these were tested. Synergies between antiseptics, surfactants, water softening agents and pH were identified and ultimately patented.

The findings of this research were then used to formulate a new wound dressing, AQUACEL Ag+ Extra, which was proven to be a significant improvement on its predecessor.

Once the dressing manufacturing process was developed and validated, the next step was clinical studies. In a pivotal safety study, led by Professor Sir Keith Harding of Cardiff University and the Welsh Wound Innovation

Centre, the dressing was found to be effective at facilitating healing of infected and non-infected chronic leg ulcers that were likely compromised by biofilm.

The new dressing reduces suffering for patients, decreases costs for the NHS, and also limits the use of antibiotics, because they may not be required if wounds are treated early and successfully. It received two awards at the Journal of Wound Care's World Union of Wound Healing Societies Awards, has recently been approved by the FDA and will be launched in the USA in October 2018

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Deeside

# Innovative insole for foot ulcers

Kaydiar is developing a reconfigurable device to prevent and manage pressure-induced skin lesions such as foot ulcers.

**While studying podiatry medicine at Cardiff Metropolitan University, David Barton began developing an offloading, or anti-pressure, device in the form of an insole. He set up the company Kaydiar, in partnership with Heather Smart, in order to take the idea further.**

The device, ZeroSole, is primarily designed to facilitate the healing of diabetic foot ulcers. It is estimated that around 10 per cent of people with diabetes will develop a foot ulcer at some point, and they can affect people with both type 1 and type 2. They occur because high or fluctuating blood sugar levels can cause damaged skin to heal or repair itself more slowly than usual. In addition to this, some people with diabetes suffer from reduced nerve functioning and therefore feel pain less acutely, so they may damage their foot and fail to notice until an ulcer has developed. If left to develop for too long, an ulcer can result in amputation being required.



*"Not only is ZeroSole both a treatment device for patients with foot ulcers and a preventative device for high-risk patients, but it can also act as an immediate offloading prescription, which does not need to be manufactured in a lab or delivered once the patient has had their initial appointment. For these reasons, the costs associated with foot ulcers can be heavily reduced for the NHS and the quality of life for patients can be improved."*

**David Barton**  
 Founder  
 Kaydiar



ZeroSole stems from a CAD design which was formed via a 3D printer. The resultant device is made up of platinum cured silicone cells and is worn inside a shoe to provide an offload for the ulcerated area. It is non-adhesive, which means that it can be cleaned easily so that wound hygiene can be significantly improved.

The material used can prolong the life span of the insole by up to two years of use. Therefore it is intended to provide not just short-term relief, but also long-term preventative care for chronic pressure-induced foot conditions. It has also been designed in various thicknesses so that it can be worn inside surgical boots as well as conventional shoes. The device is reconfigurable, which means that during the ulcer's healing process, continual adaptations can be made in order to optimise offloading and improve the clinical outcome.

By offering more effective management and prevention of diabetic foot ulcers, the new device has the potential to reduce the risk of infection, amputation, and in severe cases mortality. It has also been designed to handle rheumatoid arthritic ulcerations.

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Swansea

# Scanning power cables with ultrasound technology

Acuity Ultrasonics is using advanced ultrasound scanning technology to detect faults in power cables.

**Although ultrasound technology is widely used in the medical industry, its use in industrial applications has been mostly limited to metal part investigations, such as weld conformity and crack detection. This is due to the ability of ultrasound to detect air voids or boundary reflections from metal-to-metal transitions.**

Drawing from its background in sonar applications for military projects, Acuity Ultrasonics has developed advanced signal analysis techniques for investigating the transmission of ultrasound energy into cross linked polyethylene. This is a material used extensively as insulation in the manufacturing of high voltage power cables, which often transmit megawatts of energy between countries.

Polyethylene and other plastic materials are normally used as sound absorbers, in applications such as automotive noise reduction. The St Asaph-based company has created a system that can examine thick

layers of polyethylene extruded over a copper or aluminium core, with thin semiconductor layers between them designed to even out the electrical field. Using signal analysis techniques previously developed for military electronic warfare projects, the technology is able to detect extremely small features buried deep within the cable.

The system works in the same way as medical technology, relying on a change of acoustic impedance at the boundary between two different materials. In medical applications such as foetal investigations, the energy is readily transmitted into the body via a gel applied to the scanning head or the patient's body. The medical professional has the benefit of a stable site, as the body is 70 per cent water, and the ability to make several scans in order to build up a picture of what is occurring inside the body.

In the industrial application, water is used to transmit the energy from a non-contact head as a cable passes through at approximately one metre per minute. Acuity only gets one shot at a site, but can scan the total circumference of a large cable every quarter of a millimetre. This

is enough to see issues in the inner layers, which may lead to an electrical breakdown when it is eventually energised.

The advanced scanning technology is currently being put to use in power cables running on the seabed, or submarine cables, which have been constructed to withstand environmental impact. At the heart of each cable, however, is a single extruded power core, which can only be tested to a limited degree before the cable is put onto a ship and dropped on the sea bed. Therefore, by improving detection of manufacturing issues, the technology has the potential to save time and costs associated with uplifting and repairing cables that fail on the seabed.

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St Asaph



# Device detects damage to body armour

Cardiff University has collaborated with Microsemi to create an innovative device for damage detection in military body armour.

**To ensure that the British military have uncompromised ballistic protection, around five million armour units are shipped back to the UK from global operations for X-ray inspection. This process is time-consuming and represents a significant cost.**

Cardiff University's School of Engineering has teamed up with Microsemi, which has a Welsh base in Caldicot, to develop a lightweight, ultrasonic-based, hand-held system that detects damage in ballistic protective equipment. The system, known as A-Ultra, allows the ballistic protection of armour to be monitored locally, ensuring protection for the UK's armed forces and substantial cost savings for the Ministry of Defence.

The technology uses low-profile, light-weight transducers to transmit ultrasonic waves across the armour surface, which are then received

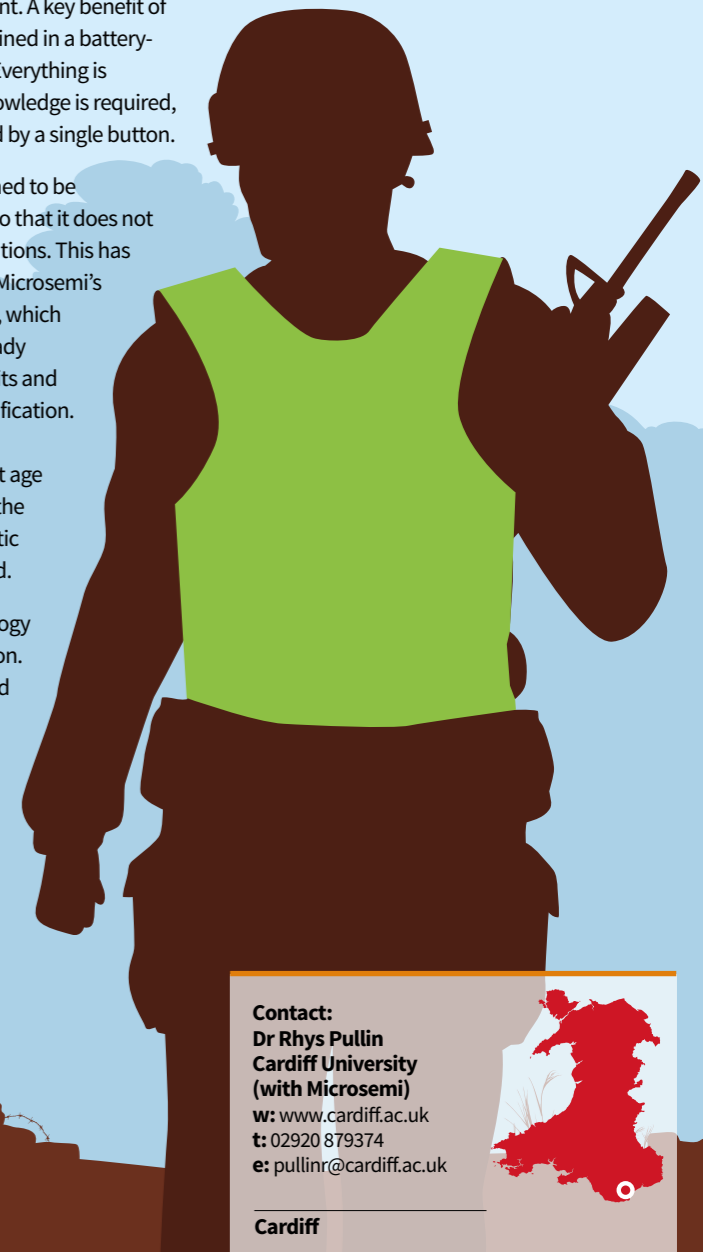
by other transducers. The system analyses the waves received, enabling the ballistic protection to be assessed, and within seconds a 'pass' or 'fail' readout is delivered to the operator.

Results are produced that are comparable to existing lab-based equipment. A key benefit of A-Ultra is that it is self-contained in a battery-powered, small-scale unit. Everything is automated and no prior knowledge is required, because the unit is operated by a single button.

The system has been designed to be unobtrusive to the wearer, so that it does not interfere with combat operations. This has been achieved by applying Microsemi's flexible circuitry technology, which can be applied to units already in-service as well as new units and future designs with no modification. In addition, serial numbers, inspection intervals and unit age can be recorded, enabling the asset management of ballistic protection to be streamlined.

Applications for the technology go beyond ballistic protection. For instance, it could be used

for the monitoring of aircraft structures, lowering the operational costs of aircrafts and reducing delays caused by maintenance issues. It could also enable protective equipment for sports to be assessed before use, ensuring that the user always has the protection required.



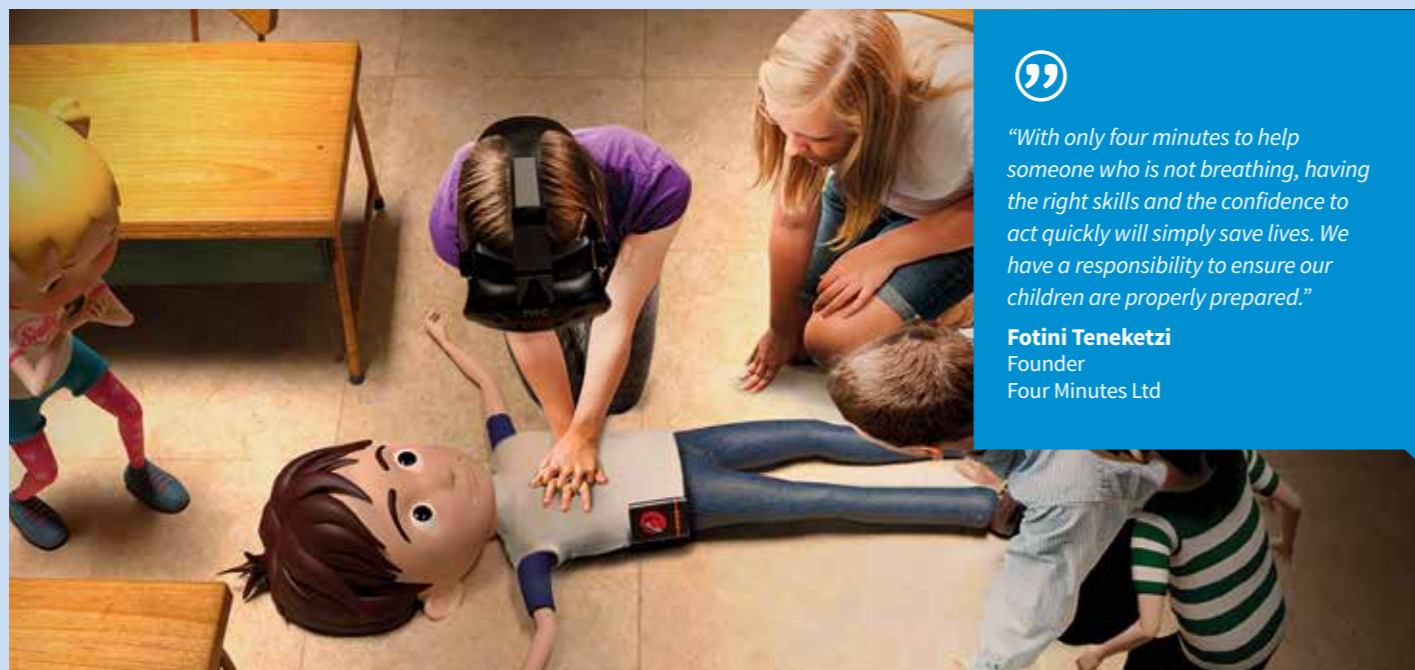
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Cardiff



# Advanced technology for immersive first aid training

Four Minutes Ltd is using mixed reality technology to provide more effective first aid training.



*"With only four minutes to help someone who is not breathing, having the right skills and the confidence to act quickly will simply save lives. We have a responsibility to ensure our children are properly prepared."*

**Fotini Teneketzi**  
Founder  
Four Minutes Ltd

**Every year in the UK, over 28,000 people die from Sudden Cardiac Arrest (SCA). Of the people who suffer a SCA outside of hospital, only 5 per cent survive.**

In contrast, the survival rate for SCA outside of hospital in Norway is 25 per cent. This difference is largely due to the number of citizens who are able to respond to a life-threatening emergency quickly and efficiently, as over 90 per cent of Norway's population have received CPR training. First aid training is often considered to be time-consuming and, as a result, less than 1 in 20 people in the UK are trained.

European Resuscitation Council studies have also found that despite the human and financial resources expended on resuscitation training worldwide, conventional resuscitation training programmes have generally not achieved an optimal level of skill acquisition or retention. Typically those trained will lose the confidence to act within three months.

The quality of cardiopulmonary resuscitation (CPR) is increasingly recognised as being important for good survival outcomes after cardiopulmonary arrest, but there is evidence that CPR performance is sub-optimal, even in supposedly 'well-trained' health professionals. CPR performance during and immediately after completion of resuscitation training has been shown to be less than ideal.

Caerphilly-based company Four Minutes Ltd is aiming to address this skills gap with a new way to provide first aid training that is both quicker to deliver and more accurate. In collaboration with the Centre of Excellence in Mobile and Emerging Technologies (CEMET) at the University of South Wales, the company has developed an innovative CPR training system using mixed reality.

The system makes use of a standard virtual reality headset, custom mixed reality sensors and a CPR manikin to recreate real-life emergency scenarios. With combined visual and tactile feedback, it can offer a more realistic, immersive first aid training experience for the participant than if they followed the usual method of simply

practising on a manikin. AI is used to coach the participant into delivering a more effective rescue technique and this improves accuracy, confidence and knowledge retention.

By introducing the new training technology in schools, children would learn vital, life-saving skills at a young age. They would gain the ability to instinctively help in an emergency, with the confidence to act without hesitation, and the social impact could be significant. Four Minutes Ltd is hoping to change the way in which critical emergency skills are delivered worldwide.

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Caerphilly

# Using AI to help suicide prevention

Researchers at Swansea University are exploring how AI could be used to analyse health data with the aim of suicide prevention.

**Each year around 800,000 people across the world take their own lives, and unfortunately it is not easy to identify those at risk.**

A large number of variables and complex interactions mean that only a trained clinician is able to assess for immediate risk of suicide. However, the majority of people who take their own lives attend services other than mental health in their final year for apparently unrelated reasons. New research from Swansea University has now looked at ways of using this health information in order to identify the most vulnerable.

A team including researchers from Swansea University's Medical School and School of Law carried out the work, in collaboration with academic colleagues from European universities and an emergency medicine consultant at Princess of Wales Hospital in Bridgend. Their findings revealed that more than 80 per cent of suicide cases studied had at least one contact with their GP during the last year of their lives.

The team wanted to see if they could develop an algorithm that analyses routinely collected health data to flag people, so that when patients present with seemingly unrelated conditions, practitioners can ask them appropriate questions about their thoughts and feelings if required. AI can now play a crucial role in processing millions of records with thousands of variables to build a risk model very quickly. It can then process the health history of patients and highlight those who may be at risk.

Swansea University's SAIL Databank was used to obtain information about more than 2,000 suicides held in SID-Cymru, which is an electronic cohort of all deaths

by suicide in Wales since 2001. Preliminary results from the research, which recorded almost 75 per cent accuracy, were very promising. The team now plans to gradually increase the complexity of the AI system in order to improve the tool's precision before carrying out thorough trials.

The proposed system would not replace clinical assessment of immediate risk, but would help clinicians to identify vulnerable people when they access health services so that the right questions may be asked.



*"AI methods have huge potential to improve suicide prevention, and this is an exciting development. However, we are still at the early development stages before any practical use. Collaborations between clinicians, academics, ethical experts, patients and people who use services are vital for the development of these innovative tools."*

**Professor Ann John**  
Swansea University Medical School



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Swansea

# Slurry technology for farms in development

**Power & Water is pioneering the advancement of slurry separation to reduce pollution while also creating savings for cattle farms.**



Slurry is a mixture of manure and water, used by farmers as a natural fertiliser for their crops.

**S**tatistics from Natural Resources Wales put the number of pollution incidents caused by Welsh dairy and beef farms at between 85 and 120 for each of the last six years, with over 60 per cent of these incidents occurring within the dairy industry. Poor slurry management can have a serious environmental impact, so it is becoming an increasingly pressing issue for farmers.

Swansea-based company Power & Water is working to develop an economically and environmentally viable slurry management system to address the agricultural industry's impact on the environment. Their technology is designed to improve slurry management, reduce air and water pollution, and produce water that is clean enough to be re-used on the farms or safely discharged back into the watercourse.

Initial trials of the new technology are taking place at Gelli Aur, Coleg Sir Gâr's research farm in Carmarthenshire, which has a 200-cow dairy herd. In its first week of operation, the system managed to separate 90 per cent of liquids from the 35 tonnes of slurry being processed each day, exceeding researchers' expectations.

Two different separation systems are being trialled at the farm. One uses

centrifugal force to remove the solids, while the other pushes slurry through a mesh screen. Slurry is pumped into the separators and, once water has been extracted, the residue is a tenth of its original volume. This solid material drops into a storage area before being scooped up and stored in a covered area, ready for spreading.

The filtered liquid, which is around 4-5 per cent dry matter, passes to another treatment area where an oxidation system breaks down the ammonia into nitrogen and hydrogen. It also removes any remaining solids, which are routed back and added to the compressed slurry underneath the separator.

Early results from the trial indicate that substantial savings are possible, especially for a large dairy unit such as Gelli Aur.

It is currently thought that the centrifuge system is more energy intensive but produces more solids, whereas the screw press is cheaper to install but results in less separation. Researchers will ultimately establish which system produces the optimum results, refining the processes along the way. They anticipate a further two years of refinements before the equipment will be ready to be rolled out. They are also working with Natural Resources Wales to determine what quality standards the water should meet before it can be discharged.



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**Swansea**

# Nanoparticles from tea leaves destroy cancer cells

Scientists at Swansea University have discovered that nanoparticles derived from tea leaves can inhibit the growth of lung cancer cells.

Quantum dots are tiny particles that measure less than 10 nanometres. Although nanoparticles are already used in healthcare, quantum dots have only recently attracted the attention of researchers, but they are already showing promise for use in various applications, including for tumour imaging.



The standard method of producing quantum dots is complicated and requires chemicals, so it is expensive and has toxic side effects. For this reason, scientists from SPECIFIC at Swansea University, in collaboration with two Indian universities, decided to explore a non-toxic, plant-based alternative method of producing quantum dots using tea leaf extract. In addition to avoiding the use of chemicals, the new process could also have environmental benefits by making use of waste tea leaves which would otherwise go to landfill.

Tea leaves contain a wide variety of compounds including polyphenols, amino acids, vitamins and antioxidants. The team mixed tea leaf extract with cadmium sulphate and sodium sulphide and

discovery. They found that the dots actually inhibited the growth of the cancer cells, destroying up to 80 per cent of them. This happened because the dots were able to penetrate into tiny pores on the cancer cell walls, known as nanopores, and it is thought that this ability may be related to the tea extract particles.

The team's discovery suggests that quantum dots are a promising avenue to explore in developing new cancer treatments. They

allowed the solution to incubate, causing quantum dots to form. Results showed that, in comparison to using chemicals, this alternative method of producing quantum dots is simpler, cheaper and less toxic, confirming the findings of other research in this field.

After producing their quantum dots, the team then applied them to lung cancer cells, in order to test their capabilities in detecting tumours, and made an unexpected



*"Building on this exciting discovery, the next step is to scale up our operation, hopefully with the help of other collaborators. We want to investigate the role of tea leaf extract in cancer cell imaging, and the interface between quantum dots and the cancer cell. We would like to set up a 'quantum dot factory' which will allow us to explore more fully the ways in which they can be used."*

**Dr Sudhagar Pitchaimuthu**  
Lead researcher  
Swansea University

are also investigating other potential uses, including in solar cells, water pollutant treatments, for antimicrobial paint used in operating theatres and in sun creams.

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Swansea



# First lab recreation of garlic extract

Researchers in Wales have managed to recreate for the very first time an antibiotic compound found in garlic.

**The medical use of garlic dates back many thousand years. Ajoene, a major constituent found in fresh garlic, is proven to be an effective antibacterial, antimicrobial and antifungal agent and has also shown promise in chemotherapy treatments for cancer**

Research has demonstrated that the therapeutic effectiveness of ajoene is a result of its ability to interfere with the chemical communication signals between bacteria, preventing them from growing and spreading. Until now, the compound has been extracted from crushed garlic as a starting material, but this has typically resulted in low and unreliable yields.

For the first time, researchers from Cardiff University's School of Chemistry, in collaboration with Abertillery-based company Neem Biotech, have developed a reliable method for creating ajoene without the need for garlic as a starting material. Testing the resulting compound's activity against bacteria, the team found that the synthetic version performs similarly to, or sometimes even better than, natural version extracted from garlic.

The new, fully synthetic approach is based on readily available components. It opens up the possibility of producing the

compound more efficiently than extracting it from crushed garlic, and the synthesis can be scaled up so that larger amounts can be produced. It could also enable researchers to make derivatives of ajoene and further explore its potential as a therapeutic compound.

In addition to these benefits, the team believes that the compound could be used as a novel drug in the fight against antibiotic resistance.

Antibiotic resistance occurs when bacteria develop the ability to defeat the drugs that have been designed to kill them. It is therefore an urgent threat to public health. As bacteria build up a resistance to traditional antibiotic drugs, scientists are constantly searching for new and novel compounds to combat this.



*"Using easily available starting materials we've successfully developed an efficient, robust and reliable way of making ajoene. The remarkable antibacterial properties of this compound have shown great promise and we hope that this new breakthrough will accelerate efforts to produce ajoene in large volumes and better test its effectiveness as a therapeutic drug."*

**Professor Thomas Wirth**  
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Cardiff

# Groundbreaking technology recycles MDF

MDF Recovery has developed an innovative recycling technology to recover wood fibre from waste MDF.

**Medium-density fibreboard, or MDF, is an engineered wood product composed of refined virgin wood fibres that are mixed with resin and wax and pressed into flat sheets under pressure and at an elevated temperature. It is used predominantly for furniture production and also as a building material.**

It is estimated that around 75 million tonnes of MDF are produced globally every year. However, it is not readily recyclable. The UK alone disposes of around 350,000 tonnes of MDF annually, and the only disposal methods currently available are landfill or incineration.

MDF Recovery, based in Anglesey, has developed an environmentally friendly alternative to dispose of MDF. The company's



*"Our technology can be retro-fitted or designed into new plants, and offers a robust solution for reworking waste and increasing the yield at the MDF manufacturing facility. Zero waste production is now a real possibility."*

**Craig Bartlett**  
Co-founder and Managing Director  
MDF Recovery

technology recovers wood fibre from the waste MDF, which can then be recycled and used to make second and third generation products including new MDF and thermal insulation materials.

During the process, waste MDF is shred at a low speed to minimise the amount of dust created and then soaked in hot water. An electrical current is then passed across the material, which raises the temperature and breaks apart the resin bonds. The wood fibres are dried for re-use, and the waxes and resins are separated into the water, then dried and pressed for incineration. Water is reused in the continuous cleaning process.

All types of MDF can be recycled because overlays such as laminates and foils are separated in the process. This enables

manufacturers to take back material from their customers and therefore provide a 'closed loop' system. The retail sector would particularly benefit from this system as large amounts of MDF are used in shop fittings and in-store furnishes.

One significant technical challenge in developing the technology was making sure that the fibres could be clean and free of laminate contamination. To achieve this, Bangor University's BioComposites Centre helped to create a simple cleaning process using air to separate out the fragments of laminates. The Centre has also been assisting by making boards from the recycled fibre and testing them in comparison to boards made from virgin fibre.

By recycling waste MDF and generating a new raw material source for the wood and natural fibre industry, the technology would lessen the demand on forests. It also has the potential to significantly reduce the disposal of MDF via environmentally damaging methods such as landfill and incineration.

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Anglesey



# Nappy recycling to reduce landfill waste

**NappiCycle has created a new process for recycling disposable nappies and diverting them from landfill.**

**Since their introduction in the 1950s, disposable baby nappies have been convenient, easy to use and relatively cheap for parents. Modern disposable nappies are a highly engineered composite product. They consist of a protective outer layer of breathable polyethylene films, layered with non-woven synthetic textile fibre, and a core of absorbent cellulose fibre fluff containing water absorbing polymers.**

The average number of nappy changes for infants between birth and two and half years is estimated at around 4.5 nappies per day, which equates to 4,100 nappies per child. Once used, a disposable nappy can weigh up to 200g, meaning that a child can produce around 820kg of waste nappies during the first two and a half years of its life.

As the name suggests, a disposable nappy is a single use product. In the UK, used nappies are generally collected from households by Local Authorities and are then either landfilled or incinerated. A WRAP Cymru waste composition report for Wales found that nappies represent as much as 9 per cent of household collected waste. In Wales alone, it is estimated that around 50,000 tonnes of nappy waste are generated annually.

Although the materials incorporated in a disposable nappy are recyclable, the complexity of its composite structure and the nature of its super absorbent polymers make separation of these materials for recovery very difficult.

Carmarthenshire-based company NappiCycle has developed an innovative treatment process that chemically 'cracks' the super absorbent polymers, releasing the absorbed liquid and thus allowing



the separation of waste from the recyclable materials. The separated materials are then further processed to wash, clean, sterilise and dry them.

Over the past year, the company has processed the equivalent of 40 million nappies and diverted 8,000 tonnes of waste from landfill. It has enabled many Local Authorities to separately collect nappies from their residents, knowing there is a cost-effective 'circular economy' solution that recovers and recycles the raw materials to be utilised a second or even a third time. The recycling technology is introducing a more environmentally sustainable solution for dealing with disposable nappy waste, while also providing new opportunities for manufacturers of fibre-based products.

Due to the level of interest from prospective manufacturers, NappiCycle now intends to build a second, larger facility in Wales during 2019/20, which, in conjunction with the existing facility, would provide sufficient capacity to process the majority of waste nappies generated in Wales.



The main output is a mixture of synthetic and natural based cellulosic fibres in pellet form. This is now being put to use as replacement raw material, which can be used in the manufacture of new products such as thermal and acoustic insulation panels, fibreboards, packaging and spill absorbent products.



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**Ammanford**

# Innovation in advanced packaging technologies

**SPTS Technologies has developed innovative wafer processing solutions for advanced packaging of semiconductor devices.**

**T**he semiconductor industry is always looking to make devices smaller, faster and more power-efficient. This is particularly true for mobile communications and wearable devices, where reducing costs is also a key driver.

To fit more functionality into a smaller area, device manufacturers have been looking for advanced packaging methods to combine different die together as closely as possible, saving space and increasing performance and speed with less power consumption. Among

semiconductor device manufacturers, the fastest growing solution is Fan-Out Wafer Level Packaging (FOWLP).

The use of FOWLP reduces costs and makes the package thinner, which benefits smartphone makers, but it introduces some challenges for the PVD supplier. Newport-based company SPTS Technologies has developed its Sigma fxP PVD system to combat these issues, while maximising wafer throughput to reduce manufacturing costs.

To address the requirements of emerging advanced packaging applications, the company has introduced three main innovations for PVD on FOWLP wafers. The first is a fully integrated multi-wafer degas module, which can effectively degas up to 75 wafers simultaneously. This allows for

longer degas times to improve the electrical performance of the deposited metal, without impacting wafer throughput. The second is a pre-clean treatment, specifically designed to prepare the bond pad surface for deposition without releasing excessive levels of carbon monoxide, which would cause unwanted contamination.

The third new innovation is a pasting ring that reduces the need for a full pasting step, which interrupts production, from every 10 wafers to once every 1000 wafers. These three innovations all contribute to improvements in the PVD film quality while typically doubling wafer throughput for the device manufacturers, and SPTS Technologies recently won a Queen's Award for Enterprise in Innovation for these developments.



Physical Vapour Deposition (PVD) is a well-established process within the semiconductor industry, used to deposit thin metal films onto semiconductor wafers in order to create electrical connections during the manufacturing of chips or 'die' on the wafer.

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