The BioComposites Centre
ANNUAL REPORT 2015

BC 25 Years 1989-2014

PRIFYSGOL BANGOR UNIVERSITY

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BEACON
From plants to products
O blanhigion i gynhyrchion
RegioStars 2014 Winners

Llywodraeth Cymru
Welsh Government

ERDF
Llywodraeth Cymru
Welsh Government
Ewrop & Chymru: Buddsoddi yn eich dyfodol
Cronfa Datblygu Rhanbarthol Ewrop
Europe & Wales: Investing in your future
European Regional Development Fund

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Annual Report 2015

Welcome

Our 2014/15 financial year got off to a flying start in September with our Panel Products Master Class and 25th Anniversary Dinner. To help celebrate we invited past staff members and guests to commemorate this success with an evening of lectures, followed by a lovely meal and all in good company.

Getting ready for the celebrations prompted me to look back at our past achievements and look forward with a new perspective. Increasingly research funding is focussing on impact and this year the BioComposites Centre (BC) produced an impact case study on the work of Prof Mark Lawther in developing a novel fractionation process. This research led to a recent multi-million pound investment in a new food ingredient factory in Sweden. Collecting the evidence to support a case study involved a great deal of effort and I learnt a lot from this process. With this in mind, we must ensure we can continue to provide strong case studies and a key to this is the data we need to evidence our future claims. This will feature strongly in our future strategy moving forward in the next 5 years.

This year I have seen a greater emphasis on communication and dissemination of research. EU and UK Governments highlight this as a key area for improvement. I therefore hope that our 2nd annual report, the enhancement of our web page and the continued development of dissemination plans within all of our research will help support, promote and publicise our activities.

In 2015, we also secured new funding through the European Regional Development Fund (ERDF) with the successful launch of BEACON+. This is a sign that we have achieved and secured significant benefits to Wales. With BEACON we had an award winning project that induced investment of over £7M through 54 collaborative projects and assisted 150 companies. We will continue to build upon this success and work to develop and strengthen the bio-economy within Wales and the UK through the new BEACON+ investment.

So, once again thanks to staff and a big thank you to all our project collaborators and funders for all your support.

Strategic aims and objectives

The EU's vision is for a Bio-based Industry that will optimise land use and food security through a sustainable, resource-efficient and largely waste-free utilisation of renewable raw materials. Since 1989, BC has led at the forefront of research & development and the commercial application of bio-based alternatives. To help achieve its objectives the Centre has four strategic research themes:

- Biorefining managed by Dr Adam Charlton, looking at the process and production technologies needed to convert and manufacture new products from biomass or waste materials
- Low Impact Materials managed by Dr Graham Ormondroyd, looking at the characterisation and enhancement of bio-based materials with improved performance
- Chemistry of Natural Products managed by Dr Slava Tverezovskiy, looking at the isolation, characterisation and functionalization of natural molecules/polymers
- Supercritical CO_2 managed by Prof Ray Marriott, looking at the fractionation, extraction and modification of bio-based molecules

Developing collaborations and exploring new technologies, is led by our Open Innovations Manager Radek Braganca.

BC works at the interface where academic research meets with industry seeking to look at the utilisation, conversion and development of bio-based feedstocks.

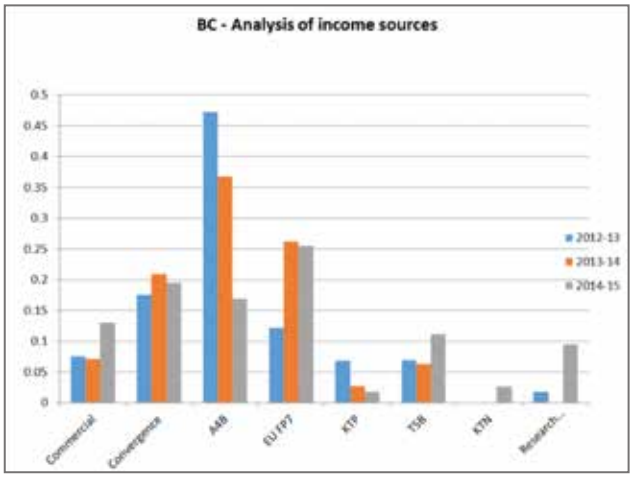
A key aim for 2014/15 was raising awareness of the work undertaken at BC and this is being achieved through a number of initiatives. This year saw BC host a series of visits from Innovate UK's Lead Technologists. Lead Technologists identify upcoming research areas and shape future funding calls. The visits to Bangor included tours of our Biorefining Technology Transfer Centre (BTTC) facility at Mona, highlighting the capability BC has in demonstrating technologies to industry.

Successful new projects this year include funding secured from Innovate UK, BBSRC and EPSRC. In September 2014 we started our first ever project using a synthetic biology approach to synthesise novel herbicides, funded by BBSRC. The 3 year project is a collaboration with Bangor University's School of Biological Sciences and commercial partners Hockley International Ltd and Almac.

In October 2014, we started working with MDF Recovery Ltd to look at the recycling of MDF. The project was funded through Innovate UK's competition on Supply Chains for a Circular Economy.

In April 2015, BC kicked off a new EPSRC funded project looking at the challenges of straw fractionation working with Beijing Forestry University. The collaboration includes a major global packaging company and we hope that this will lead to new collaborations with China.

This year we have also increased our commercial income. Having commercial funding ensures that we understand the market demand faced by companies. Having a commercial relationship with an industrial client helps us understand their future needs and this insight can then be effectively developed into future collaborative research.



In 2014/15, we continued to invest in new equipment and in our people. This year we successfully supported staff members with their re-grading and encouraged applications for professional Charter and Fellowships of Institutes such as IOM3.

Table 1. Staff numbers for 2014/15

Research Staff	18
Technical	10
Administrative and project support	4
PhD students	4
KTP Associates	1
Total	**37**
Student internships	3

Challenges in 2015/16 will be to focus on H2020 projects, continue to work with Innovate UK funding and to increase our commercial work. H2020 will be challenging as it is very competitive, however, as a region with a commitment to the bio-economy Wales could play a bigger role and help leverage additional funding. With a wealth of opportunities and support from the senior management team, I look forward to meeting these challenges.

Dr Rob Elias, Director.


Rob Elias


Adam Charlton


Graham Ormondroyd


Radek Braganca


Ray Marriott


Viacheslav Tverezovskiy

National and UK Funding

£479,000 invested in Biotechnology for Green Pesticides

The Biotechnology for Green Pesticides project is BC's first project to utilise a synthetic biology approach. This three year research is co-funded through BBSRC/ Innovate UK and it aims to bring to the market a novel natural herbicide produced via an enzymatic route from an abundant natural oil. "It will be a close collaboration between BC, the School of Biological Sciences and two commercial partners, Hockley International and Almac," explains Dr Viacheslav Tverezovskiy, who is leading this research.

Frank Howard, MD and owner of Hockley International commented, "Hockley has worked with the friendly and professional team at the BioComposites Centre for some four years on a large KTP project and some smaller items of research. Now we collaborate in a new major three year project in synthetic biology along with Bangor University and Almac which promises to be most exciting and scientifically challenging for us all."

Professor Tom Moody, Head of Biocatalysis & Isotope Chemistry at Almac adds, "Almac is very excited about the project between Bangor and Hockley and the development of a specific enzyme technology that will enhance not just the project but also the UK development of value adding technologies."

Mona helps close the loop and build a circular economy

Driven by the need to improve and recycle the materials used by large retailers has led to the development of a consortium to tackle the issues of recycling MDF. To support the research MDF Recovery Ltd won an Innovate UK competition securing a total grant of £535,000.

Managing Director Craig Bartlett of MDF Recovery who is the project manager and inventor of the technology explains, "Having access to the equipment and facilities at Mona is really important for the project. As a small company it would be impossible for me to find the money needed to bring together process equipment like fibre dryers, presses and fractionation systems. So having all this equipment at Mona is really helpful".

Using a patented process technology waste MDF from off cuts or old furniture can be reclaimed and used to make new MDF or insulation products. BC Technician Dafydd Glyn Roberts helps run the trials and is getting to grips with designing a new fibre fractionation processes. "Working on this project has helped me develop some of my engineering skills. Being part of a team is really interesting and we have developed a new process to handle the fibres. My role is now to help scale this with Multiplex, the engineering partners for MDF Recovery," explains Dafydd.

Other project partners in the consortium include C-Tech Innovation, Helistrat Management Services, SITA, Natural Building Technologies Ltd and Axium Process Ltd.

BAW project meeting

China straw fractionation project

Prestigious EPSRC funding won to collaborate with China on straw biorefinery

In April 2015, an exciting collaboration won funding through a Manufacturing Sustainability competition run by Innovate UK. The grant brings together Beijing Forestry University, global coating company PPG and Beaumaris Technology Ltd. to develop a biorefinery process based on straw. The investment brings a £593,000 grant to the UK and Chinese partners.

The project will look at the fractionation of straw for chemicals and fibres using the newly commissioned wet fractionation line at BTTC, Mona. The aim is to develop a novel bio-refinery process that will extract new chemicals for coatings, phenolic components for adhesives and fibres for packaging applications. Dr Adam Charlton and Dr Qiuyun Liu will be managing the project for BC.

"Getting EPSRC funding is significant," commented Adam. "The project aims to tackle a number of significant technical challenges. A key step is to develop a process that can economically separate the straw. Using the wet fractionation line and the expertise of Beaumaris Technology, we hope we can develop some really novel approaches."

The wet fractionation line uses heat and mechanical processes in combination with enzymes to carefully open up the biomass structure. This prevents damage to the cell wall constituents and makes it easier to fractionate and separate the different components. "The process was first developed for the food industry and we are now using it for other industrial applications. Using the BTTC facility at Mona will enable us to demonstrate the new methods," explains Prof Mark Lawther of Beaumaris Technology Ltd.

Working with Chinese businesses and Prof Sun at Beijing Forestry University will enable the team to develop new skills in the extraction of sugars and lignin for the development of new coatings and resin systems. The Chinese industrial partners include Shandong Longlive Bio-technology Co Ltd. Longlive is a main manufacturer of natural products such as sugars and starches for food and industrial applications and will be an important technology partner for the consortium. In October 2015, the UK team will visit Beijing to learn more about the development of the biotechnology market in China.

NRN-LCEE Research cluster "Plants and Architecture"

This year BC became part of Sêr Cymru National Research Network for Low Carbon, Energy and the Environment (NRN-LCEE). The research cluster is a collaboration between Bangor, Aberystwyth and Cardiff Universities, and the subject is "Plants and Architecture". The Network aims to encourage research that crosses traditional boundaries between disciplines and improves cooperation and knowledge exchange between Universities. The four year project funded by Welsh Government will enable the appointment of a new research fellow at BC and a joint PhD student with IBERS at Aberystwyth University. The research cluster has three primary objectives, as Dr Graham Ormondroyd explains: "We want to investigate the interaction between plants

and buildings, for example looking at ways of growing crops as part of building design; looking at the benefit that plants bring to the living space as a source of low carbon materials to improve in-door air quality and study the impact on human well-being."

Prof Iain Donnison, Aberystwyth University commented, "The challenge will be to bring together the three disciplines of plant science, materials science and architecture and for each of the disciplines to learn from each other. It will be an exciting journey working between the disciplines to create the crops, buildings and cities of the future."

Beacon +

BEACON is a partnership between Bangor, Aberystwyth and Swansea Universities helping companies develop bio-based technologies. Funding from the Welsh European Funding Office through the European Regional Development Fund has allowed the partners to work across the supply chain, through collaboration with Welsh SMEs from a wide range of sectors, in order to generate a number of products from biomass (e.g. fuels, energy, chemicals and materials), using a concept called biorefining. BC, the lead partner at Bangor University, has expertise across a number of areas including composite and packaging materials produced from biomass, and the extraction of bioactive plant chemicals for a range of applications in the food, personal care and cosmetics sectors. The first phase of funding (2010-2015) has allowed BC to recruit new staff from a range of disciplines including process engineering, chemical process development and life cycle assessment. It also enabled investment in novel pilot plant equipment to assist with the upscaling of various processes. Some items of new equipment are highlighted elsewhere in this report.

As a result of this funding BEACON has assisted 150 Welsh SMEs in the Convergence Regions of Wales, across many different sectors, from conducting small feasibility studies through to larger collaborative projects which have resulted in additional RC:UK (Innovate UK) and EU (Horizon 2020 funding) being secured. A total of 52 new jobs have been created across the three universities and over £7 million of additional research funding been secured.


Mona BTTC

BEACON's success was highlighted when in 2014 it won the European Union's Regiostars Awards in the category 'Sustainable growth: Green growth and jobs through Bio-economy' having been selected from 80 projects which are supported by EU cohesion policy funds.

The first phase of funding finished in June 2015, a bid for a further 4 years of funding to consolidate and expand the project's activities was submitted and approved in the summer 2015. BEACON + will follow on and develop new and larger projects for Wales.

Building success in modified wood


Thermally modified wood

A thermally modified timber developed during collaborative research with local companies has been used to clad Halen Mon's new Saltcote building on Anglesey. Larch timber from Welsh forests was thermally treated at the UK's only active thermal modification kiln on Anglesey for the elegant new building.

The project, which developed the thermal modification process, involved eight partners and Bangor University. Partners covered the supply chain from sawmill, timber merchant, timber treatment and joinery and other secondary processors of wood. The thermal treatment process is better known from European imports of Thermowood, but this lower intensity process was developed to work well with local timbers and to be easily produced by small businesses. Treatment of larch was less severe than European processes, due to the inherent natural durability of larch heartwood. The product was an attractive colour, and was easily machined to a good finish with enhanced appearance and stability. High quality joinery products are another target market for the treated timber.

Project manager Dr Morwenna Spear said, "The scale up of the technology from the lab and pilot scale (by BC and Coed Cymru) to the full scale (by Menter Mon

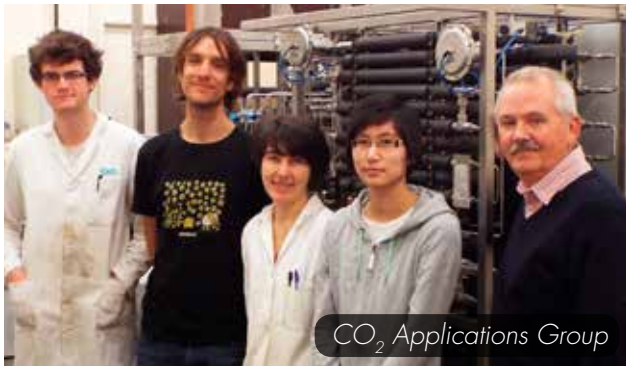
and Coed Mon) were significant outputs. Seeing the final installation of the thermally treated cladding product on a prominent tourist attraction is a brilliant showcase for this technology."

The project was funded by the Welsh Government using European Regional Development Funds through the Academic Expertise for Business (A4B).

CO_2 Lab expands

The long term strategic objective of the CO_2 Lab at BC is to establish an applications group that will be recognised as the leading UK centre for supercritical fluid extraction, fractionation and reaction chemistry. In part this has already been achieved by the establishment of the laboratory and pilot scale process plant, with supporting pre-treatment and analytical facilities. The CO_2 Lab is recognised by industry and academia as a unique resource for the development and scale-up of CO_2 processes and this is reflected in the many collaborative projects in the last year. This has been further enhanced by the drive towards the use of greener process techniques and the reduction in the use of volatile organic compounds (VOCs).

In the last year we have established new applications for the use of supercritical carbon dioxide ($scCO_2$), particularly in the downstream processing of fermentation products, most notably biosurfactants, and the fractionation of complex natural products such as essential oils. This has resulted in patents, publications and wider dissemination at conferences in the UK and Europe. We have carried out collaborative research with 22 UK and European companies from multi nationals to SMEs and with academic groups at Bath, Birmingham, Imperial College, Nottingham and Ulster. We have completed two Welsh Government A4B projects, both of which were highly successful and led to the development of commercial products. Our three year TSB funded (now Innovate UK) sustainable manufacturing project finishes at the end of 2015 but in the last year we have developed the processes through the pilot plant stage and carried out successful technology transfer to a 2000kg scale at a contract manufacturing facility in Europe.



CO_2 Applications Group

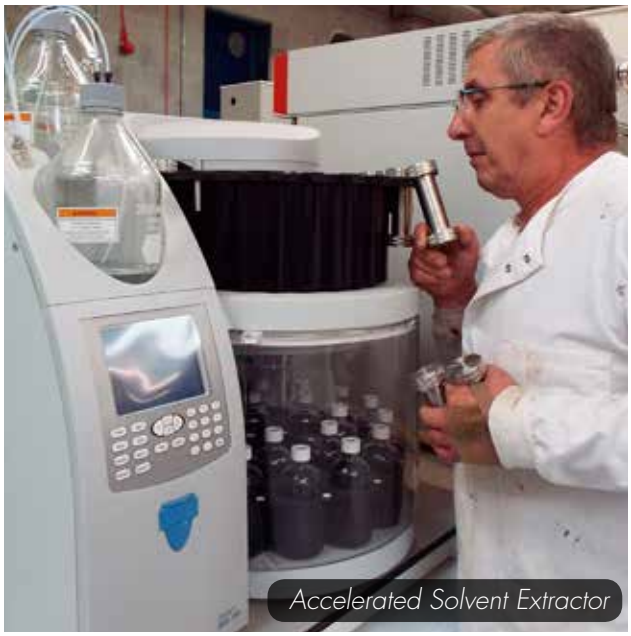
One of the most exciting areas of research at present is the production of high value molecules by enzymatic synthesis in $scCO_2$. During this year we have constructed and tested a continuous reactor that is run on one of our laboratory rigs. This has enabled us to study reaction kinetics in detail and to begin to understand the potential for this technology which continues to surprise us in its efficiency, stability and economics. With all of these applications the energy requirements and life cycle analysis is a crucial part of developing "greener" alternative processes and is embedded into all of our projects. Optimisation of process parameters to minimise energy use is a key part of every project and we have published our first papers on the optimisation of oilseed extraction.

There is now, more than ever, a greater awareness of the potential for $scCO_2$ to be used as a process solvent and the CO_2 applications group at BC is ideally placed to support this.

Investment in Infrastructure

An ASE way for extraction of biomass

Faster and more accurate extractions with the Accelerated Solvent Extractor (ASE) are now possible with a Dionex ASE 350 system. The ASE is used to extract solid and semi-solid sample matrices using common solvents. Operating at high temperature and pressure the kinetics of the extraction process are enhanced resulting in extraction efficiencies similar to a Soxhlet extractor, but in less time and using less solvent. ASE can be used for the extraction of polychlorinated biphenyls (PCBs),



Accelerated Solvent Extractor

organochlorine pesticides (OCPs), base/neutral/acid (BNA) compounds, organophosphorus pesticides (OPPs) and herbicides.

Dr Dave Preskett explains, "The equipment can handle a number of applications including: determining perchlorate levels in food and soil samples; PAH compounds from environmental materials including soils, sludge, and other solid wastes and extraction of phenolic compounds from plant tissue which is an area I am currently studying. Using this equipment really helps to speed up the number of experiments I can complete in a day." The equipment was purchased through support from the Welsh Government's A4B scheme and is currently the only one in Wales.

Ultra filtration unit for fractionation plant

This year we installed a pilot scale wet biomass fractionation line at our Biorefining Technology Transfer Centre (BTTC).

The line is used to fractionate wet biomass (plant material) into a series of products that have value for applications in the food, nutraceuticals and cosmetics industry. This pilot scale equipment will demonstrate to industry that enzymes, rather than chemicals can be utilised to breakdown a wide range of biomass (e.g. food processing waste, agricultural co-products) into its component parts including sugars and proteins. The system is flexible and uses state of the art processing techniques for wet biomass.

The line is an integrated system consisting of a number of sections including two 150 litre stirred stainless steel tanks connected to a colloidal wet mill and linked to a series of centrifuges (separators and decanters). One of the key processes is the use of membrane filtration to separate out various fractions that are produced as a result of enzymatic hydroylsis. To do this a pilot scale ultrafiltration unit, supplied by Axium Process Ltd, which can separate out materials with well defined molecular weight ranges has been installed in line.


Ultra Filtration Unit

The final part of the pilot scale wet fractionation line is our new Anhydro Laboratory Spray dryer. This equipment is designed for scientific testing work, industrial research and development, as well as for small-scale production. It will allow us to take specific fractions from the wet line (e.g. sugars or proteins) dissolved in water and dry them to produce powders. The equipment is capable of removing up to ~7.5 Kg of water per hour from a sample.

VSEP filtration unit

In 2014, BC's separation capabilities substantially expanded with the acquisition of VSEP Series LP filtration unit. This machine can handle a full breadth of membrane filters – from microfiltration (0.02 - 1µm) and ultrafiltration (2-200kDa) to nanofiltration (90-1000Da) and reverse osmosis (30-80Da). Laboratory mode with 1 membrane


VSEP Training

is suitable for small research samples while Pilot mode with 38 membranes can handle filtration rate up to 100L/h. "Due to vibration of the membranes, the VSEP filtration unit has a very high throughput and does not lose filtration rate over time as much as other systems," explained Dr Viacheslav Tverezovskiy, who manages the Chemistry of Natural Products Group. BC staff received full training from New Logic Research (who supplied the unit) to operate the equipment.

People and Awards

Ron Cockcroft Award

Bronia Stefanowski received the Ron Cockroft Award in 2015. The International Research Group on Wood Protection (IRG-WP) presents this prestigious award to PhD students to enable them to attend the annual conference and present their work to an international audience.

The IRG-WP is an international society with a focus on wood protection, preservation and degradation involving all forms of organisms from decay fungi to termites and marine borers. It is acknowledged as one of the leading groups in this area.

Bronia Stefanowski

Bronia presented her work on 'The Development of a rapid screening method to determine the susceptibility to mould growth of novel construction and insulation products' at the IRG/WP annual conference in Vina del Mar, Chile. The paper was well received and stimulated a good discussion.

Bronia, currently in the 2nd year of her PhD at BC, commented, "Going to the IRG conference was fantastic - it allowed me to experience presenting to an international audience as well as to network with some of the most influential people in wood protection."

Fellowships – IOM3

The start of 2015 has seen two members of BC's materials research group, Dr Morwenna Spear and Dr Simon Curling, accepted to the highest grade of membership of the Institute of Materials, Minerals and Mining (IOM3), a major UK engineering institution and a leading authority on materials.

Dr Graham Ormondroyd, head of the materials research group commented, "This award for Morwenna and Simon has shown that they are able to adapt their skills across the materials research sector whilst retaining and developing their specialist areas of research. I am very pleased that the BioComposites Centre has helped support their professional development."

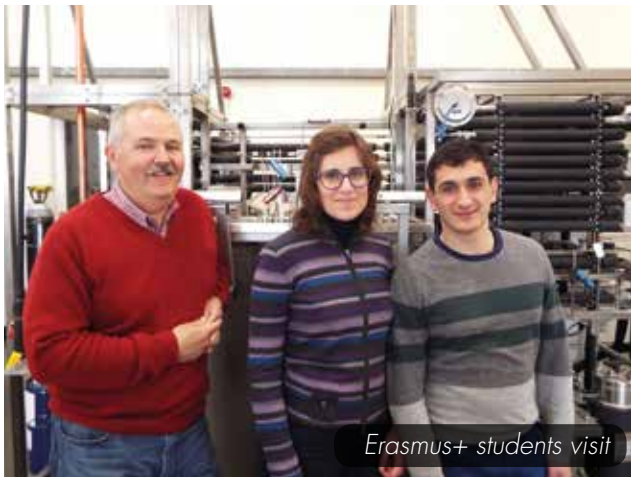
Their fellowships were awarded through the Wood Technology Society, a division of IOM3. The aim of the Society is to advance and encourage scientific, technical and practical knowledge of timber and wood based materials.

ADAPTAVATE UK finalist in Clean Launchpad EU competition

Congratulations to ADAPTAVATE who have gone from strength to strength with the advancement of their low carbon alternative to plasterboard. Tom Robinson first approached BC in early 2014 with the idea of setting up a company to manufacture a product he had developed while being a student at CAT (the Centre for Alternative Technology). Firstly through LIMNet (Low Impact Materials Network) and then through BEACON BC have helped in that journey. In September 2014, ADAPTAVATE represented the UK at the Clean Launchpad finals in Valencia, Spain and won a place on the Climate-KIC Accelerator programme. Now this young start-up company is facing the new challenge of how to scale up production to meet growing interest and orders. Interest includes some big names like Kevin McCloud, architect and presenter of the popular TV show Grand Designs, who chose ADAPTAVATE to feature as "Green Heroes" at Grand Design Live which took place at ExCel in London from 2 - 10 May 2015.

Erasmus+ students visit CO_2 Lab

In April 2015, we welcomed two Erasmus students from University of Salerno, Camilla Milano and Giovanni Salvatore, to work in the CO_2 applications group for three months. During the visit, Camilla studied the extraction and fractionation of sugars using $scCO_2$ and Giovanni compared the enzymatic synthesis of esters in traditional solvents such as heptane with synthesis in $scCO_2$. Both projects were very successful and have significant applications in industry. The work will be submitted for publication within the next few months. This is the first experience we have had with visiting Erasmus students and it has been very positive and rewarding for us all.

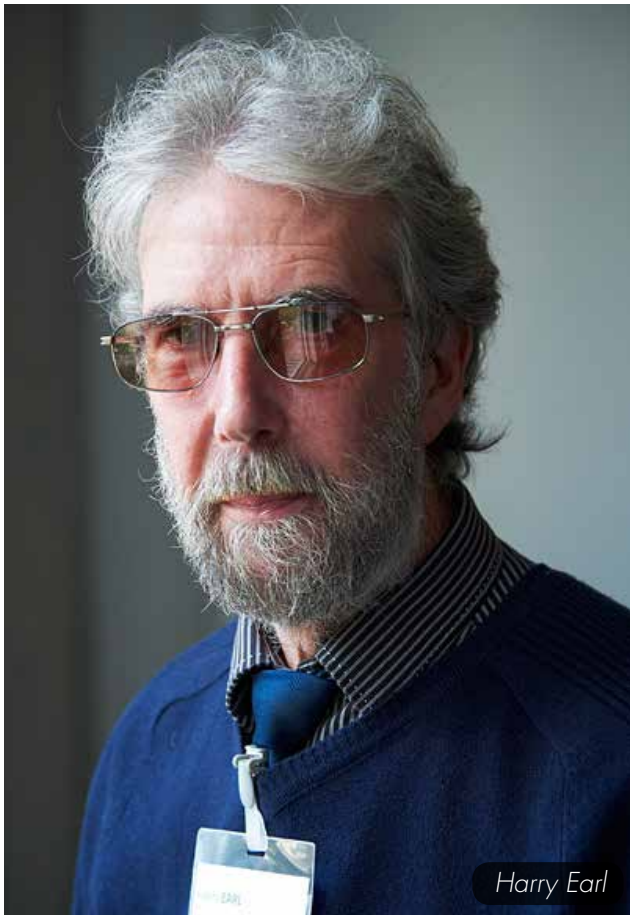


Erasmus+ students visit

We are now already planning further collaborations with other universities. "The Erasmus scheme gives us valuable links to European universities that have complementary skills and interests. Developing collaborations and relationships with EU research groups is a key aim for us to achieve new funding under Horizon 2020," explains Prof Ray Marriott.

Launch of the Harry Earl Memorial Scholarship

Industrial contributions from Kronospan and CRC Ltd have led to the establishment of a new scholarship fund offered by BC. The memorial scholarship fund commemorates the life of Harry following his sudden death in October 2013.



Harry Earl

"Harry had an impressive professional career that spanned academia and industry," explains Dr Rob Elias. "To help commemorate his life we are offering individual awards of £500 to assist early career people working in the wood based panel sector. The aim of the award is to help successful applicants achieve their professional goals and as Harry generously helped and supported his junior colleagues I am sure he would approve."

Harry gained his PhD at Bangor University and started his woodscience career by establishing the forerunner of the BioComposites Centre, Wood Tec. Here, Harry worked with companies to develop novel technologies for timber treatments; ground breaking work was undertaken including early studies into the acetylation of wood fibre. Leaving Bangor Harry held senior technical positions in industry at factories throughout the UK: in Cowie for Norbord, at Knowsley for Sonae and finally as Technical Manager at Kronospan, Chirk.

Networks

China Link brings new opportunities

Adam Charlton joined Prof Dave Chadwick (School of the Environment, Natural Resources and Geography) to represent Bangor University as part of a Welsh Government mission to Beijing's Capital Agri-Business Group in December 2014. The visit was designed to promote the strength of Wales' R&D capability in the food supply chain and enhance the close collaboration between Welsh scientists, the Chinese food industry and Chinese academia. It also helped Chinese business to understand Wales' investment environment, attract investment from China and maximise cooperation opportunities.

Wales-China collaboration

The group visited dairy farms, milk and feed processing factories and had a meeting at the State Administration of Foreign Expert Affairs with the Deputy Administrator Mr Zhaohua Sun and Director Mr Zhu Xuefung. The meeting provided an opportunity to promote existing links

between BC and Beijing and discuss future collaborations with Chinese companies and academic groups. We look forward to continuing collaborations and return visits in the near future.

Following the workshop, Dr Adam Charlton visited the labs of Prof Runcang Sun at the Beijing Forestry University (BFU). Prof Sun is Director of the Beijing Key Laboratory of Lignocellulosic Chemistry and Dean of the College of Materials Science and Technology at BFU, and has collaborated with the BioComposites Centre for many years. Following a tour of Prof Sun's laboratory there was also an opportunity to visit some of the biotechnology companies which he collaborates with. These companies are based in Qingdao City, Shangdong Province which is about three hours train journey from Beijing. The companies are involved in the production of a wide range of value added products from biomass residues, including bioethanol, adhesives and artificial sweeteners.

Some of these companies and Prof Sun's group are also partners in a recently funded UK-China project which has been supported by Innovate UK, through the prestigious 'Manufacturing Sustainability (with China)' initiative. The two year project, with a value of £593,000 is jointly led by the BioComposites Centre and BFU and will investigate the production of value added materials and chemicals from straw, using a range of pre-treatment and fractionation technologies.

Centre helps Indian Coir Industry add value

In February 2015, The Department of Coir Development, Government of Kerala, India invited Dr Rob Elias to give a talk at their International Symposium on the use and development of natural fibre products at the fifth Coir Kerala Fair. The event aims at exploring and expanding the international market for coir products from Kerala and encourages use of latest machinery and technology in the coir production sector.

Coir symposium

Rob Elias explained the huge possibilities of marketing natural fibre-based materials in Europe. He cited areas for coir research that could be of relevance to this large European market including combination with other fibres, use of thermoset bioresins, as well as applications in construction and food packaging. Rob also urged coir researchers in India to take advantage of the funding offered through the India-UK Collaborative Industrial R&D Programme under which industries can bid for funding.

InnovaWood Network General Assembly

The 2015 General Assembly of InnovaWood was held in the Croatian Capital of Zagreb, 10-11th June. BC joined the network in 2014 to support the development of EU research into wood based products and Dr Rob Elias reports back on the progress achieved to date.

InnovaWood is an umbrella organisation that integrates four European networks in the Forest, Wood-based and Furniture industries into a more effective mechanism to support innovation in these sectors. The overall aim of InnovaWood is to bring business benefit to the forestry, wood and furniture chain by providing a forum for member organisations to contribute more effectively to the development of the sector.

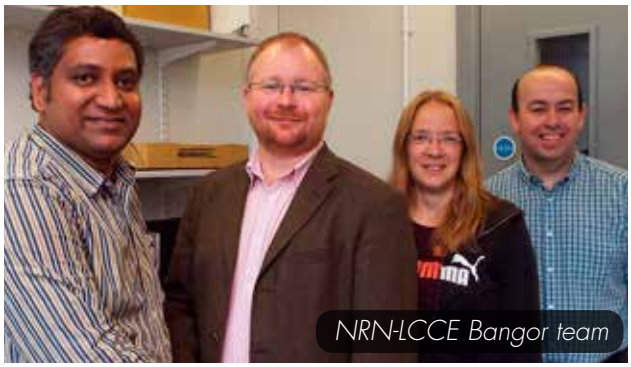
"The meeting format consisted of a series of lectures and workshops over 2 days and was attended by 40 people from 17 different countries that represented 27 different member institutions," explained Rob.

In the poster session, BC promoted closed loop recycling of construction wastes with its recycled MDF project. The Innovate UK funded project with MDF Recovery Ltd attracted a lot of attention.

"We are now developing a consortium of research centres and companies interested in developing an EU project. Using the InnovaWood network has really helped develop contacts and I hope will help BC win new projects," commented Rob Elias.

LIMNet wraps up

LIMNet, the Low Impact Materials Network wrapped up after 18 months, in December 2014. This project, funded by Welsh Government through the Academic Expertise for Business programme (A4B), brought together three Welsh Universities: Bangor, Swansea and the University of South Wales all which have an interest in the development of low impact materials. Ceri Loxton, who coordinated the network from the BioComposites Centre said, "Working within this network has opened up a whole range of exciting new prospects for the use of low impact materials in different sectors of the Welsh economy. We look forward to continuing to work in this area."



NRN-LCCE Bangor team

Outputs from the project included 11 seminars and workshops covering the three areas of (1) 3D printing and fabrication (2) construction materials and (3) smart and biomimetic materials. Eighteen scoping discussions and 15 assists were undertaken with Welsh companies. The range of assistance provided covered testing materials, making samples, sourcing information, linking to other academic partners, identifying sources of funding support and partnering in proposal writing. Bangor will be continuing with aspects of LIMNet with the appointment of Dr R.T. Durai Prabhakaran who joined BC in August as part of the NRN- LCEE Research cluster "Plants and Architecture" which will encompass many biomimetic themes.

Ugandan collaboration underway

This year has seen representatives from Bangor University take part in a University mission to Uganda to sign agreement to cooperate with Makerere University, Kampala (MUK). The agreement between Bangor and MUK will work as a platform for collaboration under the recently commissioned EC programmes Joint European-African Research and Innovation Agenda on Waste Management, to boost collaborative research and innovation.

Dr Graham Ormondroyd who participated in the visit said, "This agreement will bring a great opportunity to BC and the University by opening the doors for collaborative research with new partners within Africa. There are many complimentary areas of potential research and new funding streams to translate the work of the BioComposites Centre to this new platform."

Uganda collaboration

Currently staff from BC are working with MUK to finance a program on the valorisation of waste from food production within Uganda.

BBSRC - NIBB

In 2014, BBSRC launched 13 Networks in Industrial Biotechnology and Bioenergy that focus on unique research fields. Many of these research areas are directly relevant to the work of BC and we are members of almost all of the networks. The networks organise workshops, conferences and fund Business Innovation Vouchers (£5k) and Proof of Concept studies (<£150K). Since their launch the CO_2 applications group have activity participated with these networks. As a direct result the CO_2 applications group are currently engaged in three Business Innovation Vouchers with industrial partners and two Proof of Concept studies. "These projects have been funded by the IBCarb network, High Value Chemicals from Plants network and Plants to Products network," explains Prof Ray Marriott. "We also actively participate and present our work at network events. This often initiates new areas of research for us."

EVENTS

2nd UK Conference on Supercritical Fluids - Applications and Opportunities

Prof Ray Marriott and the CO_2 applications group organised and hosted the 2nd UK Conference on Supercritical Fluids, at Bangor University's Neuadd Reichel Conference Centre. "The last conference was 10 years ago," explains Ray, "so it was about time for the 2nd and it was a great opportunity for us to host it here in Bangor."

The conference brought together academic researchers and industry to promote the application of supercritical fluids. Attended by 84 delegates it was particularly pleasing to see that almost half of the delegates were from industry. This provided an excellent opportunity for networking with potential new project partners. Most of the delegates were from the UK with just 15% coming from the EU or further afield.

The conference covered four main themes: extraction and fractionation using supercritical fluids, reactions in supercritical fluids, particle generation and technological applications of supercritical fluids. It also gave an


CO_2 conference

CO_2 conference

CO_2 conference

opportunity for BC to demonstrate to delegates the capability of the CO_2 Lab, which has some of the best facilities in the UK.

In parallel to the conference, an exhibition allowed UK companies to showcase their services to this sector with laboratory and commercial equipment suppliers, bulk gas providers, stakeholders such as networks and agencies, including the Welsh Government, that all provide support for the development of new CO_2 applications. The conference was generously sponsored by the Welsh Government, Unilever and SciMed.

"Hosting this event helps raise awareness for the industry and although it is difficult to establish a direct link to the conference, the level of new industrial project work this year is at a record level," commented Ray. Following the conference Ray's team have been very busy writing new collaborative proposals with the project partners identified at the conference.

COST Action FP1303 Mould Training School

In June, BC hosted a 3-day training school on the evaluation of mould risk in buildings and on materials as part of COST action FP 1303 'performance of bio-based building materials'. Scientists from BC joined with experts from Bangor University and the Norwegian institutes of Mycoteam and Skog Landskap in a series of talks and practical sessions. The training school gave an introduction to the evaluation of mould and decay of bio-based construction materials.


Mould training school

Sixteen students from 13 European countries spent three days learning how to assess mould growth. A highlight of the course included access to a derelict building owned by Bangor University. Here students had first-hand experience in sampling moulds in a real life situation. Over the next two days, the students learnt how to culture these samples and identify the moulds seen in the old house. Other topics covered within the training school included the effects of moulds on human health and the current standards available for standardised testing.

Dr Simon Curling said, "The students took a real hands-on approach to the learning. They developed a better understanding of mould fungi and of the need for testing. I hope that this will be useful for improving the durability of future bio-based products."


Past & present BC staff

25 Years of Research at Centre

On the 16th September 2014, the BioComposites Centre celebrated its 25th Anniversary. To help commemorate the special occasion a gala dinner was held in Bangor. Guests included past and present staff along with delegates from the Panel Products Master Class and Bangor University's Vice Chancellor Prof John G. Hughes.

The celebrations started with guest lectures from Dr Adrian Higson and Prof Mark Lawther. Adrian works for the National Non-Food Crop Centre and he gave an overview of research opportunities within the bio-based sector. "The importance of the BioComposites Centre's research programmes like BEACON and the capability of demonstrating new technologies are key to working in this sector," explained Adrian.

Prof Mark Lawther talked about his role as a director of BC in the 1990s. With his insight, Mark explained some of the past significant achievements. Founded by Dr James Bolton, research included wood acetylation with Profs Bart Banks and Roger Rowell, pioneering chemical characterisation and straw fractionation with Prof Sun and the first studies of adhesive applications in MDF with Prof David Robson.

The celebrations continued over dinner with speeches from Dr Rob Elias and Mr Andrew Carpenter. Rob welcomed guests and paid tribute to the work of past and present employees and he thanked Nicola Sturrs, Becky Snell and Ceri Loxton for all their help in planning and organising the event. "I would like to thank everybody for their support and help over the years that have made the BioComposites Centre such a success," added Rob. Mr Andrew Carpenter, CEO of the Structural Timber Association, completed the evening by highlighting the importance of wood based research in the construction sector.


25 years celebration


25 years celebration


25 years celebration

Shoppers get to see packaging of the future

Prototype green packaging, developed as part of the STARS (Sustainable Products from Ryegrass) project, was on display at Waitrose, Menai Bridge on 18th November 2014. The STARS project, funded with support from the Welsh Government through the A4B scheme, was a collaborative project led by the BioComposites Centre at Bangor University, in partnership with Aberystwyth University and several industrial partners including Waitrose.

The Waitrose store hosted a display showing a variety of food items packed in the grass packaging product range, which currently includes food trays, fruit punnets and egg boxes. Shoppers were asked to comment on the product range to provide valuable feedback for the project. All the packaging on display was made using the new pulp moulding machine, supplied by Adare and located at the BC's Biorefining Technology Transfer Centre at Mona, Anglesey.

Quentin Clark, Head of Sustainability and Ethical Sourcing, Waitrose said, "Waitrose has been very pleased to have been involved with this work for a number of reasons. Obviously, the opportunity to explore novel ways to create more sustainable materials, such as packaging, holds its own attraction but this has been a great demonstration of a more open approach that shows how academia and business can work together, each contributing their expertise, to help deliver real, practical science to the market."

Biobased packaging

Bangor University's Vice Chancellor, Prof John G. Hughes commented, "The BioComposites Centre has a strong track record of working collaboratively with companies in Wales in order to commercialise sustainable products. Bangor is proud to be part of this very exciting project and we look forward to seeing the collaboration develop as part of the University's commitment to Wales and local business."

STARS and BEACON a winning success

The BEACON project received an invitation to present at the recent 3rd Bioeconomy Stakeholders' Conference, Turin, October 8 and 9, 2014. The theme of the conference session was 'Connecting the biomass: illustrating the bioeconomy system in action by following the flows of biomass and residues' and BEACON was presenting as a RegioStars 2014 winner, in the category 'Sustainable growth: Green growth and jobs through Bio-economy'. The RegioStars awards honour Europe's most inspirational and innovative regional projects. Finalists are selected on the basis of four key criteria: innovation, impact, sustainability and partnership. 19 finalists in 4 categories were identified from 80 projects which are supported by EU cohesion policy funds.


Biobased packaging

Attending and presenting were Adam Charlton (Bangor University), Mike Morris (Aberystwyth University), Steve Kelly (Swansea University) and Quentin Clark from Waitrose who provided an insight into sustainability from the retail sector.

Hidden Worlds - Get recycling that plastic packaging

This year a joint collaboration with Rebecca Colley Jones of Bangor's Sustainability Lab helped local school children learn more about materials used in packaging and how old materials can be easily recycled. As part of the annual Bangor Science Festival, The Hidden Worlds event, held on 14th March 2015, is where research scientists from Bangor University showcase their current projects to the public.

The BioComposites Centre's Becky Snell talked with local children about the materials used to make packaging. The display included products like fruit trays, punnets, egg boxes and pizza discs all made using natural materials. However, the highlight of the day was a recycling challenge. Children and some reluctant parents were set the task of sorting plastic into their different categories. "It was a great way of highlighting the different materials used to make things like bottles and containers used by the food industry," explained Becky.

Successful sorting of the waste resulted in the award of a junior waste sorting certificate awarded by Rebecca Colley Jones, Fellow and past Chair of the Chartered Institute of Waste Cymru.

Recycling challenge

Princess Royal shown STARS products

Princess Anne was shown a range of sustainable packaging products made from ryegrass, which were the successful result of the A4B STARS project.

The Princess Royal visited Bangor University's Henfaes Research Station at Abergwyngregyn on Friday 30th March. Rob Elias, Director of BC, and Karen Graley, Packaging Manager for Waitrose, were there to exhibit the work that we have been doing on sustainable packaging. Princess Anne showed a good deal of interest and knowledge and asked about the impact on land, food security and the product Live Cycle Analysis.

Royal visit

Further information

Our website has more details about the Centre and its facilities, our work and expertise and the current projects that we are involved with, together with the latest news. Why not take a look at http://www.bc.bangor.ac.uk

You can also follow us on twitter @bcbangor

Staff List

Staff Category	Name
Research Staff	Adam Charlton
	Ahmed Al-Dulayymi
	Campbell Skinner
	Ceri Loxton
	Courtney Williamson
	Dave Preskett
	Graham Ormondroyd
	Luis Martin Navarro
	Morwenna Spear
	Olga Tverezovskaya
	Paul Baker
	Quiyun Liu
	Radek Braganca
	Ray Marriott
	Rebecca Snell
	Rob Elias
	Simon Curling
	Viacheslav Tverezovskiy
Technicians	Anna Cervi
	Cerys Cowley
	Dafydd Roberts
	Derek Heathcote
	Gee-Sian Leung
	Gwenda Davies
	Jon Nicholls
	Nick Laflin
	Shon Jones
	Thanasis Dimitriu
Administration and Finance	Dominic Breslin
	Judith Burgess
	Nicola Sturrs
	Raine Williams
PhD students	Bronia Stefanowski
	Elie Mansour
	Sam Wright
	Sayma Akhter (Joint with CNS)
KTP Associate	Alan Hughes

Publications

Book chapters

Marriott, R. The Application of Supercritical Carbon Dioxide, Extraction of Functional Compounds. In: Chemical Processes for a Sustainable Future, Ed. Letcher T., Scott J. and Patterson D.A., Royal Society of Chemistry, 2015, 603-627

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Marriott R. (2015) Food waste processing using scCO2 – applications and limitations, FoodWasteNet Workshop, Reading, July 2015

Martin L. and Marriott R. (2015), Purification of Biosurfactants using Green Solvent Technologies, RRB11 Conference, York, June 2015

Marriott R. (2015) Fractionation of Complex Liquid Mixtures using Supercritical CO2 with Solid Supports, RRB11 Conference, York, June 2015

Marriott R. (2015) Extraction and Fractionation using Supercritical CO2, HVCfP Network Conference, Leeds, April 2015

Marriott R. (2015) Extraction of Flavour from Herbs and Spices, BHTA Flavour symposium, Reading University, March 2015

Marriott R. (2015) Valorisation of Co-products from Alcoholic Beverage Production, Beacon Conference, Bangor University, January 2015

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BioComposites Centre

Innovation in biomaterials for industry

Working in partnership with:

BBSRC bioscience for the future

EPSRC Engineering and Physical Sciences Research Council

BEACON From plants to products O blanhigion i gynhyrchion

AD NETWORK Harnessing Anaerobic Digestion

ASBP The Alliance for Sustainable Building Products

BREAD4PLA

BIO MAT PACK

cost Action FP1006

Innovate UK Technology Strategy Board

ECO-SEE Improving the indoor environment of energy efficient buildings

INNOVAWOOD

BIGODOS


LIGNOVAL


COST FP1303
Performance of bio-based building materials


KTN
the
Knowledge Transfer
Network


Multiplex
ENGINEERING LTD


High Value Chemicals
from Plants


IBCarb
NETWORK


NNFCC
The Bioeconomy Consultants


Hub Cymru Africa

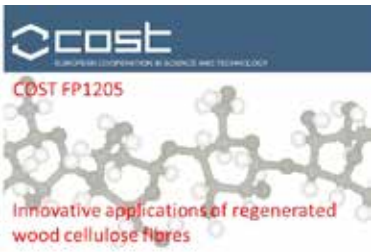

P2P
From Plants to Products
A Network of Integrated Technologies


LOW CARBON, ENERGY & ENVIRONMENT
RESEARCH NETWORK WALES RHWYDWAITH YMCHWIL
CARBON ISEL, YNNI A'R AMGYLCHEDD CYMRU


LBNet
Lignocellulosic
Biorefinery Network


VENTUREFEST
WALES 2015


BRIGIT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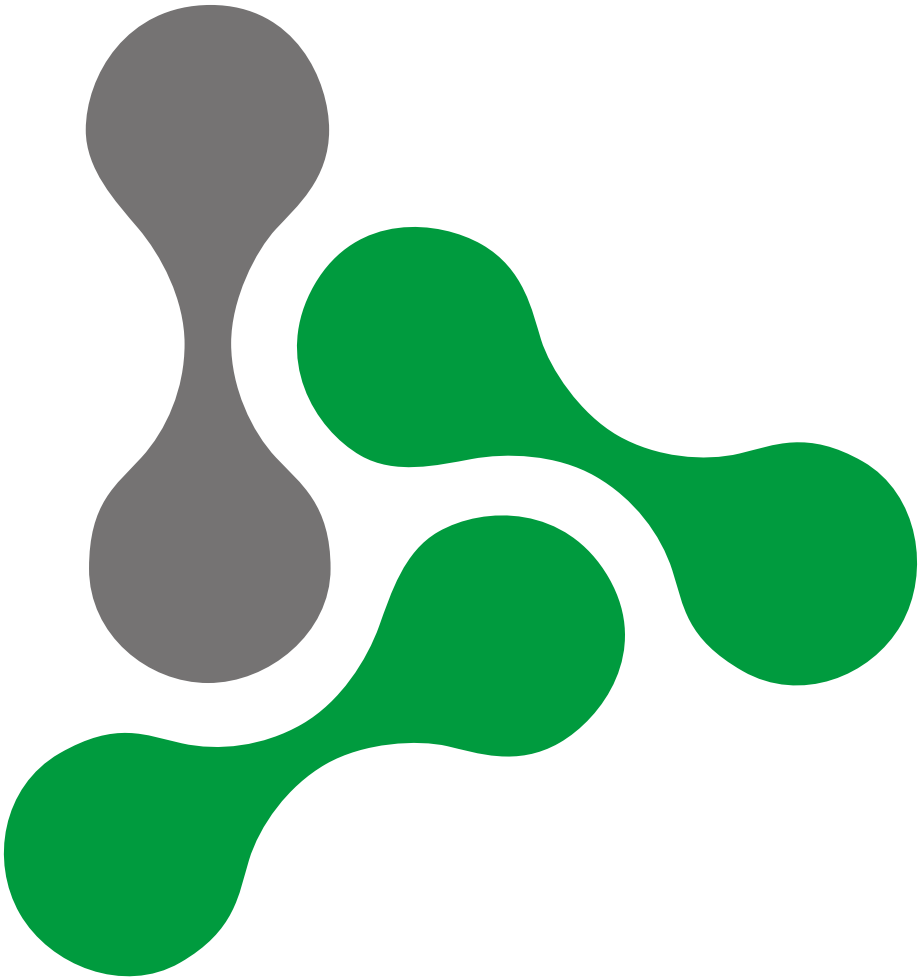
Innovative applications of regenerated
wood cellulose fibres


FoodWasteNet


Llywodraeth Cymru
Welsh Government


ERDF
Llywodraeth Cymru
Welsh Government
Ewrop & Chymru: Buddsoddi yn eich dyfodol
Cronfa Datblygu Rhanbarthol Ewrop
Europe & Wales: Investing in your future
European Regional Development Fund



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