# The BioComposites Centre
# ANNUAL REPORT 2020

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The BioComposites Centre
**ANNUAL REPORT 2020**

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BEACON
From plants to products
O blanhigion i gynhyrchion

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 2020

## Welcome *Dr Rob Elias: Director*

This year I would like to say a big thankyou to all the team for working together under some trying circumstances. Keeping our projects on track, helping our colleagues deliver their lab work and keeping our clients and sponsors up to date on progress during this period was a challenge. Well done everyone and a huge thank you!

We have all had to adapt to many changes in our working practices. A switch to online meetings, the closing and then restricted access to our laboratories, pilot facilities and field trials has been difficult. Getting things done has taken longer and involved more planning but in all cases, we have achieved. our aims which is a testament to everyone's commitment to getting the research done.

As well as continuing existing research projects with partners in China, India, Canada and Uganda we have developed new areas of research.

We successfully contributed to approaches to help combat the spread of COVID-19 through our work on bioactive compounds with virustatic properties; we looked at new biobased packaging formats to help support the e-commerce supply for online fish delivery and we are working on new approaches to help farmers decarbonise, develop secure food supply chains and move away from toxic chemical interventions to protect their crops.

We have also invested in new resources. New people joined our team and we have funds for additional equipment that will support the circular economy, encouraging the greater use of recycled materials such as wood in the built environment.

This investment in equipment and people will provide a strong platform to build our strategic research aims in line with Welsh and UK strategies. This will support and help to rebuild the economy through collaboration with SMEs and multinationals.

This year we have continued to develop and support strategic areas of research excellence within the College of Environmental Sciences and Engineering with joint funded projects linked to the University's Research Farm at Henfaes and to the Centre for Environmental BioTechnology (CEB). New areas of research collaboration are underway to look at the issues of microplastics and the growing use of AgriTech in food production and will support future student employability with internships, KTPs and open days. We will continue our planning to move our pilot plant to a new site on the M-SPARC Science Campus, this will further enhance our ability to work with industry and develop the region's economy.

*Dr Rob Elias: Director*

## Health and Safety a priority this year.

One of the key features of 2020 has of course been the COVID-19 pandemic which has had a major impact in all areas of the world and all aspects of life.

The first lockdown with its stay-at-home message obviously stopped BC from working in our laboratories but we continued to work supporting our clients and partners as best we could whilst adjusting to working from home.

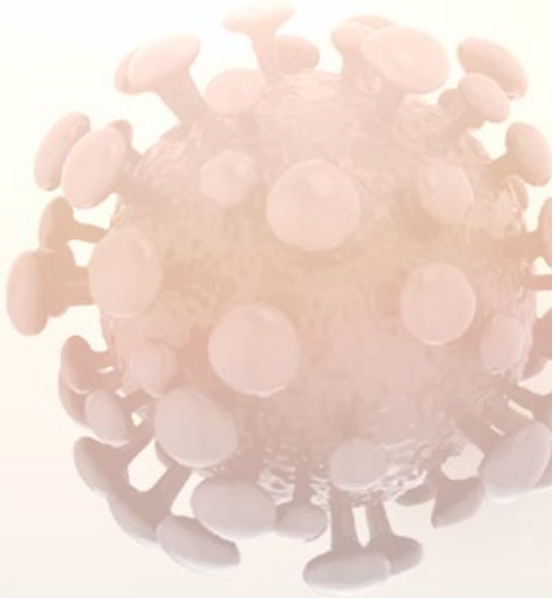
Later in the year we worked closely with the University Health and Safety Units to be able to re-enter our labs for the first time in a few months. Getting the labs back up and running required new ways of working, with safety a priority. This involved the time-consuming task of assessing the methods and risks involved with every project to see what steps could be made to increase COVID-19 safety.

Social distancing caused some issues with lab occupancy, but BC rose to the occasion with an in-house app, developed by Dr Athanasios Dimitriou, to book work areas that allowed us to keep a safe distance and use our time effectively.

During subsequent lockdowns here in Wales essential work has been able to be performed in our labs with our staff only on site when required, so if our staff do not answer their office phones they may be working from home.

Of course, with Microsoft Teams and Zoom the de facto communication and meeting methods that too has meant learning new ways of doing things and has, inadvertently, added to the fame of our staff's cats! Although we do of course miss our meetings and visits to partners!

As the pandemic has proceeded and changed, BC has worked closely with the University, and will continue to do so, to adjust and adapt to each new development. For example, the University provided asymptomatic testing for our staff after the Christmas holidays, to both increase safety and provide peace of mind. In 2021 we hope things will start returning to normal but in the meantime, we will continue to strive to deliver both top quality research and a COVID-19 safe working environment for our staff.



# National and International Funding

## Ten years of Life Cycle Assessment

This year marks ten years since our first full-time LCA analyst, Campbell Skinner, joined the Centre, although our involvement with life cycle assessment goes back a lot longer.

Campbell joined the team in 2011, originally to work on the BEACON biorefining project, but has since been involved in assessing environmental footprints for a range of biobased materials and technologies, across numerous research projects. Today, interest in LCA is such that the approach is included it in many of our research proposals and we have recently recruited a new member of the team to cope with demand.

BEACON
From plants to products
O blanhigion i gynhyrchion


*Campbell Skinner, BEACON Life Cycle Assessment analyst*


*George Roberts*

George Roberts, a recent Bangor University graduate, joined us in October 2020 to work on a Smart Partnerships project with Lignia Wood Company. This innovative project is using both environmental LCA and a relatively new approach called social LCA. Social LCA applies lifecycle assessment principles to assessing the social sustainability of a product. Our industrial partners at Lignia are confident that the research will demonstrate the superior environmental and social profiles of their modified timber products relative to existing tropical hardwood alternatives.

LIGNIA®
Wood made for life

# National and International Funding

BIOME BIOPLASTICS

Other work this year has seen the team partner with Biome Bioplastics, an innovative British biotech company, to assess the carbon footprint of their biodegradable tree shelters. Around 45 million trees are planted in the UK each year and most of these are planted using non-biodegradable shelters, many of which persist in the environment after use. Our work demonstrated the carbon emissions savings that may be achievable by switching to the fully biodegradable alternative.

In a busy year, 2020 also saw our work supporting a wide range of bio-based research undertaken by colleagues here at the Centre and further afield. We look forward to the year ahead and invite opportunities for collaboration from any interested parties.

*Tree guards in situ.*

BEACON

From plants to products
O blanhigion i gynhyrchion

## Approaching 10 years of Welsh biorefining research expertise

2020 will mark ten years of the very successful BEACON programme, a collaboration between Aberystwyth, Bangor and Swansea Universities, which is part-funded by the European Regional Development Fund (ERDF) through the Welsh Government.

Since 2010, BEACON has collaborated with over 300 companies across Wales and in 2014, was winner of the prestigious European Commission's Regiostars Award, in the category: 'Sustainable growth: Green growth and jobs through bioeconomy'. In 2019, further funding for the project was approved until 2022 and project activities have been extended into North East Wales, which is great news for building new collaborative links with companies there.

This year BEACON also welcomed a new project partner, University of South Wales, which further expands the expertise and capabilities within the project team. The USW team will bring wide-ranging expertise to BEACON, from bioplastics to anaerobic and aerobic processing and biological biogas upgrading.

To celebrate the first 10 years of BEACON we are planning an event that will take place in 2021 and will involve key stakeholders that we have collaborated with over the years.

# National and International Funding

## Learning how to transfer technology from laboratory to industry in Uganda

Bangor University is working together with Ugandan industry and academic partners to learn how techniques developed at Mona Technology Transfer Centre can be commercialised in a different country.

The Stoverpack project is exploring the feasibility of scale up opportunities in Uganda that will use maize stover (the waste stalks and leaves left over after the grain has been removed) to produce pulp moulded packaging for eggs, tomatoes, and other fruit and vegetables.

"BC has a long history of developing pulp moulded products from various agricultural wastes. Working with our Ugandan partners will help us understand more about the issues surrounding scale up from laboratory to an industrial process in a different country" said Dr Charlton who leads the project for Bangor.

Maize is Uganda's most important cereal crop, the crop is grown in every part of the country and provides a direct source of income for many households, traders and millers. Increasingly, maize has become a major non-traditional export cash crop, particularly benefitting smallholdings (small farms).

Currently there no higher value outlets for maize stover, but a proportion of this material could be diverted from more traditional uses without affecting soil fertility. By establishing novel pulping and packaging technologies, the project aims to reduce waste, boost farm income, and create new jobs in the biobased packaging sector.

*Samples of the types of products that can be produced*

# National and International Funding

## Developing Compol™ further for foamed packaging products

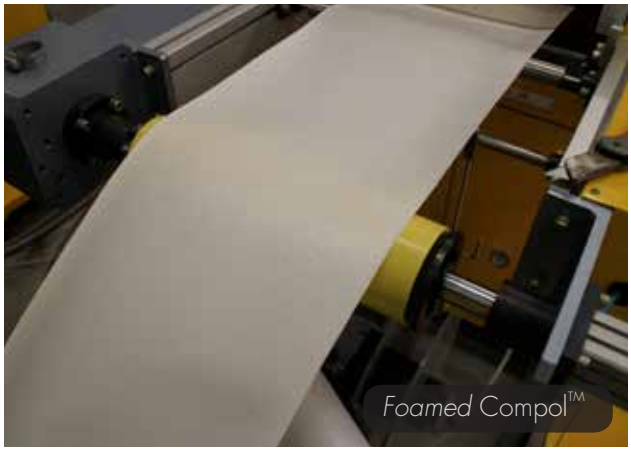
High raw material costs have limited the applications for biopolymers. Foaming is a good way to reduce not only the material cost but also the product weight.

Following on the success of the HDTBioPol (High Deflection Temperature BioBased Polymers for Horticulture and Food Service Applications) project, Wells Plastics and BC won the funding from Smart Sustainable Plastic Packaging call to develop Compol™ further for foamed trays.

Compol™ is the trade name of a biodegradable polymer developed on a project with BC and launched under this trade name in 2019.

BC have continued working with Wells Plastic to develop Compol™ and we are delighted to see that Compol™ can be foamed physically or chemically. So far up to 15% weight reduction has been achieved. The foamed sheet can be thermoformed into trays or lids, which would provide an alternative to problematic expanded polystyrene (EPS) and polyvinyl chloride (PVC) in pots, tubs and tray applications.

The project partners look forward to participating in the upcoming ISCF Smart Sustainable Plastic Packaging call.



*Foamed* Compol™

## Toothbrush Club

Reswirl intends to reduce the amount of single-use plastic with an eco-friendly toothbrush that can be returned, remoulded and transformed into new brushes.

The majority of toothbrushes are manufactured from a mixture of plastic materials that make it difficult to recycle at the end of their life. As a result, many toothbrushes end up in landfill or are littered.

To address this issue Reswirl successfully applied for a 3 month feasibility study funded by InnovateUK. In the project the Centre helped to develop a bioplastic compound suitable for this application. Dr Qiuyun Liu undertook a series of extruder trials to test out a combination of new bioplastic compounds and evaluated them for their mechanical performance.

Using this data Reswirl were than able to select the best formulation for their product prototypes and these toothbrushes were successfully evaluated in a consumer test. "We had fantastic feedback on the trials from our customers explained Conway Daw. Everyone liked feel and texture of the new brush, he explained"


The Reswirl toothbrush is made from a bespoke blend of a number of biopolymers that are able to biodegrade in marine and terrestrial environments. To promote the use of the brush the company offers a closed loop approach using a mail order system with direct delivery to the door and then direct return to the company of the used brush every 3 months. Used brushes will then be cleaned and recycled back into new plastic brush components.

For more information follow this link https://reswirl.eco/

# National and International Funding

## NASPA trials continue during COVID lockdown

Regulations and legislation are having an impact on the chemicals used to protect and grow crops and climate change is impacting the environmental conditions in which crops will be grown! The development of the plant biostimulant sector is an alternate approach to manage these changes. The Interreg Atlantic funded project NASPA is setting out a scientific approach to establish these benefits with partners across the Atlantic region.

Biostimulants are broadly defined as compounds derived from natural substances that contain active substances and/or microorganisms that, when applied to the plant or rhizosphere, promote greater efficiency of use of nutrients and/or can increase the tolerances droughts or floods whilst maintaining the quality and yield of the crops.

However, the function of biostimulants is not to provide nutrients- to the plant (such as conventional fertilisers) or to kill pathogenic fungi (such as conventional fungicide). However, they are involved in the processes of absorption and assimilation of nutrients, which then improve plant vigor making crops less susceptible to diseases.

Recent research regarding the use of biostimulants in plants references a range of potentially beneficial effects, such as :

- Significant improvement in the mechanisms of absorption and translocation of nutrients in plants, increasing their bioavailability.
- Improved resistance to environmental stresses, both biotic stresses, due to plant diseases, and abiotic stresses that are expected to be more frequent with Global Warming;

The BioComposites Centre working with the College of Natural Sciences, in Bangor, is collaborating with academics and industrial partners using Interreg funding, The project is seeking to develop new supply chains and will help to produce new biostimulant and biofungicide formulations.

Project Manager Dr Radek Braganca explains "We are really looking forward to the next developments in this sector and the application of imaging technologies." Simon Fox a NASPA commercial partner Emerald Crop Sciences Ltd based in the UK explains "We are now actively working to develop funding for this sector, combining biostimulant treatments with remote monitoring will be a powerful approach in the future of UK farming."

*Imaging of Wheat trial at Henfaes research centre using a drone with specilist cameras*

NASPA Interreg Atlantic Area

# National and International Funding

## Biodegradable mulch film to target soil pollution in China

Working closely with Chinese partners, the BC team have made considerable progress on this Newton funded project to developing cost competitive, biodegradable agricultural mulch films for arable crops.

Covering fields with plastic films helps maintain soil moisture and protect against pests, the technique has played a key role in boosting yields and raising the quality of crops. However, the plastic mulches currently used by farmers, if not removed, break down into small pieces and contribute to microplastic contamination of the soil.

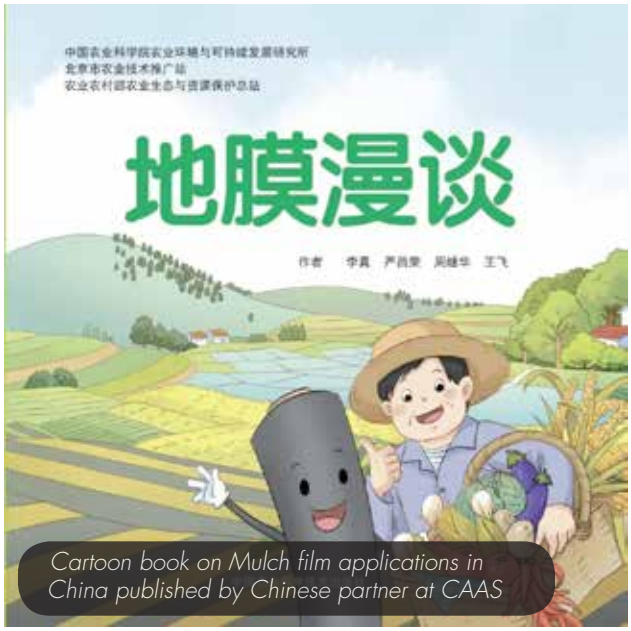
The project has been busy over the last year developing formulations for biodegradable mulch films and running demonstration trials in the UK and China.

Led by expert Prof Yan Changrong, Chinese partners ran demonstration trials on different crops in various locations. Mobile apps and a cartoon book were developed to disseminate results of the mulching technology widely in China.

Biodegradable mulch films from China, supplied by Huasheng, were used on UK demonstration trials organised by Velcourt with local farmers in Dorset. Trial manager, Matthew Alexzander, was happy to see that the films worked on Samco equipment as he explained Samco was one of the biggest suppliers for mulching machinery in the UK.

Film degradation trials started at the end of July on a vineyard site, films started to degrade after two months, and kept functioning for another month before losing functionality. This three-month service life would be suitable for most crops.

The team are now working on the formulations so that films will degrade faster after usage.




*Cartoon book on Mulch film applications in China published by Chinese partner at CAAS*

## Working with WKW throws up more opportunities to strengthen forestry and wood science in Bangor

BC staff member Ceri Loxton has been on secondment with Woodknowledge Wales (WKW) since 2016, primarily looking after the conference and workshops related to the Home-Grown Homes Project. Covid-19 threw up challenges including cancelling the WKW annual conference and all events and workshops moving online.

"Whilst moving everything online was disappointing and challenging to start with," said Ceri "the WKW team quickly adapted, we have been able to run more events, interact with more people and focus on producing some fantastic reports for the Home-Grown Homes Project".

The Home-Grown Homes Project has been a three-year research project for Powys County Council with WKW leading the delivery team with partners BM-TRADA, Cardiff Metropolitan University and Coed Cymru. The research

*Construction site*

# National and International Funding

team were looking at practical solutions and policy recommendations for improving the supply of timber from Welsh forests to build timber frame homes with improved quality and performance.

The Home-Grown Homes Project has produced a variety of documents including a number of practical tools & guidance documents with topics covering; zero carbon housing, embodied carbon, building performance evaluations and how to invest in woodlands for carbon capture.

"We thought the hard work was in doing the research and producing the publications" said Gary Newman chief executive of Woodknowledge Wales, "but actually for the project to have any meaningful impact going forward the real work starts now. WKW needs to carry on disseminating the information and getting the recommendations embedded in policy changes. One thing that has emerged from the research project is the urgent need for knowledge and skills training across the supply chain from forest to finished product. Bangor University is in a unique position within Wales to provide this having both a world-renowned forestry department and the BioComposites Centre with its history of timber products development."

"The secondment with WKW and working on the Home-Grown Homes Project has been a fantastic opportunity for Ceri and BC to learn more about what areas of research might be coming up on the horizon and also where knowledge gaps exist that we may be able to fill" said Dr Rob Elias. "We look forward to new opportunities and joint ventures in the future."

https://woodknowledge.wales/home-grown-homes

## KTP project develops new range of recyclable wood-based boards

A Knowledge Technology Partnership (KTP) project between Sundeala Ltd and BC is developing wood-based panel products which incorporate multiple types of recycled fibre types and micro-fibrillated cellulose (MFC). Sundeala is developing this breakthrough innovation in the panels market with the support of Innovate UK.

The addition of MFC into high density (HD) board acts as a strengthening agent by enhancing the strength properties of the conventional wooden panels and the introduction of biodegradable natural polymers offers an alternative, recyclable solution to the paper industry. Sundeala's goal is to aid the circular economy by manufacturing this new range of biobased products for construction and furniture applications.

The project started in 2019 and lasts two years. The KTP position is being occupied by Natalia Pynirtzi, a research associate from BC, who started working at the company in early June 2020. Natalia is a postgraduate materials scientist with expertise on the characterisation and mechanical testing of cellulosic nanocomposites.

Working with Mr Christopher Pearce, company supervisor at Sundeala, they have successfully set up a quality control lab at the Sundeala plant in Cam, Gloucestershire and recently completed the installation of a brand-new pilot machine. The pilot machine will save time and costs allowing for further investigation of the HD board by adding various fibres and changing multiple variables to identify the perfect combination of furnish and MFC.

*KTP associate Natalia Pynirtzi working in the Sundeala Lab*

The KTP project is currently halfway through implementation. Industrial trials are taking place every month and substantial improvement has been made during the first year of running. We look forward to future developments on this very productive KTP collaboration.

# National and International Funding

## Waste crab shells may help to fight coronavirus.

Pennotec and BC are working together to address COVID-19 challenges.

A long-term collaboration between a Gwynedd-based innovative SME, Pennotec (Pennog Ltd) and BC has evolved to address challenges related to COVID-19.

BC has previously worked with Pennotec on three successful projects to extract a natural polysaccharide, chitosan, from crab shells.

"Chitosan has several valuable properties, and we investigated its novel functional derivatives." explained BC chemistry researcher Dr Olga Tverezovskaya. "Now we hope to create a protective coating which can be applied to medical equipment, as well as masks and gowns worn by NHS staff."

The Virucidal Coatings project is a nine-month proof of concept study that has won a highly competitive, Business-Led Innovation in Response to Global Disruption (COVID-19) funding. The Innovate UK funded project aims to address the future demand for single-use PPE (Personal Protective Equipment) and medical devices in a world impacted by the pandemic.

Pennotec managing director Dr Jonathan Hughes said: "We are excited about this new application for our chitosans. Our business is focused on developing natural products from wastes that have benefits to health, society and the environment. Medical materials are a new departure for us."

BC and Pennotec are working to address the need for high-risk locations and activities; hospitals, social care, hospitality, wellness and social centres to be more resilient and efficient in their handling and use of PPE.

The innovative coating solution being developed will render materials that are in contact with the COVID-19 and other viruses safe. This will convert PPE in active use from a potential virus transmitter into mobile virus-deactivating devices. It could be used on a range of innovative products and would protect against more than just COVID-19, due to antimicrobial and antifungal properties of chitosan.

Dr Viacheslav Tverezovskiy, head of chemistry research at BC said that the group has a, "track record of developing chitosan" for products. This is underpinned by our work on smart food packaging in recent years. During those projects, BC researchers learned how to attach antimicrobial compounds to various materials.

The crab shells providing the raw material are not only natural, but they are also local as they are provided by Gwynedd firm Selective Seafoods. The company usually supplies catering companies with cooked crab, and the shells are a by-product.

*Dr Jonathan Hughes, MD of Pennotec, pictured with crab-shells - which could be used in preparation of a virucidal material for PPE coating*

# National and International Funding

## North Wales rapeseed waste for beauty products, burgers and building panels

BC is participating in a three-year £3 million project, Pro-Enrich, looking at how to add value to waste from food crops such as rapeseed, olives, oranges and tomatoes. Funding has been received from the Bio-Based Industries Joint Undertaking as part of the European Horizon 2020 programme.

Pro-Enrich aims to save millions of tons of waste from food production being dumped and instead turn it into a range of products from chemicals for the food industry through to building materials and beauty products.

Dr Adam Charlton, a member of the BC, Bangor University project team, said: "We are looking at ways of using the waste from food production to make a range of useful products in ways that are commercially viable.''

In this project BC are focused on finding new and higher value uses for agricultural waste and to act as a bridge between research conducted at laboratory scale and commercial products, through collaboration with industry.

"Pro-Enrich is a very prestigious project to be involved with," said Dr Charlton "to get this kind of EU funding you have to show you are generating value and working with partners who have got a route to market."

The project is technically challenging, particularly when it comes to scaling the processes up to commercial levels, which is what BC are trying to do at the Technology Transfer Centre at Mona, Anglesey.

# National and International Funding

## Adding value to industrial 'waste'

A new Innovate UK project funded under the Industrial Grand Challenge Fund was kicked off early in 2020. Led by Cambond Limited the project looks to take waste from the foundation industries and add value to them by producing adhesives and building products. In this project, partners are working with the recycled paper industry in the UK converting waste materials into building products. The project is currently around halfway through, building panels have successfully been produced with superior properties to their standard wood-based counterparts. Dr. Gareth Roberts from Cambond Ltd., recently congratulated the BC team on delivering clear guidance on the science behind, and methodology to produce the panels.

*Simon Curling during trials at Bangor*

## Biologically Derived Polyesters and Polyamides - Production, Processing and Circular Life (BioPOL4Life)

The Biopol4Life project, funded by Sêr Cymru, is a capacity building collaboration between University of South Wales, Bangor and Aberystwyth Universities focused on developing biopolymer expertise in Wales.

Almost all aspects of our everyday lives are dependent on the availability and use of low cost polymers (plastics). It is imperative that we work towards a reduction in their use, but their full eradication will be very difficult to achieve in numerous sectors. The vast majority of polymers that we use today are produced using fossil carbon, a finite resource that contributes towards global warming. Fossil based polymers cause pollution in our soils, rivers and oceans and their accumulation and long-term degradation is impacting on climate change and biodiversity. Whilst some fossil-based polymers should be recycled, there are technical and economic challenges to recycle them all indefinitely.

"Project partners believe that biopolymers could be able to replace some of the conventional polymers and have the ability to support the circular economy by significantly reducing emissions and increase biodiversity," said Dr Viacheslav Tverezovskiy, BC Lead.

In this project BC collaborates internally with CEB (Centre for Environmental Biotechnology) to improve industrial biotechnology (IB) production of microbial derived polyesters and polyamides, concentrating on their life cycle from feedstocks, polymer production, processing, end of life impact and circular recovery.

This project is complementary to the Plastic Research Centre of Wales, another new initiative supported by the Centre.

A SÊR CYMRU PROJECT
biopol 4 life
GROWING BIOPOLYMER EXPERTISE

# National and International Funding

## Coatings for Compostable-Recyclable High Barrier Packaging Film (HiBarFilm)

Innovate UK project led by Haydale, a UK based advanced functional materials company, specialised in the modification of nanomaterials for industrial coating applications. HiBarFilm is a novel-packaging design based on coating monomaterial-films with a thin coating that could either be recyclable and compostable (cellulose) or recyclable (polyolefine, such as LDPE or PP). The aim is to provide a single film coated with a high barrier nanomaterial containing coating, which can provide the barrier performance necessary to reduce food waste, but could be applied to recyclable or compostable films with typically low barrier performance, enhancing their performance to compete with multilayer films.

To create a mono-layer recyclable or compostable material coated with a unique material that will be an oxygen and water barrier and have the equivalent mechanical properties of current products in the market. This will be achieved by using a diluted form of functionalized graphene in a solution suitable for various coating techniques.

Monolayer films would enable easier recycling compared to their multilayer counterparts, these are not as commonly used due to the reduced barrier performance obtained from monolayer films, however if the barrier properties could be improved by the incorporation of nanomaterials directly into the plastic matrix then it could enable these more recyclable materials to be utilised in a wider application set.

Two nanomaterial enhanced thermoplastics were supplied as 10wt. % masterbatches for dilution and extrusion into films. A nano enhanced HDPE was supplied, the nanomaterial in this case was more targeted towards mechanical improvements and is masterbatched into a blow moulding grade of HDPE. The second masterbatch is a specific functional nanomaterial designed to provide barrier properties and is functionalised using hydrophobic chemistries. This bespoke barrier nanomaterial is masterbatched into a polybutylene terephthalate (PBT) carrier and then diluted on film extrusion with polyethylene terephthalate (PET).

# Networks & Committees

## Sustainable Energy Efficiency Centre

The cross college, WEFO funded Sustainable Energy Efficiency Centre (SEEC) continues to go from strength to strength. The team have attracted additional funding that surpasses the requirements of the project to date and these new projects support the work in Ocean Energy and Energy Efficient Structures.

Recent work by the Energy Efficient Structures team (which BC heads up) has led to the development of new environmental sensors for the in-door environment and the development of new computer models to understand the performance of the buildings on campus. In 2021 this work will continue and allow the effects of new materials on the performance of buildings to be modelled at scale and onsite.

The BC team has also led on the cross-cutting themes (CCTs) of the project, with Dr Morwenna Spear acting as CCT champion, and working with the CCT leads from across the project, and in other structurally funded projects within the University. Dr Spear said "It has been great to engage with others to deliver Welsh language support, promoting women in STEM subjects and looking at issues like sustainability. The SEEC team contains such diverse skills and expertise, working for common goals and reducing environmental impact."


*Dr Thanasis Dimitriou, Materials scientist is working on the project*

## Natural Materials Association goes from strength to strength

Dr Graham Ormondroyd, who sits on the board of the Natural Materials Association (NMA) has worked with the BC and NMA teams to deliver a series of monthly seminars around natural materials throughout the current pandemic. The seminars have been wide-ranging on their topics with talks on construction to anthropology and biopolymers to spider's silk. The seminars have been well attended, with attendance peaking at around 75 people.

The seminar series will continue into 2021 and details of the seminars can be found on the NMA twitter feed @natmatassoc.

# People & Awards

## New PhD student at BioComposites Centre - Carlo Kupfernagel

BC Materials have welcomed a new PhD student this year, Carlo Kupfernagel. He will be working with Lignia Wood Company on a KESS 2 funded PhD studentship looking at new timber species for wood modification.

Lignia currently manufacture resin modified timber using Radiata pine, but are keen to identify additional species, preferably which can be sourced locally, that are suitable for this process. His supervisor Dr Morwenna Spear commented, "This will be an interesting challenge, both in terms of wood permeability and the effect on curing reactions and processing conditions. Carlo is making a great start at looking at this complex task."

A video interview between Carlo and his company supervisor, Dr Andy Pitman, showed that Lignia are pleased with progress, and this method of collaborating with Bangor University. The video and transcript are available on this link http://kess2.ac.uk/case-studies/wood-modification/

*Carlo Kupfernagel.*

## KTP Associate - Natalia Pynirtzi

My research journey started three years ago after graduating with a BSc degree in Physics from the of University of Crete in Greece. In 2017 I started an internship working on carbon fibre nanocomposites at the Aerospace Engineering department of Queen's University of Belfast. After the completion of my internship, I studied for an MSc in Materials Science and Engineering at QUB, where I graduated last December. During my master's course I developed a special interest in the function of biomaterials, thus, my thesis was conducted on the synthesis and analysis of nano-cellulosic bio-composites.

After my graduation I was searching for R&D research positions and during the spring of 2020 I got the KTP position, which is a collaboration between Sundeala Ltd and BC. The project is based on the manufacture of innovative panels with enhanced strength properties, which are made of 100% recycled materials and micro fibrillated cellulose. The goal is to develop a product that is going to be 100% recyclable, supporting circular economy applications. I am particularly enjoying my time working with both Sundeala and BC. This project offers a combination between all my areas of interest and I am especially happy to participate in the production of a new sustainable bio-composite material that is going to have a positive environmental impact by terms of eliminating waste and the use of natural recourses.

*Natalia Pynirtzi.*

## Joshua Davies – Research Technician

I have a background in chemistry having obtained a first-class BSc in Chemistry and a MScRes in Chemistry at Bangor University. Currently, I am working at BioComposites as a research technician. I am working on a couple of projects, both involving the reduction of nitrogen losses in agriculture. Most importantly, these projects aim to reduce emissions of the potent greenhouse gas, nitrous oxide (N2O). The POSTCOVA project aims to reduce nitrogen loss by lessening the amount of nitrogen-based fertilisers used on crops, whereas, the NASPA project aims to reduce nitrogen loss by utilising biological nitrification inhibitors (BNIs). I am really enjoying working toward the reduction of greenhouse gas emissions in agriculture because it is a very important topic relating to the health of the planet.


*Joshua Davies.*

## Oliver Wright – Research Technician Intern

I joined BC in October as a research technician intern as part of a placement year in industry. I am currently in my third year of studying Chemistry with Industrial Experience at Bangor University. I am working on a number of projects, but primarily the analysis of volatile organic compounds (VOCs) from both sound and decaying timber building materials.

I am interested in the field of green chemistry, more specifically natural and synthetic organic synthesis, natural product extraction and waste minimisation/utilisation. Although my placement has been affected by COVID-19, I am thoroughly enjoying the experience of working at BC. The extensive number of projects have given me in-depth experience in numerous areas of chemistry. I have also thoroughly enjoyed learning and applying new methods and improving my competence with new pieces of equipment.


*Oliver Wright.*

## Bethan Brown – Research Technician

During my time at BC, I worked on many different projects. From utilising white rot fungi species to degrading chicken feathers, to extracting high value waste compounds using supercritical CO2.. I was able to expand my horizons and experience many distinct aspects of interdisciplinary research.

The highlight project I worked on in 2020 was, 'Developing viricidal coatings from seafood waste'. It was an amazing opportunity to work on projects that are currently so relevant, given the current situation with COVID-19. I loved having the chance to apply the knowledge obtained during my degree to challenges that we are currently facing.

The work I undertook at BC has been fantastic preparation for beginning my PhD, which I am undertaking at the University of Nottingham. I owe a great deal of thanks to all the staff members at BC and their supervision which prepared me to take this next step.


*Bethan Brown.*

# New Equipment & Services

## Centre for Efficient Timber Recovery and Recycling (CETReR)

The BioComposites Centre has secured funding, from the Welsh Government Circular Economy Capital Fund 2020-21, to set up a new centre to facilitate and encourage the recovery and reuse of timber.

Recycling and reuse of waste wood is a core requirement of UK and European waste directives, and although there may be divergence on certain aspects, a simple aim remains that, where possible, recycled wood should be used for products rather than energy production.

A critical issue for efficient reuse of waste wood is the identification of contaminants, the presence of which causes down grading, thus reducing both value and options for recycling. Although techniques do exist for separation or identification, few municipal waste handling facilities, and even fewer SME's or community-based enterprises will have this capability, and so waste wood will not be used to its full potential. Also, with new treatments coming onto the market, recycling options and how to deal with these in the future will be needed.

This exciting project will transfer and augment the existing academic and technical knowledge in BC (based on years of wood-based product testing and development) into practical options for the waste recovery sector. The project will address steps to assist segregation and sorting, identification of contaminants and options for adding value.

Adding additional capability to the existing expertise at BC will facilitate a range of analysis and advice offered in one location. This will help to bridge the knowledge gap and identify both RE-USE and RECYCLING options.

The extra testing capability will include adding EDX to our Scanning Electron Microscope to upgraded imaging allowing detailed elemental characterisation of both products and raw materials. A hyper spectral camera will also be added to our imaging capability to enhance material characterisation. At a larger scale BC will be adding a timber grader to characterise larger samples of timber and an emissions chamber to upgrade our capability for perform VOC (volatile organic compounds) emission characterisation. This new capability will improve our ability to meet our clients and partners requirements.

## Unique capability to deliver fire retardant leeching tests now offered by BC

Despite the many advantages that wood has to offer as a construction material, its fire performance has restricted usage in several applications. To tackle the fire prevention issue, fire-retardant products are promising to improve the fire resistance of timber. However, a fire retardant can be leached out of treated wood during weathering. To ensure that fire-retardant treated materials will maintain their performance after natural weathering an accelerated weathering process must be applied to the treated samples prior to a full Single Burning Item (SBI) fire test.

BC has developed test equipment which can perform the two accelerated weathering methods as described in BS EN 16755:2017. The test rig contains two compartments, one for each method. Each compartment has a total area of 4.96 m2 and is designed to test a total of 4.5 m2 sample area (3 x 1.5 m2).

Method A is a 12-cycle process. Each cycle has a duration of one week and consists of a 96-hour wetting stage followed by 72 hours of drying in a kiln.

Method B has a duration of six weeks. Each cycle has a duration of 24 hours and consists of 4 hours of wetting, 4 hours of drying, 4 hours of wetting, 4 hours of drying and finally, 8 hours of rest. During drying in method B UV light is also applied.

# Events

## Timber 2020 conference

Staff from the BioComposites Centre were well represented at the Wood Technology Society's Timber 2020 conference this autumn. The event moved to become an online event, held in September, in response to the ongoing Coronavirus situation.

BC has a strong connection with the Wood Technology Society, in which Dr Graham Ormondroyd is Chair of the Board, and Dr Morwenna Spear led on the conference scientific committee alongside academics and consultants from across the UK.

At the event BC's newest PhD student Carlo Kupfernagel presented data from his previous internship at Bangor, which looked at fatigue in differently modified timbers.

Past KTP Associate, Dr Bronia Stefanowski presented work from Lignia Wood Company, where she has now gained a post as R&D Manager. In her new role at the company Bronia supervises PhD and MEng students from different universities, who also attended and presented at the event.

Dr Morwenna Spear presented work on resin-treated end-grain wood cobbles from a research project undertaken with Coed Cymru.

Dr Graham Ormondroyd introduced social LCA (Life Cycle Analysis), which is an area of growing interest for the Centre.

Many talks at the event were from different universities (Bath, Bristol, Edinburgh, Edinburgh Napier , Coventry, Swansea, Trinity St David's, London Metropolitan and Portsmouth); and were balanced by talks from companies and trade bodies including the TTF and TDCA.

The new online format meant the event was well-attended, and many delegates enjoyed a chance to network and catch up with colleagues from across the UK and beyond in the various coffee-break sessions and online social event.

# Publications & Publicity

## Papers published

C. Skinner, P. Baker, J., Tomkinson, D. Richards and A. Charlton, A. (2020). Pressurised disc refining of wheat straw as a pre-treatment approach for agricultural residues: A preliminary assessment of energy consumption and fibre composition; Bioresource Technology, 304, 122976 [published on-line 8 February 2020]. https://doi.org/10.1016/j.biortech.2020.122976 (peer-reviewed)

P. Baker and A. Charlton (2020). Chemical and enzymatic approaches to isolate functional proteins from four major European crop residues - A review; P. Baker and A. Charlton, Innovative Food Science and Emerging Technologies, 59, 102239 (https://doi.org/10.1016/j.ifset.2019.102239)

Nath S., Waugh D.G., Ormondroyd G., Spear M., Curling S., Pitman A., Mason P. (2020) Laser incising of wood: A Review, Lasers in Engineering 45

Natha S, Waugh D.G, Ormondroyd G.A, Spear M.J, Pitman A.J, Sahood S, Curling S.F, Mason P. (2020) CO2 laser interactions with wood tissues during single pulse laser-incision. Optics & Laser Technology 126 June

Curling SF, Ormondroyd GA (2020) Observed and projected changes in the climate based decay hazard of timber in the United Kingdom. Scientific Reports 10 (1), 1-9

Spear MJ, Curling SF, Dimitriou A, Ormondroyd GA. (2021). Review of Functional Treatments for Modified Wood. Coatings. 11(3):327. https://doi.org/10.3390/coatings11030327

Broda M, Curling S, Frankowski M. (2021) [The effect of the drying method on the cell wall structure and sorption properties of waterlogged archaeological wood. Wood Science and Technology 55, 971-989

Spear M.J. and Broda M. (2020) Comparison of contemporary elm (Ulmus spp.) and degraded archaeological elm: the use of DMA at ambient moisture conditions. Materials 13(21): 5026 19pp. doi:10.3390/ma13215026

Ashaduzzaman Md., Hale M.D., Ormondroyd G.A. and Spear M.J. (2020) Dynamic mechanical analysis of Scots pine and three tropical hardwoods. International Wood Products Journal 11(4): 189-203. https://doi.org/10.1080/20426445.2020.1799910

## Conference / workshop presentation

2-3.3.20 Newton Bhabha UK-India Industrial Waste Challenge, Indian Institute of Technology, Mumbai, India. Mid-term review meeting for the Bioreview project. Verbal presentation on results from Bangor University followed by Q&A by the project assessment panel

1. Spear M, Ormondroyd G.A, Curling S.F, Kupfernagel C. (2020) The effects of fatigue cycling on modified Scots pine. Proceedings of Timber 2020, London, United Kingdom October 2020

2. Curling S.F, Ormondroyd G.A, (2020) An update on the potential effects of climate change on durability of timber in the UK Proceedings of Timber 2020, London, United Kingdom October 2020

3. Stefanowski B.K, Spear M.J, Curling S.F, Pitman A.J, Bailey R.J.D, Mathias J, Evans N.,. Ayala L, Theobald T., and. Ormondroyd G.A Properties of LIGNIA Modified Wood (2020) Proceedings of Timber 2020, London, United Kingdom October 2020

Spear M.J., Hill C.A.S. and Price C. (2020) A conceptual methodology for estimating stored sequestered carbon in the built environment. Submitted to SEB 20 conference. In: Sustainability and energy in buildings 2020 – Proceedings of the 12th International Conference on Sustainability in Energy and Buildings (KES-SEB-20), Eds, J. Littlewood, R.J. Howlett A. Capozzoli and L.C. Cain. Springer. 11pp.

# Publications & Publicity

Spear M.J. and Jones D. (2020) Paving the way: the potential for phenol formaldehyde resin treatment for durable end-grain cobbles. In: Proceedings of Timber 2020, 9 -10 September 2020, online event organised by the Wood Technology Society. pp. 165-176.

Nath S., Waugh D.G., Ormondroyd G., Spear M., Pitman A., Mason P. (2020) CO2 laser drilling of woods for chemical preservative treatment, ILAS2020, 20-21 May 2020, Daventry, UK.

## Media interviews

19.10.20 BBC Radio 4 - Farming Today: Agricultural by-products, rural broadband and vegetable gene bank. Interview on biobased product and supply chain development

21.1.20 BBC Radio Wales Science Café with Adam Walton. The Problem with Plastic. Adam Charlton talking about research into fibre-based packaging as an alternative to single use plastics in the UK and Uganda

## Magazine articles:

Autumn 2020 - Advances Wales 94: Agriculture and Food: Producing sustainable packaging from agricultural waste

October 2020 - articles in the Daily Post, Western Mail on the BBI funded Pro-Enrich project
September 2020 - e-News Bulletin (Welsh Government)- article on the BBI funded Pro-Enrich project

21.8.20: Food Manufacture magazine:' Upcycling food waste into new proteins and ingredients'.
Article on the BBI funded Pro-Enrich project (https://www.foodmanufacture.co.uk/Article/2020/08/21/Plant-based functional-food-ingredientsscrutinised-in-ProEnrich-project)

Spear M. (2020) Technically Speaking: Have we Hit the Buffers?
Wood Based Panels International, August/September 2020

Spear M., Norton A., and Hill C. (2020) Carbon capture and storage the natural way.
Forestry and Timber News, April 2020, p62-63. Published by Confor

Spear M. (2020) Technically Speaking: Are we finally ready for bio-based resins?
Wood Based Panels International, March 2020

Spear M. (2020) Capturing timber's potential. Materials World, March 2020, p35-37.

Spear M. (2020) How does timber sequester carbon? Lignia Heart (blog) 17th Feb 2020,
https://www.lignia.comblog/how-does-timber-sequester-carbon

# Staff List

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| | Athanasios Dimitriou |
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| | Dave Preskett |
| | Graham Ormondroyd |
| | Morwenna Spear |
| | Jalia Nabukalu Packwood |
| | Olga Tverezovskaya |
| | Paul Baker |
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| **PhD students** | Carlo Kupfernagel |
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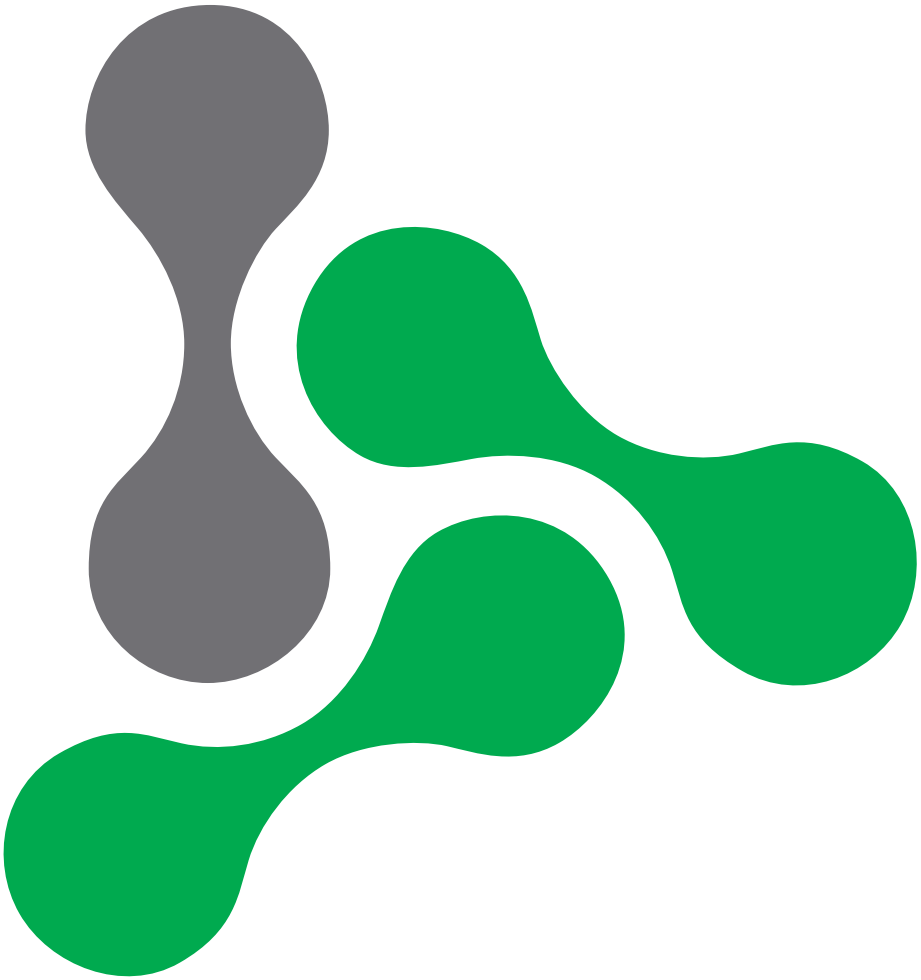

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