Newsletter

October 2021

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Dear readers

BIOnTop has reached halfway point and we are excited to give you an update on the latest progress, recent deliverables, and publications of our project partners. We will be looking at bio-based coatings to improve barrier properties, chain extensions of PLA-based blends, water-based PHA formulations for coatings, the results of our survey on consumer perceptions, and an overview of the EU Single-Use Plastics Directive and its relevance for the bioplastics sector.

BIOnTop aims to develop **novel bio-based and compostable packaging and textiles through experimental research on copolymers and compounds with customized biodegradability and multifunctional coating solutions**. The 4-year research project is carried out by 21 teams and a total of almost 170 experts from research institutes, the mechanical engineering sector, food and packaging companies, and trade bodies from 8 EU countries.

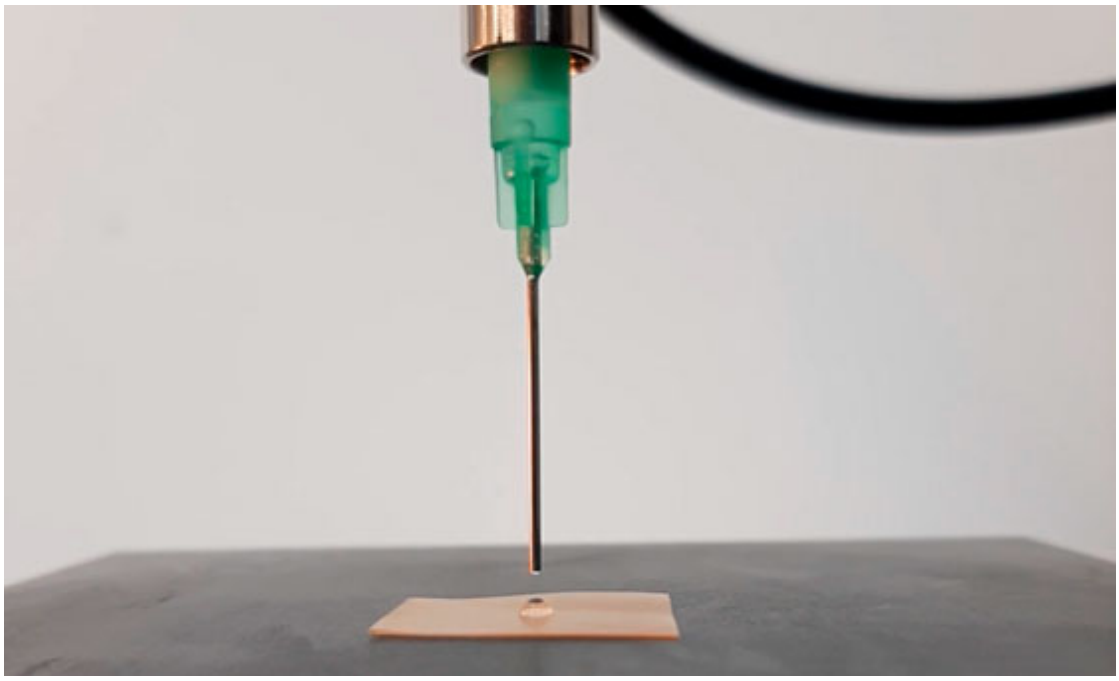

Photo: Preparation of the water contact angle measurement on grafted whey protein-based film. Copyright: Hochschule Albstadt-Sigmaringen

Updates from BIOnTop

With the first half of the project completed, BIOnTop has some exciting preliminary findings to show for itself as it enters the next phase of pilot production and validation of the developed bio-based mono- and multi-layer films and trays, nets, and textile packaging.

The first two years of the project have already produced promising preliminary findings, including the formulation of the developed copolymers by reactive extrusion and scaling-up of the selected lactic acid copolymers to semi-industrial scale. The final formulations for films, trays and textiles had been selected. Furthermore, first steps towards the fabrication of the final products have been taken with the characterisation of the PLA-based compounds and the processing parameters for sheets, films, and filaments.

"These milestones laid the groundwork for the next phase of the project's pilot production and validation of the developed bio-based packaging materials, which are currently ongoing. Initial experimental tests of the different desired end-of-life routes including recycling and reprocessing, as well as industrial and home composting are well underway. Moreover, first interims life cycle sustainability assessments have been conducted for the developed materials", says **Rafael Alonso Ruiz of the Chemical Technology Group at AIMPLAS, BIOnTop's technical project coordinator and consortium lead.**

"In the next six months, the project partners are geared towards the processing and production of the mono- and multilayer films that will lead eventually to the final packaging solutions for fruits and vegetables, and dairy and personal care products. The processing of nets and the development of textile fibres and fabrics for packaging will be underway during this period as well. These developed products will be in parallel studied regarding their end-of-life properties."

Water based PHA formulations for coating and printing

PHA is a biopolymer synthesised by different organisms in an environment rich in carbohydrates such as sugars or oils but a lack of nutrients. These organisms synthesise PHA to store carbohydrates within their cells for later use. Commercially, PHA is created in bioreactors where bacteria generate up to 80% of their weight in PHA before the polymer is extracted. Depending on the strain of bacteria and the carbohydrate source different types of PHA can be obtained.

To expand the applications of PHA, BIOnTop consortium partner Centexbel has developed a water based PHA dispersion aiming at textile coating and screen-printing. These formulations consist of water, PHA powder, bio-based plasticiser, and bio-based additives to reach the correct viscosity, colour, and improve stability. This formulation can then either be applied on top of a textile as coating or screen-printed into decorative patterns after which the PHA is fused by heating to 180°C. The obtained coatings and prints exhibit excellent abrasion resistance, degrade very quickly in a soil burial test and are about twice as flexible as comparable PLA coatings. However, because of the biodegradable nature of PLA and PHA the resistance to washing is quite poor due to the weak hydrolysis resistance. More work is ongoing to improve this aspect and create formulations with tuneable durability.

Centexbel presented these insights on their latest advances on water based PHA formulations for coating and printing at workshop on bio-based materials held in June as part of the joint communication and dissemination activities of the two European research projects BIOnTop and ECOFUNCO. The full presentation can be viewed here.

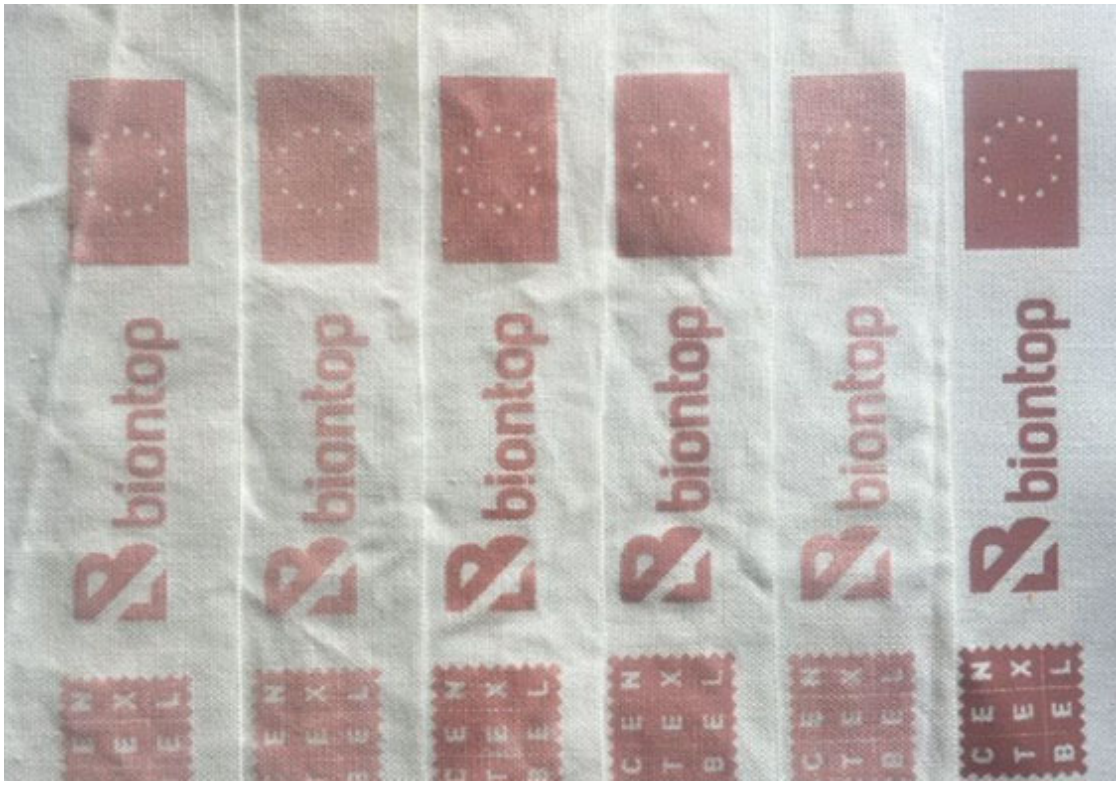

Photo: PHA Plastisol coating durability: PHA screen print with cross linker after washing. Copyright: Centexbel, 2021

Protein-based coatings for barrier improvement

BIOnTop's research teams are pursuing various strategies to optimise biopolymers **to achieve better barrier properties**. New coating technologies with a specific focus on protein-based coatings are being developed by the consortium partner and research group for **Biopolymer Processing and Functionalization BPF at the Sustainable Packaging Institute SPI of the Albstadt-Sigmaringen University (ASU)**.

By using an innovative fatty acid grafting process to modify the surface of whey protein films the researchers at ASU achieved a reduction in the water vapor permeability as well as a water repellence effect. The covalent bond formation of fatty acids on top of the whey protein films could be optimised by a variation in process parameters such as temperature and time. While pure whey protein films are hydrophilic and water droplets directly immerse into the film, the fatty acid grafted protein films show the formation of a hydrophobic surface.

Erik Sauter, researcher at the ASU and member of the BIOnTop research team, presented the team's latest findings during the joint workshop by ECOFUNCO and BIOnTop. According to Sauter, "[…] fatty acid chlorides of different chain length and fatty acid anhydride were covalently bond onto the surface of whey protein films with the transfer method and the processing conditions were varied (60– 160 °C, 0, 10 min) to determine the most efficient conditions for the fatty acid grafting process. It was observed that the chemical fatty acid grafting of the whey protein-based castfilms is dependent on the grafting temperature and time. Especially the chain length of the fatty acids and the grafting temperature change the water repellence and the water vapour permeability properties. The water vapour permeability decreases by a factor of 4.8. The hydrophilic whey protein-based films turned highly hydrophobic which was measured by a maximum contact angle of >100° against water by fatty acid grafting after applying the fatty acids using the transfer method." The full presentation can be viewed on the ECOFUNCO website.

Overall, the bio-based protein coating and fatty acid grafting approach provides high potential to develop bio-based packaging offering new end-of-life options such as home compostability and sea water degradability, which is under analysis by the BIOnTop partners. The current research work focusses on upscaling the coating and grafting as well as optimising of the coating formulations for thermoformed materials. ASU's recent experimental results on protein coatings have been outlined in detail in a recently published article (German only) in the German plastics industry magazine Plastverarbeiter.

Chain extension of PLA–based blends and composites

University of Pisa, in the framework of National Interuniversity Consortium of Materials Science and Technology (INSTM), is one of the leading project partners responsible for the development of composites production and processing on laboratory and pilot scale, and for mechanical and morphological characterization within BIOnTop. **Their recent work has focused on the research, design, and study of innovative chain extender systems of renewable origin for PLA–based biocomposites, reinforced**

with wheat bran as filler. As most currently employed chain extender compounds are fossil-based, which affects the biodegradability property of biopolymers, the aim of their recent work was thus to find promising bio-based and sustainable alternatives to provide the same enhancements.

As part of that research, Maria-Beatrice Coltelli (et al.) from the university's Department of Civil and Industrial Engineering, recently published a scientific article on the chain extension of poly(lactic acid) (PLA)-based blends and composites to control their processability and recyclability, which is available for download in **Polymers 2021**, 13(18), 3050; https://doi.org/10.3390/polym13183050.

Epoxidized soybean oil (ESO) was chosen as principal component of the chain extender systems, together with a dicarboxylic acid, malic acid (MA), or succinic acid (SA). Small–scale extrusion was carried out to investigate the effects of ESO/MA and ESO/SA on formulations of different composition (both pure PLA blends and composites). The variation of melt fluidity parameters was analysed to define the optimised concentration of modifier systems. A comparison between the effects on blends of designed bio-based systems and the action of fossil–based Joncryl was performed, to understand if the developed 'green' solutions could represent competitive and efficient substitutes. The modified composites were characterized in terms of mechanical tests, degradation, and thermal studies (TGA and DSC), and morphological analysis (SEM), to figure out their main features and to understand their potential in possible industrial applications.

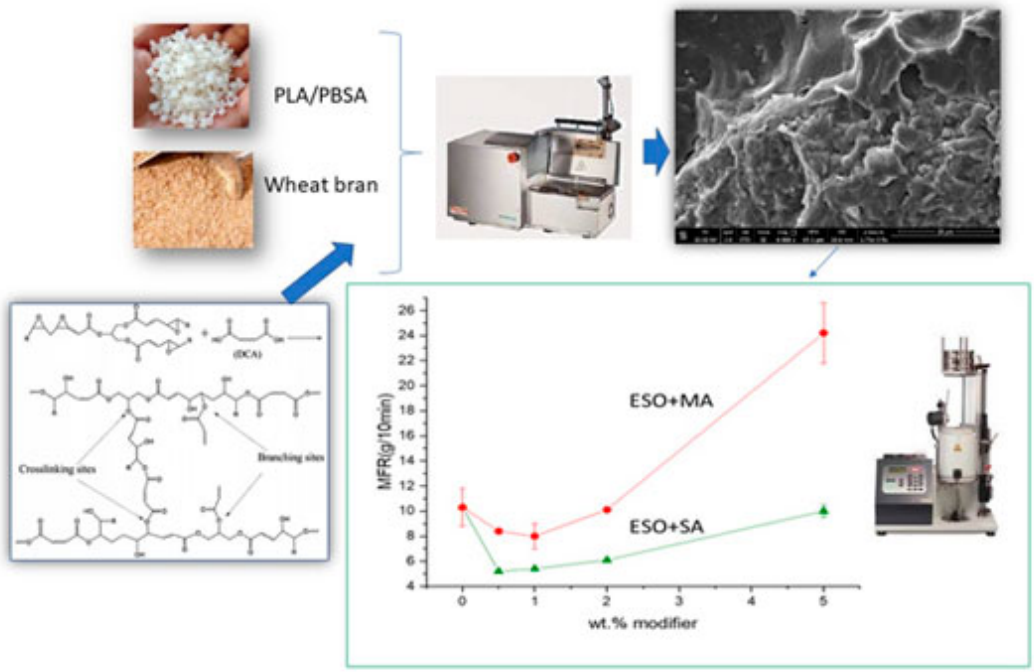

Image: University of Pisa, chain extension of PLA-blends, 2021. Copyright: Maria-Beatrice Coltelli

Survey on consumer perceptions highlights need for clearer communication

To ensure the bio-based solutions developed in BIOnTop align with real market needs, consortium partner Movimento Consumatori (MC) has been analysing

the consumer perception on bio-based packaging, and identifying their willingness to buy these new products.

MC conducted a questionnaire with over 3,000 responses from eight countries (Germany, France, Italy, Spain, Netherlands, Belgium, Greece, Malta) as well as three focus groups and interviews with consumer associations, food-chain industry companies, and other relevant institutions. The objective of the survey was to discover consumer habits and knowledge about bioplastic products, labels, different packaging materials, and end-of-life options, and to understand their views on the use of renewable feedstocks to produce plastics, incl. potential concerns regarding material origins from food by-products or the risk of leakage into the environment.

The results of the survey were analysed, and a set of recommendations drawn from the conclusions. For instance, the survey confirmed that consumers are still concerned about 'greenwashing'. It is therefore recommended that product communication must provide clear and truthful information on the raw materials involved in the production of a product and the appropriate EoL treatment. At the same time, consumers require help to distinguish bioplastics (packaging) products from other similar (but fossil-based) products. Clear labelling can be a solution, and the report recommends establishing an EU-wide logo to easily identify bioplastics and to clearly state the appropriate EoL treatment options.

The full report can be viewed on the BIOnTop website.

Implementation of the Single-use Plastics Directive. Or: How to create a legislative hotchpotch

Single-use plastic products, such as plastic straws, plastic cutlery, and EPS take-away boxes were banned in the EU this summer. But why do we still find them everywhere? Well, as always, it's complicated: even though the EU Single-Use Plastics Directive was passed in June 2019 and came into force on 3 July 2021, not all EU Member States have implemented the Directive yet due to significant delays in providing necessary documents on the part of the EU.

The guidelines including examples of what is to be considered as single-use plastic products – quite essential for the design of the national laws – were published only about

one month before the Directive formally entered into force. The result is a very unharmonized state of implementation across the EU, leading to confusion among consumers, policy makers and within the industry. Furthermore, deviating national legislative measures are threatening the internal market.

Project partner European Bioplastics (EUBP), the association of the bioplastics industry in Europe, has summarized the current state of affairs concerning single-use plastics in the EU here.

Relevant upcoming events

- 6 October 2021 | Different perspectives on food contact materials: Working together to make FCMs safer | Virtual workshop | Food Packaging Forum Austria
- 6-7 October 2021 | EFIB 2021 | Vienna, Austria | EuropaBio, BIOCOM AG
- 20 October 2021 | Upcycling bio plastic of food & drink packaging | Online workshop | upPE-T, UPLIFT, PRESERVE
- 30 November – 1 December 2021 | 16th European Bioplastics Conference 2021 | EUBP European Bioplastics | Berlin, Germany

For other relevant news, have a look on the BIOnTop tech watch.

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