biontop

Newsletter

July 2022

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Dear readers,

In our third BIOnTop newsletter issue, we are covering the latest developments of our research project, recent deliverables and publications, as well as other relevant news and events of the European bioplastics research community.

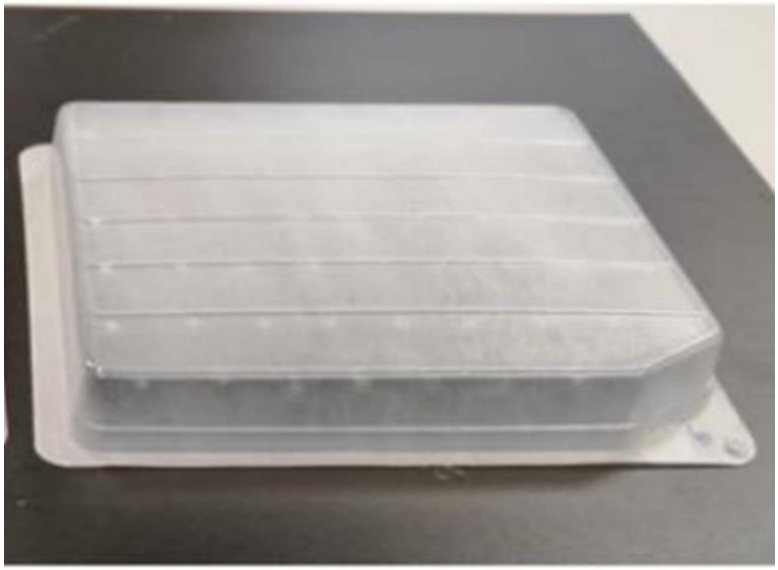
BIOnTop aims to develop **novel bio-based and compostable packaging and textiles** through **experimental research on copolymers and compounds with customized biodegradability and multifunctional coating solutions**. The 4-year research project is carried out by 21 teams and a total of almost 170 experts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

BIOnTop project well on track – Updates

Since the beginning of the project in 2019, the consortium partners started with research and development of copolymers, composites, coatings and materials that will provide BIOnTop products with the desired properties such as alternative end-of-life options (e.g. compostability) and sufficient barrier properties. The BIOnTop team from the Albstadt-Sigmaringen University focused on the development and optimisation of biopolymer coatings and fatty acid grafting technology to provide bio-based barrier properties.

In 2021, they determined the final formulations for the coatings onto PLA/PBSA film substrates which have been previously developed by experts from the University of Pisa. Prior to finishing the coating trials on a laboratory scale, the coating and fatty acid grafting technology needs upscaling to semi-industrial scale. At the same time, the group from the University of Albstadt-Sigmaringen prepared first demonstrators of trays from the coated films (see image) which are needed in further packaging and storage tests. Excellent results in oxygen barrier properties of the trays were reached by optimised whey protein coatings and alginate-based coatings.

Currently, different groups within the BIOnTop team work on the upscaling of the developed packaging material. Overall, we aim to develop bio-based packaging for fruits and vegetables, as well as for dairy and personal care products. Besides films and trays, textiles for bio-based nets for fruits and vegetables as well as bio-based textiles for food wraps and tea bags are under research. In the next months, BIOnTop focuses on the validation of the final demonstrators both for the aimed applications and their envisioned end-of-life options. In conclusion, the BIOnTop team progressed a lot in their concept of bio-based packaging which need to be continued and optimised to finally reach industrially produced bio-based and biodegradable packaging for different applications.



Thermoformed tray made of PLA-substrate with whey protein-based coating to enhance the oxygen barrier properties. Copyright: University of Albstadt-Sigmaringen.

Latest BIOnTop deliverables and publications

The initial project results have been published in two technical deliverables and one scientific paper.

- Deliverable 3.1: "**Report on the development, processing and testing of barrier and repellence coating**". A detailed report on the most promising FA grafting formulations applied on commercially available polymer substrates.

- Deliverable 3.2: **" Report on the processing and testing of the barrier and repellence coatings for BIOnTOP films & trays"** A detailed report on the formulations compatible with thermoforming applied on both commercially available polymer and adjustments required for initial tests with BIOnTOP substrates, characterisation, and process conditions at TRL3-4 as input for upscaling in WP5.

- Magazine article – Plastverarbeiter - EU-Projekt BIOnTop – Beitrag 2 **„Biobasierte Barrierebeschichtungen“**
- Magazine article – Plastverarbeiter - EU-Projekt BIOnTop – Beitrag 3 **„Optimieren von biobasierten Barrierebeschichtungen“**

More coverage on the project and current developments can be found on the project website www.biontop.eu.

BIOnTop develops bio-based barrier coatings to enhance the barrier properties of polylactic acid-based films and trays.

Multilayer composite films are commonly used for packaging sensitive food due to their very high functional properties, in particular to ensure sufficient barriers against aromas, water vapor and oxygen and thus to extend the shelf life of the packaged products. Multilayer composites are mainly produced from several petrochemical plastic layers and are therefore not recyclable and normally not biodegradable.

In the BIOnTOP project, new composites and bio-based coatings were developed to enable high functionality and biodegradability. The composite developed of polylactic acid (PLA) and polybutylene succinate co-adipate (PBSA) has improved biodegradability under home composting conditions compared to pure PLA films, but insufficient barrier properties against oxygen and water vapor to be used as a packaging material for sensitive foods. To improve these barrier properties against oxygen, bio-based coatings based on whey protein and alginate were developed. The results of the research build on previous EU projects Wheylayer and Thermowhey demonstrating that biopolymers are suitable as thermoformable barrier coatings.

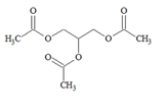
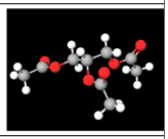
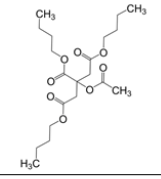
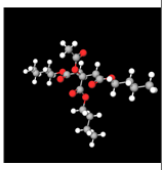
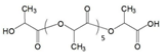
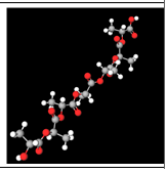
In the BIOnTop project, protein-based coatings were further developed by the Biopolymer Processing and Functionalization BPF research group at the Institute for Sustainable Packaging SPI at the Albstadt-Sigmaringen University of Applied Sciences (ASU) headed by Dr. Corina Reichert. The protein and alginate coatings were coated onto the polylactic acid (PLA) and polybutylene succinate co-adipate (PBSA) composite films with different thicknesses for different applications. For lid film application the whey protein and alginate were coated onto the PLA/-PBSA films with a thickness of the layer of 15-17µm. The OTR of the coated PLA/-PBSA films can reduce by a factor of 12 to 19. This indicates that a very small thickness of the Whey Protein and Alginate layer already leads to a reduction in the oxygen barrier. In addition to the lid application, the thermoformability of PLA/PBSA films coated with whey protein and grafted with fatty acids was also investigated. The films were thermoformed on a small laboratory machine and the developed protein layer showed no cracks subsequently. The nanoscale surface functionalization by the fatty acids thus applied a water-repellent layer that increases the easy emptying properties of the tray while protecting the moisture-sensitive protein layer. The results of the oxygen permeability measurements of the trays showed that protein coating and grafting with fatty acids improved the oxygen barrier by a factor of 90. These excellent results shows that bio-based coatings are promising to improve the oxygen barrier of packaging materials and are biodegradable

The next step will be to coat barrier coatings onto PLA/PBSA films on industrial machine and to test the industrial processability as well as the thermoformability on an industrial scale in the coming months.

Wheat bran addition to poly(lactic acid) (PLA)/poly(butylene succinate-co-adipate) (PBSA) plasticized blends: a reinforcing filler that also limits the plasticizer migration

The addition of bio-based plasticizers in poly(lactic acid) (PLA) blends is a known methodology to increase the polymer blend ductility. Hence it can be a successful strategy to produce materials suitable for flexible compostable packaging.

The migration process of three different bio-based and biodegradable plasticizers (Triacetin (TA), acetyl tri-n-butyl citrate (ATBC) and oligomeric lactic acid (OLA)) (Figure 1a) was investigated at 60°C (in severe conditions) by the Interuniversity National Consortium for Materials Science and Technology (INSTM) staff adding them at a fixed amount of 10 wt.%. Interestingly, TA revealed the greater mass loss over the time as confirmed from the calculation of the diffusion coefficients (Figure 1b), reasonably because of its lower molecular weight.

Plasticizer	Molecular weight (g/mol)	Formula	3D view
Triacetin (TA)	218.20		
o-acetyl-tri-n-butyl citrate (ATBC)	402.5		
Oligolactic acid (OLA)	500		

(a)

Blends name	Weight Loss wt.%	D (cm^2/s) Weight Averaged
PLA_PBSA_TA	6.87 ± 0.19	$4.61 \cdot 10^{-9}$
PLA_PBSA_ATBC	1.33 ± 0.33	$1.36 \cdot 10^{-10}$
PLA_PBSA_OLA	1.19 ± 0.24	$9.52 \cdot 10^{-11}$

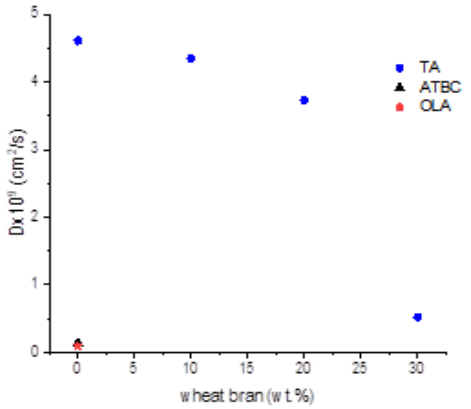
(b)

Figure 1: (a) molecular weight, formula and 3D view of TA, ATBC and OLA; (b) data of weight loss and diffusion coefficient D obtained for PLA/PBSA blend plasticized with 10% of TA, ATBC or OLA.

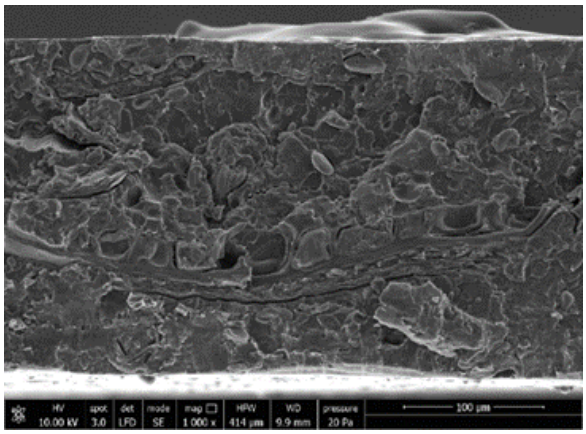
Widely available agriculture waste is constituted by bran coming from the cereal agriculture stream. In particular, the wheat bran (WB) by-product stream has been attested at about 150 million tons per year. Consequently, different research activities have been carried out mainly correlated to the bran valorisation for the biocomposites production and good results were achieved in the use of wheat bran as reinforcing filler in the BIOnTop project. However, despite of its composition rich in polysaccharides (cellulose, hemi-cellulose and starch), the WB filler ability to control the plasticizer migration has not been yet investigated before.

In the context of BIOnTop's research activities, wheat bran provided by the partner WEAREBIO was investigated as potential filler for controlling the plasticizer migration in poly(lactic acid) (PLA)/poly(butylene succinate adipate) (PBSA) binary blends. The addition of WB in different amounts (from 10 to 30 wt.%) revealed its tendency to influence the diffusion process in a manner strictly dependent on its content. A significant reduction of diffusion coefficient was observed, especially when 30% of wheat bran was added (Figure 2a). The great dimensions of the WB however, as observed by Scanning Electron Microscopy (Figure 2b), weaken the material in terms of mechanical properties suggesting to adopt a preliminary dimensional reduction of the filler to mitigate the negative observed effect. From this study the WB potential to be used as filler for controlling the plasticizer migration

emerged, thus suggesting a possible valorisation of this waste by-product in bio-based and compostable materials.



(a)



(b)

(a) diffusion coefficient (D) of biocomposites as a function of wheat bran content; (b) Scanning Electron microscopy micrograph of PLA/PBSA/TA additivated with 30% of wheat bran.

Watch out for the full article in the upcoming Journal of materials Science.

BIOnTop at the 1st Conference on Green Chemistry and Sustainable Coatings by ECOFUNCO

This project has received funding from the Bio-based Industries Joint Undertaking (JU) under the European Union's Horizon 2020 research and innovation programme under grant agreement No 837863. The JU receives support from the European Union's Horizon 2020 research and innovation programme and the Bio-based Industries Consortium.

On 16/17 June the EU Project Ecofunco (https://www.ecofunco.eu/) hosted their final event: **the 1st Conference on Green Chemistry and Sustainable Coatings.**

The BBI-JU funded ECOFUNCO project has been developed during 36 months by a consortium of 17 partners from 8 different countries, including research centers, SMEs, big industry leaders, and end-user associations. The overall objective of ECOFUNCO is to select, extract, and functionalise molecules from readily available, low-valorised biomass sources to develop new bio-based coatings for cellulosic and plastic based application.

To interconnect projects financed under the BBI-JU program and to maximise the effect of the developed solutions through all possible synergies, ECOFUNCO invited other BBI-JU projects to present their progress and results to their final event:

- FISH4FISH (Biodegradable Packaging from chitinolytic fish wastes)
- PRESERVE (High performance sustainable bio-based packaging with tailored end of life and upcycled secondary use)
- RECOVER (Development of innovative biotic symbiosis for plastic biodegradation and synthesis to solve their end of life challenges in the agriculture and food industries)
- PROLIFIC (Ultimate exploitation of agro-industrial residues: a contribution to the development of biocomposites)

- AGRIMAX (Agri and food waste valorisation co-ops based on flexible multi-feedstocks biorefinery processing technologies for new high added value applications) and as the opening talk

- BIOnTop (https://biontop.eu/).

Sergio J. Quesada (ENCO) described the main results of BIOnTop so far: the PLA-based polymers developed to date, their formulations and additives, their raw materials, the manufacturing mechanisms of the five demonstrators, and the strategies followed for their end of life.

Sergio J. Quesada at the 1st Conference on Green Chemistry and Sustainable Coatings.

The main focus of the presentation was the developed coatings. BIOnTop coatings have made it possible to improve the barrier properties of BIOnTop's bioplastics developed. BIOnTop employs protein-based coatings (e.g., alginate) or fatty acid grafting of nanometric layers. These layers, in spite of being applied in multilayer films, can be removed for subsequent recyclability or biodegradability. Furthermore, the hydrophobic grafting contributes to reducing product waste at the end of the packaging use through a release/easy emptying effect. Likewise, in the field of the textiles, BIOnTop has developed coatings allowing reprocessing of the fibres without significant loss of properties. BIOnTop coatings also bring beneficial properties to the consumer, like non-stick/product-release and easy emptying, as well as waterproofed fabrics.

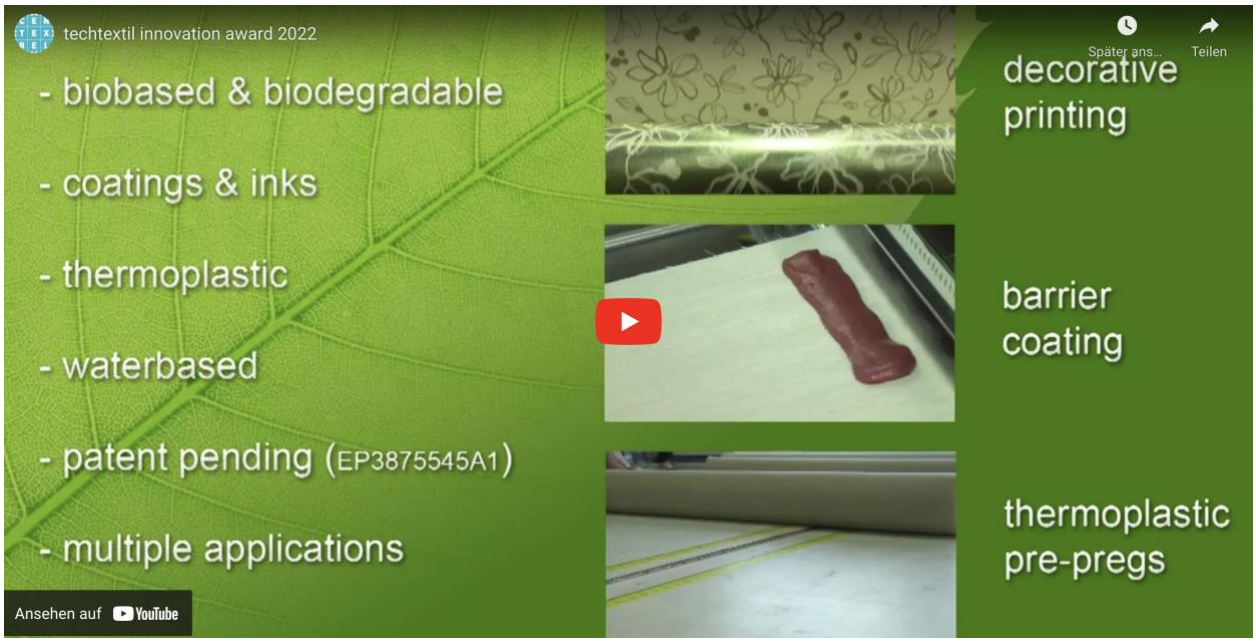
The BIOnTop coatings are been used in the manufacturing of new packaging solutions trays and films for dairy and personal care, recyclable coated textiles, (e.g., monofilament woven fabric tea bags), reusable coated woven fabrics (e.g., food wraps) and reusable secondary packaging from secondary raw materials (extruded blown bags & non-woven bags).

Overall, these demonstrators have a bio-based content greater than 85%. When these products hit the market, they will make a crucial contribution to helping tackle the worrying global plastic waste problem.

Centexbel wins Techtextil Innovation award 2022 with "bio-based & biodegradable coating & ink development"

BIOnTop consortium partner Centexbel is proud to announce to have won the **Techtextil Innovation award 2022** in the category "new approaches to sustainability & circular economy" with a **breakthrough innovation in bio-based coatings.**

The invention works especially well with polylactic acid (PLA), a bio-based polymer made from sugars, but it is also suited to work with polyhydroxyalkanoate (PHA), a naturally occurring bacterial polymer that has recently been introduced to market. The production of these bio-based coating pastes does not require solvents or any specialized equipment, resulting in a lower environmental impact and reasonable pricing. The newest generation of bio-based plasticizers is used in the dispersion to make the coatings flexible and applicable for a broad array of substrates, including flexible textiles. The dispersions can be used in both coating and screen-printing applications and are very resistant to abrasion. It is important to note that thanks to their inherent biodegradability, the developed inks and coatings do not release persistent microplastics, as they will degrade within a short timeframe.



Centexbel is the Belgian knowledge centre for the textiles and plastics industry and has successfully adapted the formulations to two different industrial processes. While initially developed for innovative food packaging within the European project BIOnTop, the formulation was successfully adapted for use on wallpaper (in cooperation with Masureel International) and coated flax fabric used in the production of thermoplastic composites (in cooperation with Flaxco). In addition to these industrial processes, Centexbel demonstrated that these coating pastes can be used for carpet backing, artificial leather, and barrier coatings.

Link to Centexbel press release 21 June 2022

Relevant events and dates

- 6 July 2022 // Unlocking a bioeconomy across Europe: How to scale up national strategies, build skills and fuel investments? // Online event
- 11 – 15 July // Summer School 2022 to promote knowledge in additive manufacturing // Barcelona, Spain
- Until 21 July 2022 // Sustainable EU food system // Public consultation
- 13 – 16 September 2022 // 18th International Symposium on Biopolymers // Sion, Switzerland
- 19 – 26 October 2022 // K 2022 // Düsseldorf, Germany
- 13 – 15 November 2022 // 11th International Conference on Fiber & Polymer Biotechnology // Graz, Austria
- 1 December 2022 // 9th Biorizon Annual Event on Bio-Aromatics // Online event
- 6 – 7 December 2022 // 17th European Bioplastics Conference // Berlin, Germany – hybrid event

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

This project has received funding from the Bio Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 837761.