Bionanopolys

HIGHLIGHTS NO. 8

WELCOME

to the final newsletter issue of the Bionanopolys Open Innovation Test Bed (OITB) project!
As we approach the end of 2024, we also mark the conclusion of Bionanopolys as an EU project. However, this is far from the end of the journey – it's the beginning of an exciting new chapter. Moving forward, Bionanopolys will continue as an association, a collaborative network of diverse pilot plants, ensuring that our Open Innovation Test Bed (OITB) platform remains a driving force for innovation. It will continue to pave the way for advancements in bio-based nanotechnology.

This final newsletter is dedicated to celebrating our success stories and the highlights of the past four years. We also want to take this opportunity to thank our partners and stakeholders who have been instrumental in transforming challenges into opportunities. Together, we've laid the groundwork for a greener future and a legacy of sustainable innovation.

WE WISH YOU A JOYFUL CHRISTMAS & ALL THE BEST FOR 2025 & THE YEARS AHEAD. HERE'S TO CONTINUING THIS JOURNEY TOGETHER!

CONTENT

BIONANOPOLYS' SUCCESS STORIES

SHAPING THE FUTURE OF SUSTAINABLE MATERIALS

Written by Katharina Schwaiger, acib GmbH

FOR FOUR YEARS,

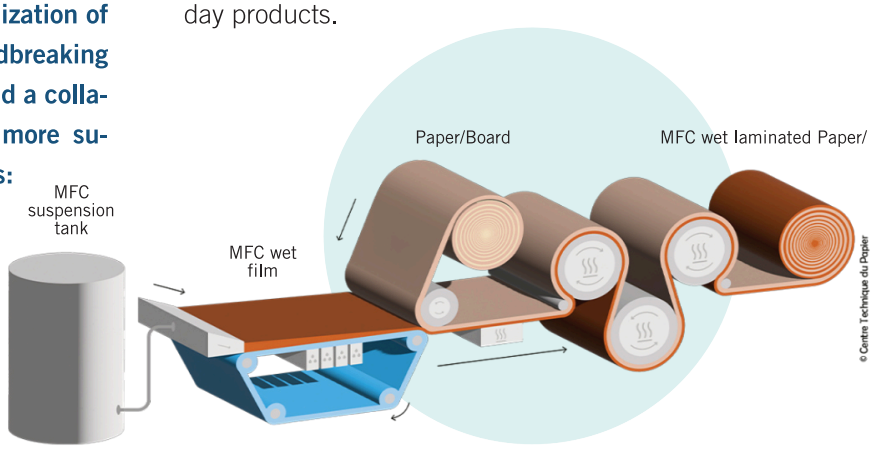
the Bionanopolys project has been tackling one of the most pressing challenges of our time: how to integrate sustainability into material production. By creating an Open Innovation Test Bed (OITB), the project offered companies access to advanced facilities and expertise, accelerating the development and commercialization of bio-based nanomaterials. Its results? Groundbreaking innovations, industry-wide transformations, and a collaborative ecosystem that set the stage for a more sustainable future. Here's to our Success Stories:

aitex textile research institute

textisol non woven hydroentangled cotton fabrics

SUSTAINABLE CLEANING WIPES WITH VISCOSE AND PLA

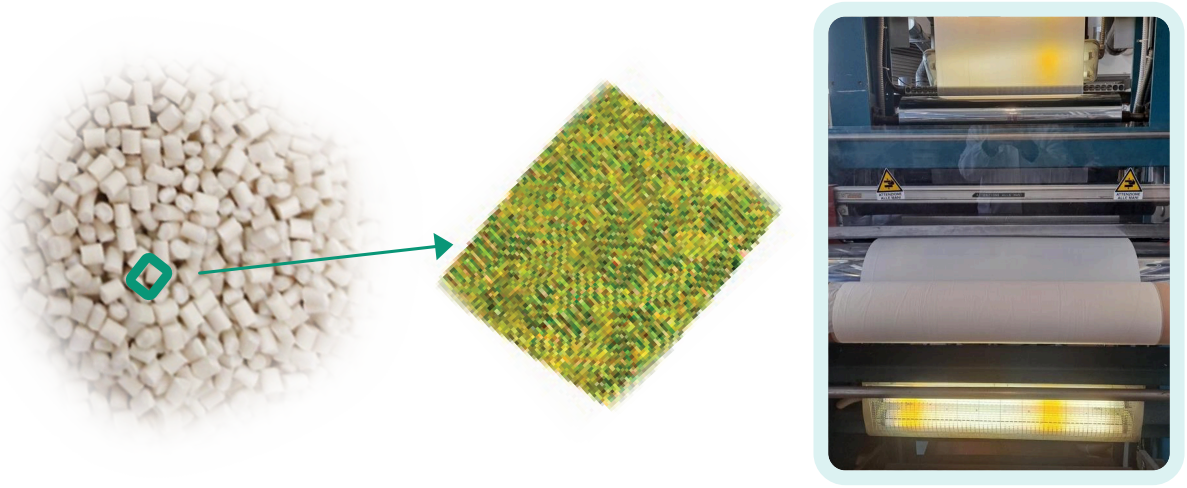
The development of sustainable cleaning wipes was a significant milestone within the Bionanopolys project. These innovative wipes, composed of 85% viscose and 15% polylactic acid (PLA), were enhanced through advanced chemical modification processes. By using reactive extrusion, PLA was imbued with antimicrobial properties, ensuring the stability of the fibers. The resulting materials were transformed into needle-punched nonwoven wipes, showcasing varying proportions of the modified PLA. These products offer superior cleaning performance while remaining fully biodegradable. This use case highlights an eco-friendly alternative to synthetic wipes, reflecting Bionanopolys' commitment to sustainability in everyday products.



ctp centre technique du papier

ENHANCED PAPER-BASED MATERIALS WITH MICROFIBRILLATED CELLULOSE (MFC)

This use case explored the potential of MFC as a reinforcement agent for paper-based materials, with the goal of improving both mechanical strength and barrier properties. The development process included cooking and bleaching cellulose fibers to produce high-quality MFC, which was then laminated onto paperboard in wet conditions. This unique approach eliminated the need for glue, providing a fully biodegradable solution. The resulting prototypes were tailored for the packaging industry, offering improved grease and oxygen resistance while maintaining the structural integrity required for diverse applications.



BIOBASED BLOCK COPOLYMERS AS ADDITIVES FOR BIOMATERIALS

The innovative development of PBS-co-PLA copolymers within UC 6 marked a breakthrough in advancing bioplastic formulations. These 100% biobased and biodegradable block copolymers served as effective plasticizers, enhancing both the processability and performance of biomaterials. With their low viscosity, the copolymers reduced electrical absorption and pressure during extrusion processes, making them highly compatible with film converting techniques.

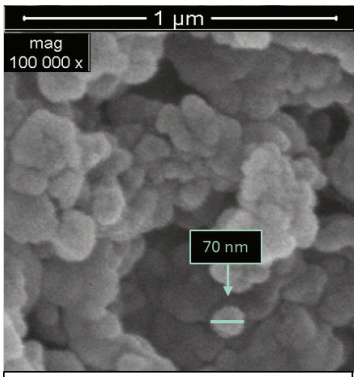
The resulting formulations showcased remarkable mechanical properties, including excellent deformability and high yield at break, ensuring durability across diverse applications. Moreover, their superior optical properties, such as high transmittance and clarity, made them ideal for producing transparent films that meet industrial standards.

MODIFIED NANOCLAYS FOR SUSTAINABLE PACKAGING

UC 9 aimed to revolutionize packaging by leveraging natural fillers in the form of nanometric-sized modified nanoclays. These innovative materials were incorporated into biodegradable formulations, serving as reinforcement additives that enhanced mechanical and barrier properties. By seamlessly integrating them into Novamont's biopolymer matrices, the project created flexible packaging prototypes with a remarkable balance of deformability, rigidity, and yield at break. Proven to perform in demanding applications such as compostable shopping bags and organic waste collection bags, these materials also demonstrated compatibility with polyhydroxyalkanoates. This achievement aligns with global efforts to reduce plastic waste and expand the use of compostable packaging alternatives.

ADVANCED NANOCELLULOSE FOR COSMETIC APPLICATIONS

In this success story, cellulose nanofibers (CNF) and nanocrystals (CNC) were developed and tested for cosmetic formulations. The team focused on incorporating these bio-based materials into sun cream emulsions, enhancing texture, hydration properties, and compatibility with other ingredients. These bio-based materials served as sustainable replacements for fossil-based additives, acting as rheological modifiers, stabilizers, SPF boosters in sunscreen emulsions, and functional ingredients in treatments for hyperhidrosis. Rigorous testing ensured enhanced texture, hydration, and compatibility, introducing eco-friendly innovation to everyday cosmetics.



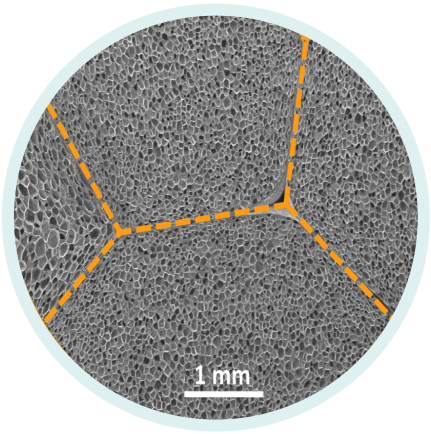
Pilot Scale - Tocopherol NCs
(from celulose source in the scope of the project)

NANOCAPSULES FROM BIOMASS FOR COSMETIC APPLICATIONS

Nanocapsules made from cellulose derivatives were developed as innovative delivery systems for active ingredients, such as antioxidants, in cosmetic formulations. The team at Centi formulated an oil-in-water emulsion using cellulose acetate butyrate (CAB) derived from biomass to encapsulate Vitamin E. These nanocapsules enhance ingredient stability and effectiveness, making them ideal for sustainable cosmetics. In vitro testing (AmbrosiaLab) using a photochemiluminescence assay confirmed the antioxidant efficacy of the biomass-derived nanocapsules, comparing favorably to those made with commercially available CAB. This advancement highlights their potential as eco-friendly and efficient solutions for modern cosmetic applications.

BIO-BASED FOAMED TRAYS FOR FOOD PACKAGING

This success story focused on developing biodegradable and recyclable foamed trays for the food packaging industry. The teams at ITENE and CELLMAT integrated bio-based polymers, including PLA and PBS, into foam formulations, incorporating nanoclays as nanofillers. These nanoclays refined the cellular structure, enabling microcell formation, which contributed to a 10–30% weight reduction compared to solid trays. Their addition also enhanced tray stiffness and improved gas barrier properties. Extensive testing ensured compliance with food safety regulations, resulting in a sustainable alternative to conventional plastic trays.



BIO-BASED POLYPROPYLENE WITH NANOCELLULOSE FOR AUTOMOTIVE APPLICATIONS

UC 17 addressed the automotive sector's demand for sustainable and lightweight materials. The project compounded bio-based polypropylene with nanocellulose, creating a durable material suitable for complex-shaped foamed parts. Using advanced bead foaming and steam-chest molding techniques, the teams at CIDAUT and CELLMAT produced prototypes with excellent recyclability and mechanical properties. These components offer an innovative solution for reducing vehicle weight while maintaining safety and performance standards, demonstrating the applicability of bio-based materials in high-demand industries.

USER CASE ECORBIO

ADVANCING SUSTAINABLE BIO-BASED FOAMS FOR CONSTRUCTION AND BEYOND

As part of this legacy, we are thrilled to feature the user case of ECORBIO, initially planned for the previous OITB Newsletter, this story found its home in this final edition. Special thanks to Ester Laguna Gutiérrez and the team at ECORBIO for providing the following insights:
ECORBIO is specialized in the development of breakthrough biopolyol production technologies and products. They wanted to evaluate the viability of one of their polyols to produce two different types of foams by using various technologies.

THIS PROJECT HAD THREE MAIN OBJECTIVES

1. Evaluate the feasibility of using the biopolyols to produce polyisocyanurate foams (PIR) tailored to produce more sustainable sandwich panels for the construction sector. With this objective in mind, different foams were produced by blending a fuel-derived polyol with the biopolyol supplied by ECORBIO.

2. Test the foaming behavior, by means of the gas dissolution foaming technology and the bead foaming technology, of thermoplastic polyurethane (TPU) synthesized using the biopolyol. For this purpose, different materials were synthesized, with different contents of hard segments, using a fuel-derived polyol, as a reference, and different blends of this fuel-derived polyol with the biopolyol supplied by ECORBIO.

3. To perform a techno-economical analysis including a market study and a risk analysis.

THREE PARTNERS HAVE BEEN INVOLVED IN THIS PROJECT.

CellMat Technologies (coordinator) was responsible for producing the foamed samples by using different technologies: reactive foaming (to produce the PIR foams) gas dissolution foaming and bead foaming (to produce the TPU foams). CIDAUT was responsible for synthesizing the TPU using the biopolyol supplied by ECORBIO. Finally, EBAN was responsible for the techno-economical analysis. The main results and conclusions obtained from this project are summarized below:

1. Production and characterization of PIR foams
The water content of the biopolyol is very high. As a consequence, it was very complicated to control the reproducibility of the foaming process. The increase in the water content had an important effect in properties like density, open cell content, cell size, etc. and therefore, on the physical properties of the final foams.
The behavior of the sample containing 10 pbw of the biopolyol was very interesting. It had a thermal conductivity like that of the reference. It had the best fire resistance and the best mechanical performance.
However, the reproducibility of this sample was very poor. Important differences were detected between three samples produced from this formulation and using both a wet and a dry biopolyol. These differences were detected in different parameters: reactivity (gel time and cream time), density, open cell content, cellular structure, and also in the physical properties: thermal conductivity, fire resistance, mechanical performance and acoustical behavior.
A significant improvement of the acoustical performance was detected as the content of biopolyol increases. This improvement was consequence of the cell opening due to the high amount of water of the own biopolyol.

2. Production and characterization of TPU foams
TPU materials were successfully synthesized using the Ecorbio's Biopolyol (5%wt). Moreover, green synthesis of TPU (in absence of solvents) was employed.
The samples presented different glass transition temperatures, melting temperatures, melting peaks and crystallinities.

After the gas dissolution foaming experiments, the sample 50%HS _5%BIOPOLYOL was selected as the most promising formulation for bead foaming since it allows obtaining low densities (0.33 g/cm3) and homogeneous cellular structures with cell sizes around 250 µm.

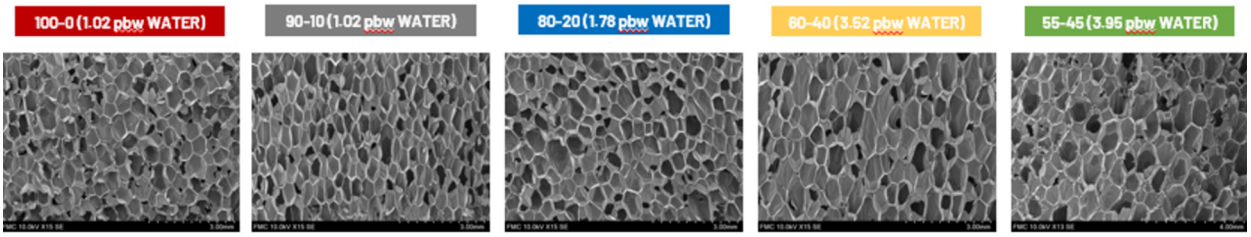
For the bead foaming tests, large quantities of 50%HS _ 5%BIOPOLYOL were synthesized and cut into small pieces. Then, they were extruded to produce solid micropellets.

Several bead foaming experiments were performed varying the saturation/foaming parameters (pressure and temperature). For each pressure there is an optimum saturation temperature. Also, it seems that the TPU allows better foaming at lower pressures (5 MPa).

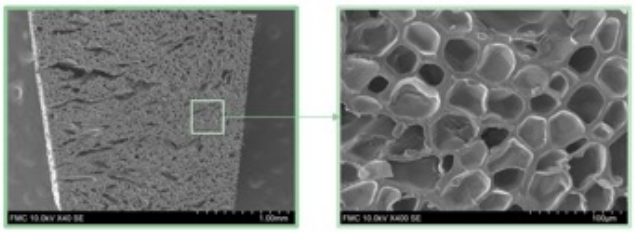
The best result was obtained at 5 MPa, 110 ºC and 10 min. This sample was characterized by a density of 480 g/cm3 and a bimodal structure characterized by large cells of around 150 µm and smaller cells of around 3 µm in the cell walls. The sample presented a double melting peak.

3. Techno-economical analysis

The Techno-Economic Analysis highlights ECORBIO's viability as a sustainable bio-based project with substantial market potential and clear competitive advantages. By strategically implementing the recommendations—continuing R&D investments, forming strategic partnerships, engaging with regulatory bodies, exploring new markets, and enhancing sustainability practices—ECORBIO can successfully enter and grow in the bio-based industry. These actions will align with the broader objectives of the BIonanopolys project and set the stage for ECORBIO's long-term success.



SEM micrographs of the PIR foams produced with the wet biopolyol.



SEM micrographs of the TPU foam produced with the formulation 50% HS containing 5% of biopolyol

HIGHLIGHTS FROM THE PAST 4 YEARS

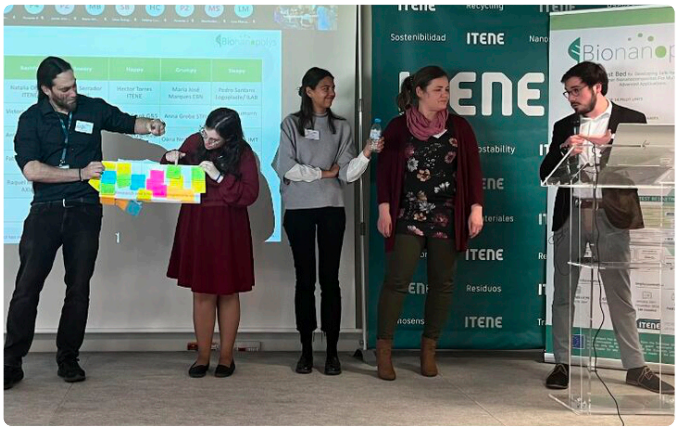
BIONANOPOLYS KICKED OFF IN JANUARY 2021

Bionanopolys kicked off in January 2021 and was forced to hold a virtual meeting due to the COVID-19 situation

FIRST & SECOND LEGAL WORKSHOPS

First & Second legal Workshops were held as hybrid meetings in Valencia. The workshops focused on how to realize a sustainable Bionanopolys ecosystem and discusses possibilities of the legal entity supporting the Single Entry Point as a unique entrance for potential customers to the services of Bionanopolys OITB.

Bionanopolys the first time at the **European Summit of Industrial Biotechnology** (esib) in November 2022. acib organized an exhibition table.



FROM 18 TO 19 APRIL 2023 THE GENERAL ASSEMBLY MEETING

took place at the premises of ITENE in Valencia, Spain.

EBAN CONGRESS 2024

Bionanopolys hosted a Pitching Session at EBAN Congress in 2024 in Tallinn, Estonia. Two rising star companies supported by Bionanopolys, Ecorbio and Algaesys were selected the top startups of the session!

ACKNOWLEDGEMENTS

A SHARED COMMITMENT TO SUSTAINABILITY

As the Horizon 2020 Bionanopolys project concludes, we celebrate the dedication of 27 European partners from 12 countries who helped establish an Open Innovation Test Bed for sustainable bio-based nanomaterials.
Through 14 pilot plants and the creation of the Single Entry Point, Bionanopolys has delivered solutions for packaging, textiles, agriculture, cosmetics, pharmaceuticals, and food, driving the transition from fossil-based to sustainable materials.

We thank every partner, contributor, and supporter for turning ambitious ideas into real progress. While the project officially ends, the OITB continues as a platform for innovation, offering technologies, expertise, and support to help industries, SMEs, and researchers bring bio-based materials to market.

The work started here will carry on, inspiring future collaborations and sustainable advancements.

THANK YOU FOR BEING PART OF THIS SHARED VISION FOR A GREENER FUTURE.
THE BIONANOPOLYS TEAM

www.bionanopolys.eu

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