

SUSTAINABLE SURFACE PROTECTION BY GLASS-LIKE HYBRID AND BIOMATERIALS COATINGS

BIO-SUSHY General overview & PFAS in paper-based packaging



BIO-SUSHY

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28/03/2025

WOOD
KPLUS



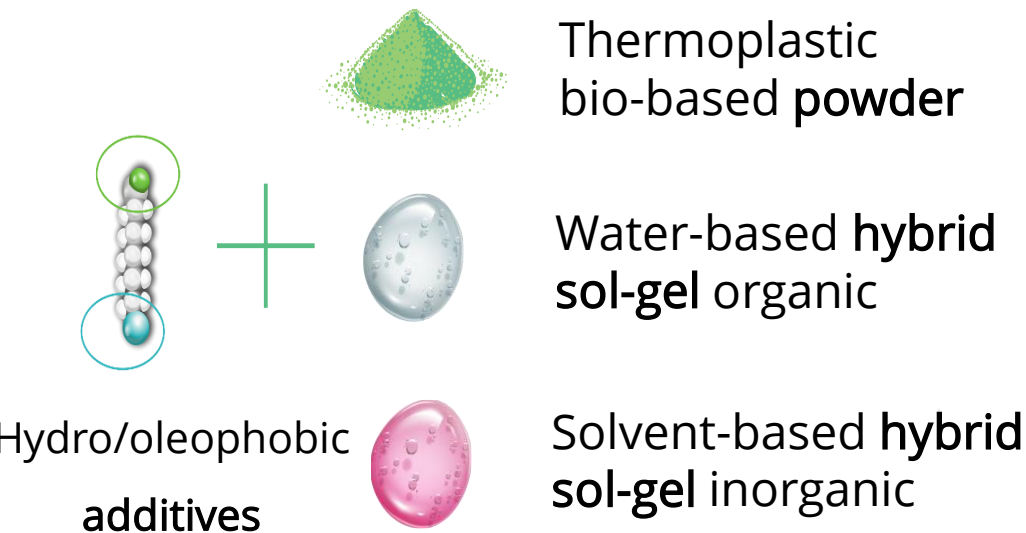
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BIO-SUSHY Objectives

BIO-SUSHY Methodology Based on 3 pillars

Develop 3 PFAS-free bio-based coatings

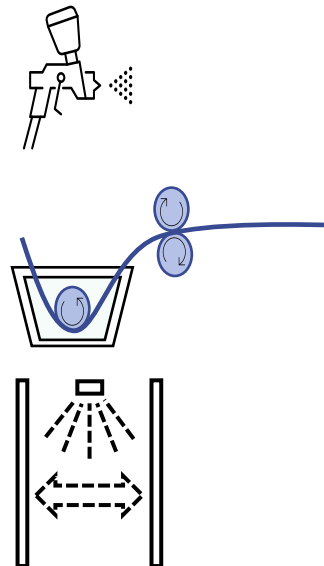


Hydro/oleophobic additives

Thermoplastic bio-based powder

Water-based hybrid sol-gel organic

Solvent-based hybrid sol-gel inorganic



R&I COATING
DEVELOPMENT



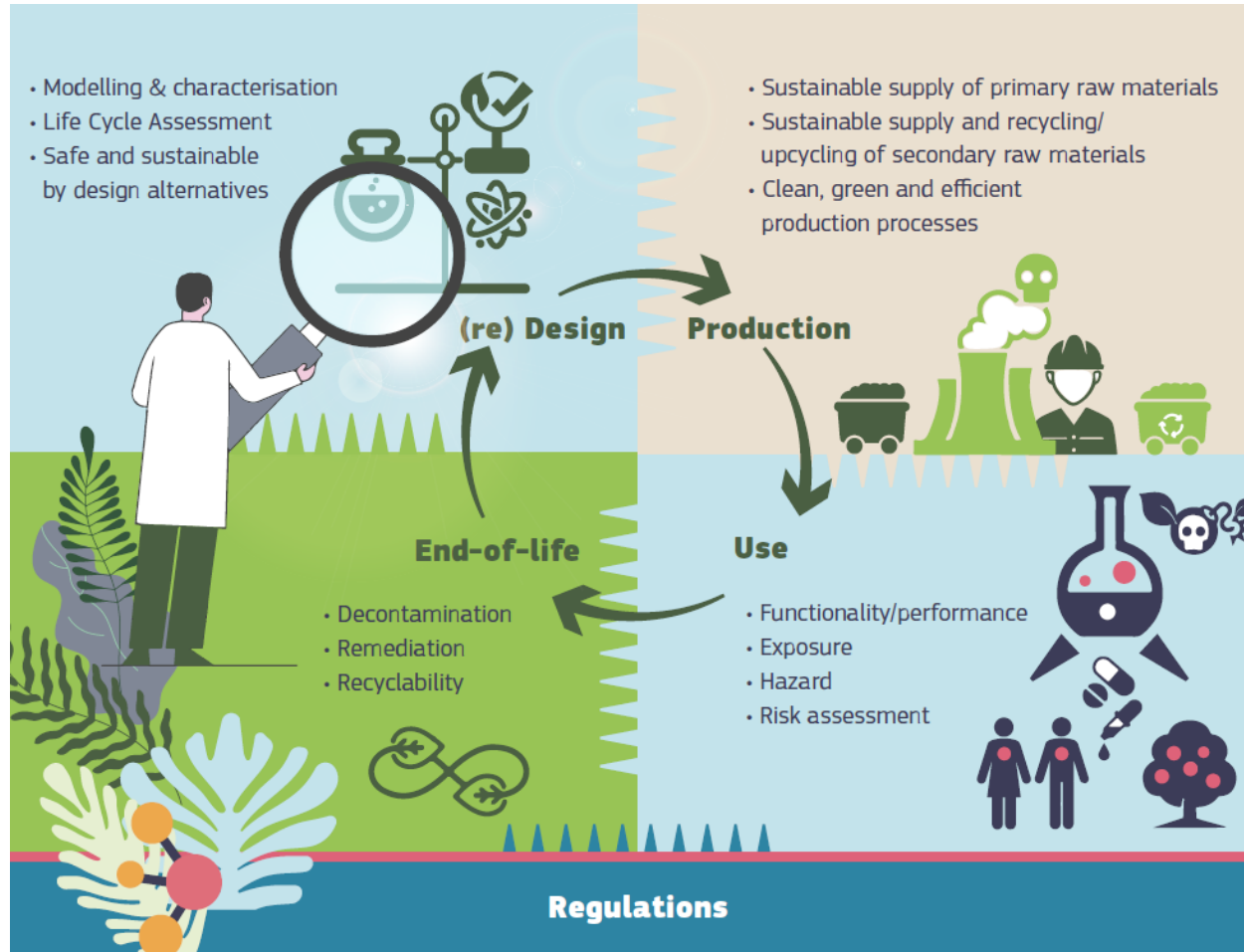
MODELLING



SAFE AND
SUSTAINABLE
BY DESIGN



Safe and Sustainable by Design



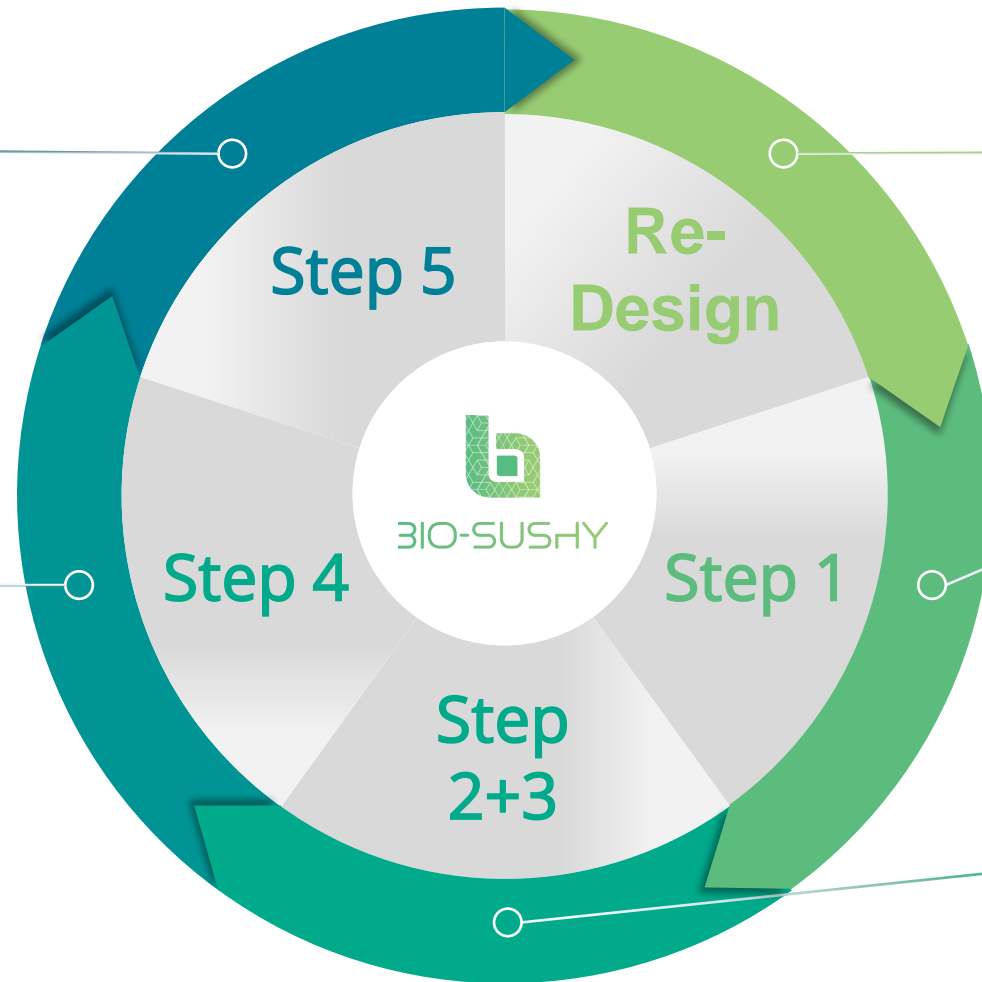
- **Development of SSbD Framework applied to PFAS-free coatings**
 - safe by material design,
 - safe by process design,
 - toxicological studies,
 - LCA, LCC, SLCA
- **Standardisation roadmap**



The 5 steps SSbD framework

- Life Cycle Costing (LCC)
- Social-LCA

- LCA
- Circularity
- End of life



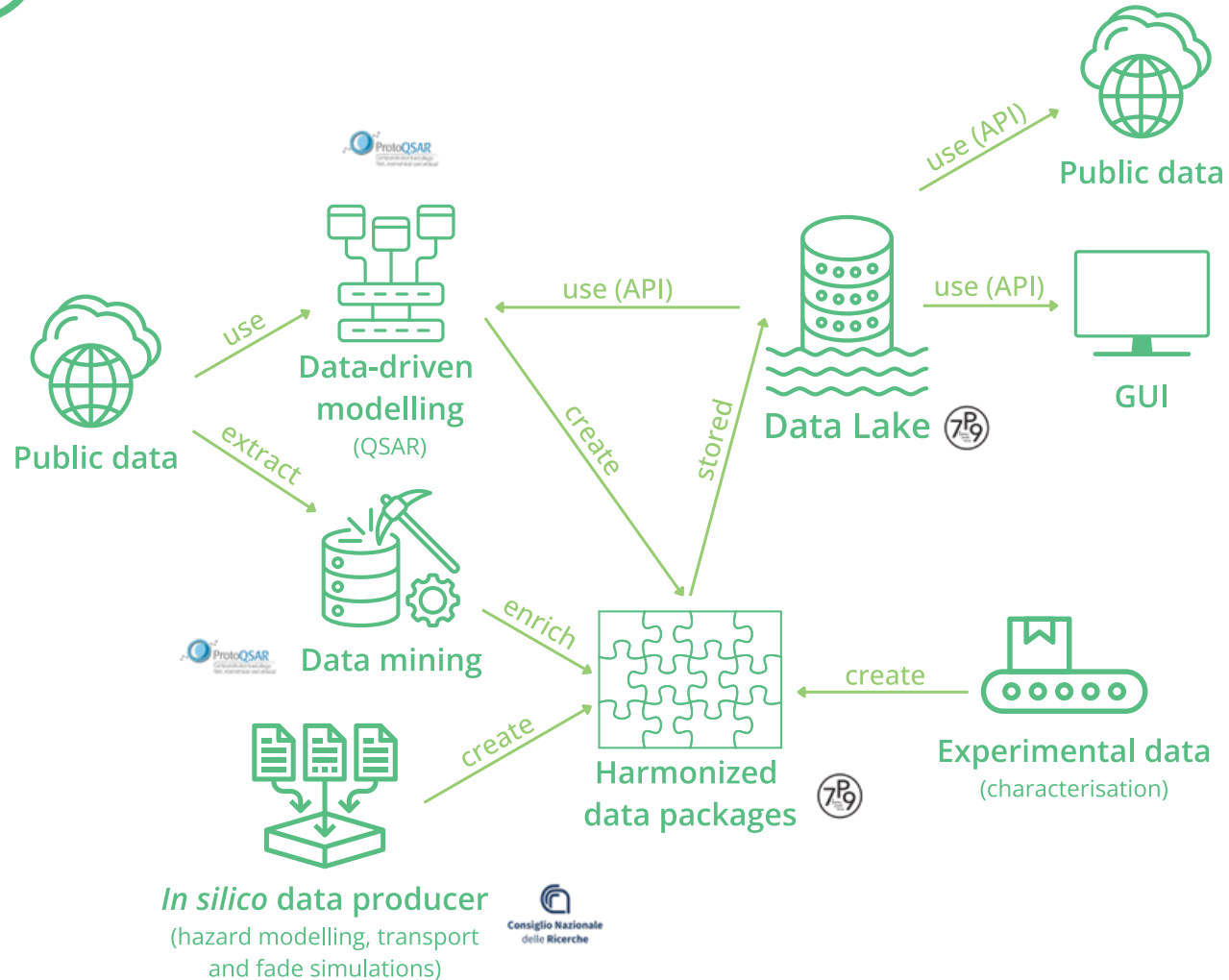
- Coating development
- Functional modelling
- Data mining
- Up-scaling

- Data mining
- QSAR

- Occupational monitoring
- Risk assessment
- Tox testing



Modelling



- Development of the BIO-SUSHY set of **computation tools** for SSbD of coatings
- Development of integrated approaches supported by the **BIO-SUSHY HUB** for effective **data management and sharing**



R&I Coating Development



TEXTILE COATING



FOOD PACKAGING



GLASS COSMETICS
PACKAGING

- Development of 3 novel SSbD coatings materials with water and oil repellency
- Validation of coating materials with 3 case studies
 - Textile
 - Food packaging
 - Glass packaging



BIO-SUSHY

FOOD PACKAGING










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Paper-based Food Trays with improved EoL



PFAS used for **short-term storage** or for holding freshly prepared food to provide **functional properties** as water and/or oil repellence.

-  Thermal resistance
-  Low impact on price
-  Limited release of components
-  Validation tests: food contact & migration tests on food trays
-  Water and oil repellency with **100% replacement of PFAS**
-  No element that could impact the **recyclability/compostability**
-  Development of **bio-based thermoplastic powder coating** coatings based on safe compounds

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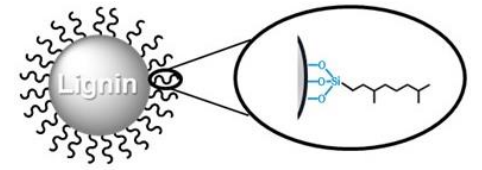
ecozema®

SIKEMIA

- Direct exposure
- Emission through incineration
- Accumulation in recycling or landfill



R&D Coating Development



Powder coating formulations

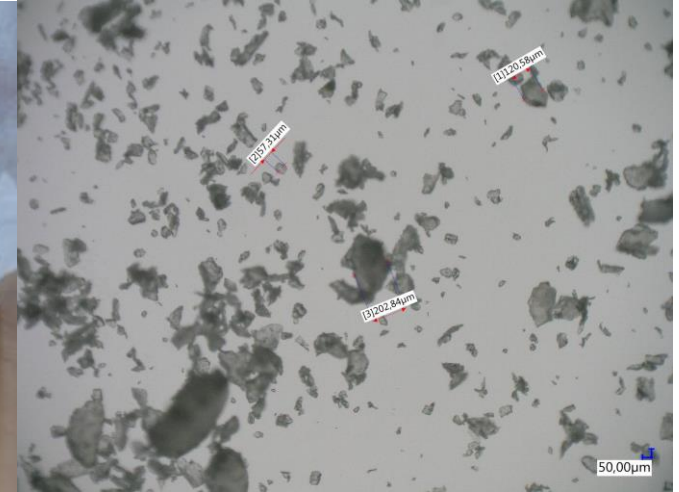
- Biobased thermoplastic powders (PHA, PBS, Carnaubawax, alkoxy silane modified Lignin) → Coating application
- Novel formulations based on mixtures of PHA, PBS, modified Lignin etc. → Compounding → Grinding → Coating application



Compounding thermoplastic matrices: Parallel, co-rotating twin screw extruder Brabender DSE20



Grinding of thermoplastic granules using cold grinding under nitrogen



Coating concept within BIO-SUSHY

Powder coating application

Powder coating experiments (lab scale) has been done on the substrate Inverform 330gsm provided by Ecozema. Paper was horizontally positioned in the powder spray booth and sprayed with the coating powder electrostatically (one side). The applied powder particle film was gelled and "smoothed" using a hot press



Powder spray equipment



Powder applied on cellulosic paper or tissue or air-laid



Gelling in the hotpress

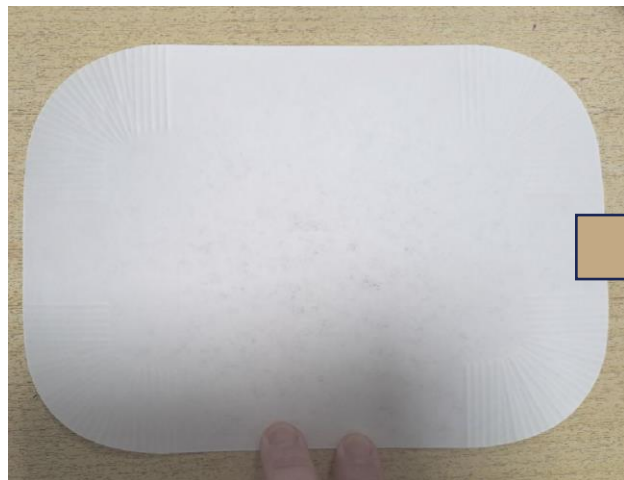


Coated cellulosic substrate

Coating concept within BIO-SUSHY

Thermoforming/dry Forming

- Thermoforming trials at ECOZEMA: The test has been conducted into a Novatec PV10-5010 PLUS, blank feed forming machine. The selected mold was for a tray size mm 195x130x30h



Cut and creased sheets



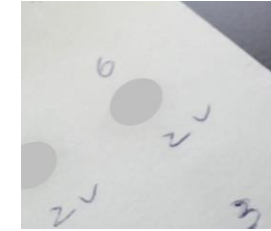
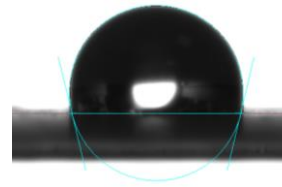
Novatec PV10-5010 PLUS, blank feed forming machine



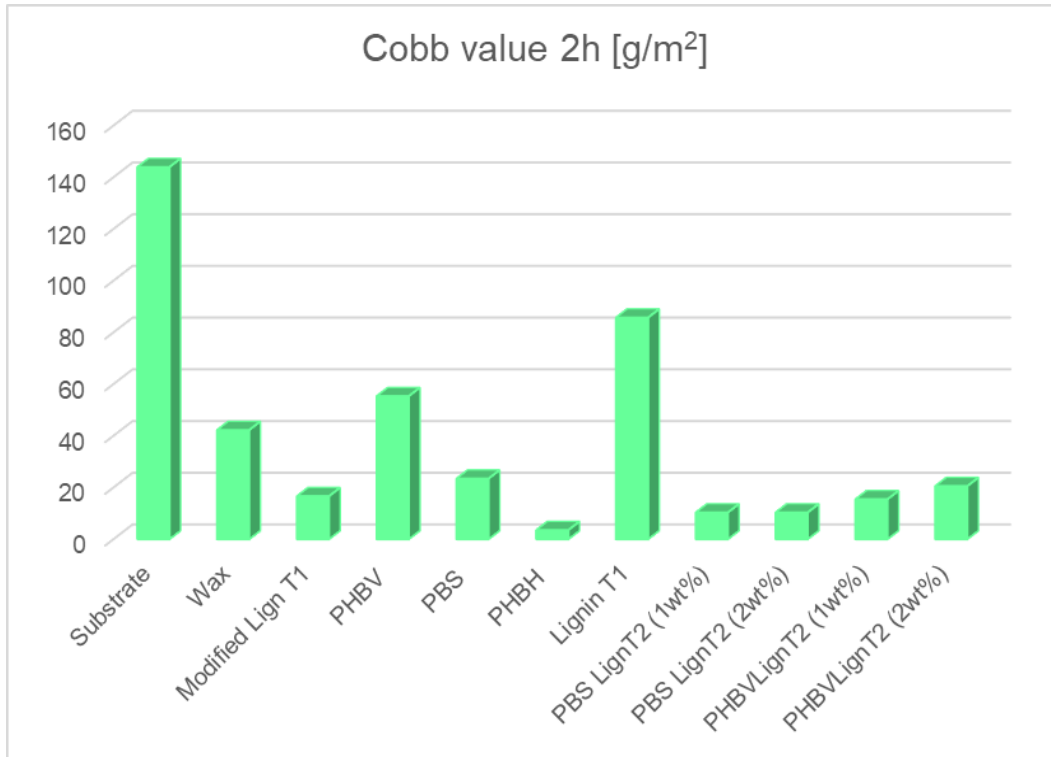
Food tray

- or dry forming

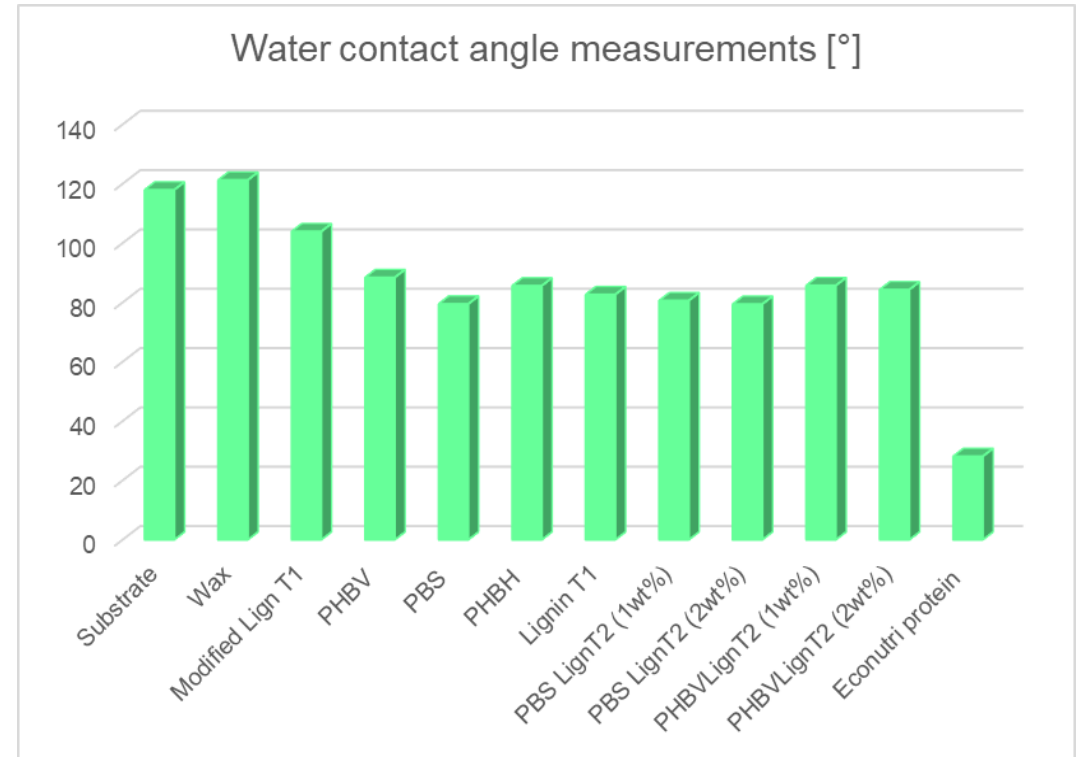
Coated paper characterization – selected results



Cobb value 2h [g/m²]



Water contact angle measurements [°]



Coated paper characterization – selected results

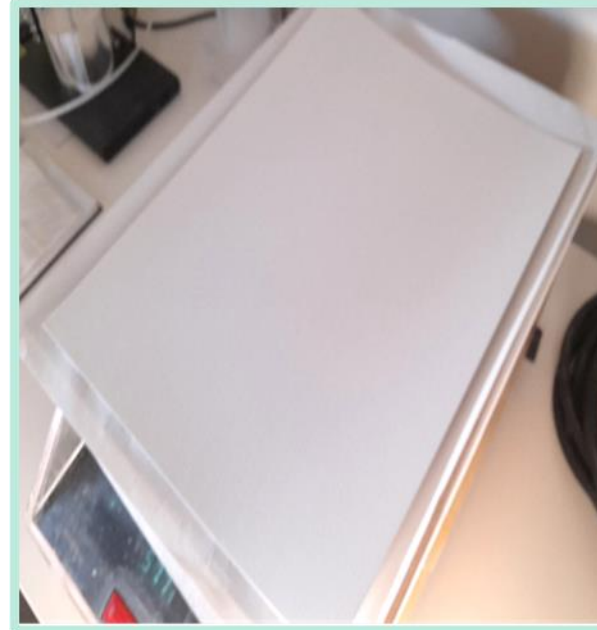
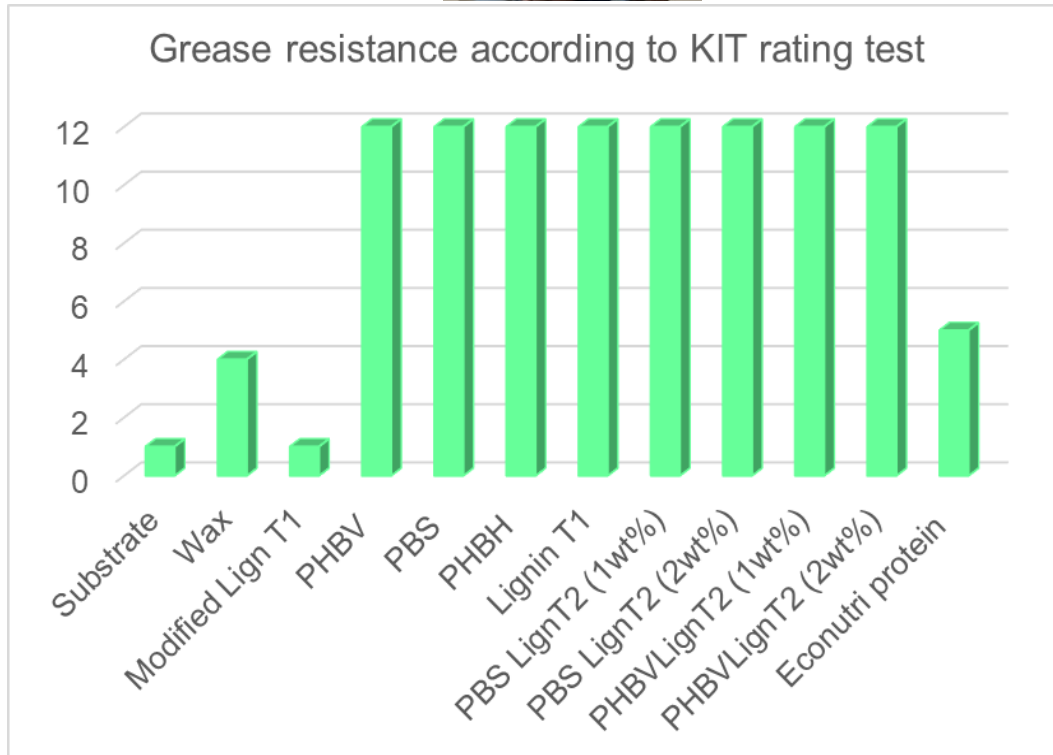
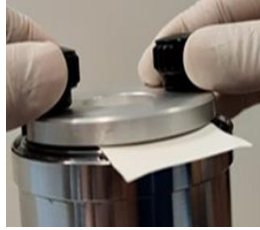
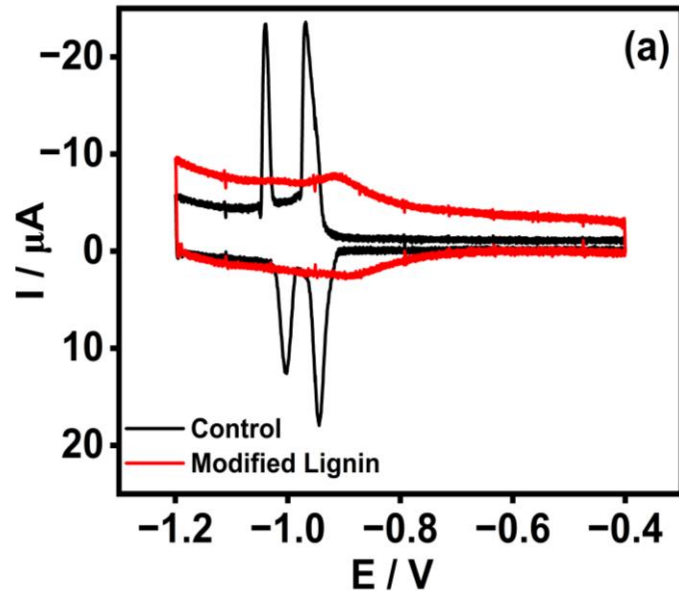


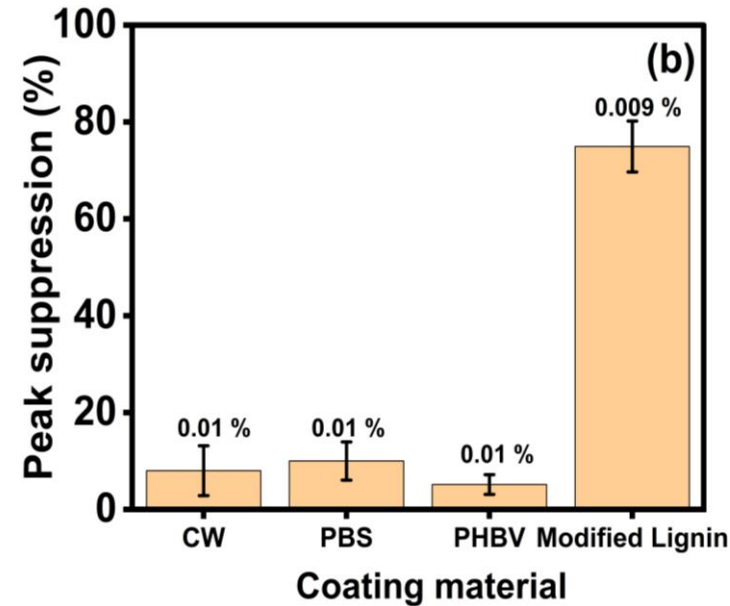
Figure: Paper substrate coated by PBS (left) and thermoformed coated paper

SSbD – in vitro cell toxicity testing

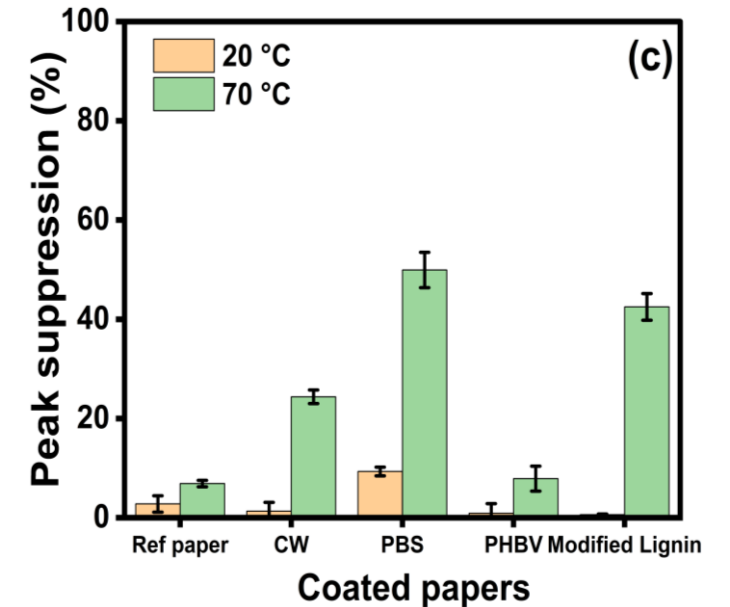
Rapid identification of biomembrane activity related to in vitro cell toxicity



(a) RCV scan of lipid layer sensor in the absence (black) and in the presence of 0.009 % modified lignin (red) in the phosphate buffered saline at 40 Vs⁻¹



(b) Percentage peak suppression in the presence of coating material carnauba wax (CW), PBS, PHBV and modified lignin at concentrations displayed on the bar graph



(c) from leachates arising from coated papers in phosphate buffer saline at 20 °C (yellow) and 70 °C (green)

Implementation of the BIO-SUSHY powder coatings & next steps

- **Industry Collaboration:**

- End-user Ecozema: Testing coatings in real world paper & fiber-based packaging
- Scalability: Technologies compatible with existing industrial lines – extrusion coating

- **LCA insights:**

- Reduced environmental impact (if data available)
- Social benefits: S-LCA insights

- **Next steps**

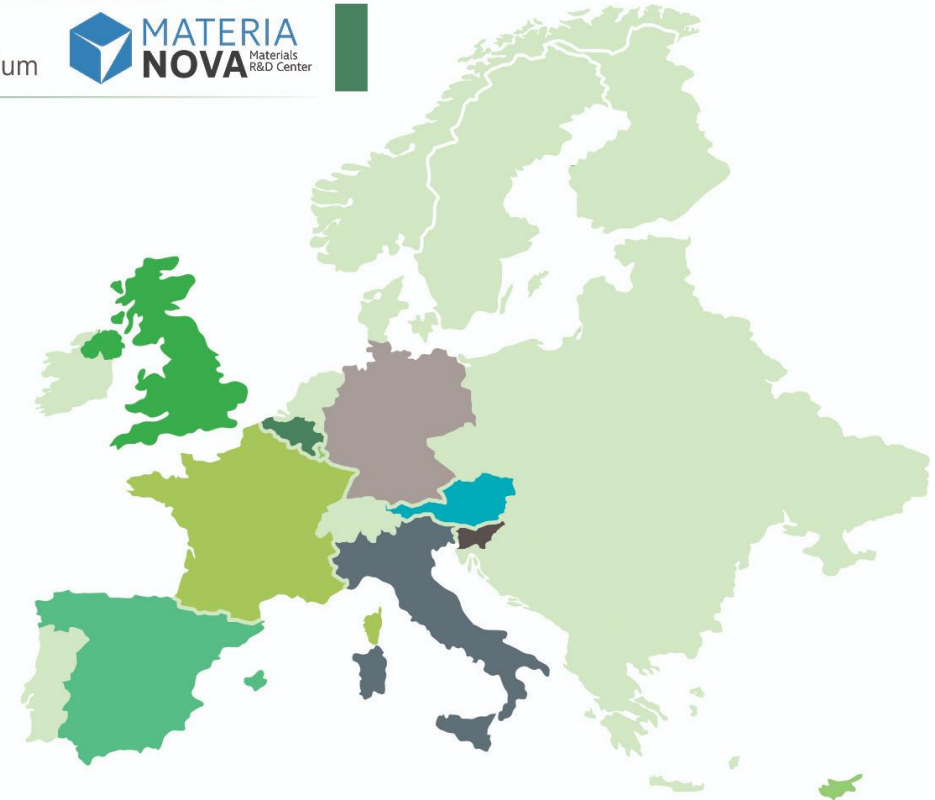
- Increasing Lignin content in coating formulations (obtaining the maximum loading and avoiding potential leakage)
- Upscaling of coating formulation using different technologies (roll to roll dry powder application technologies or extrusion coating)
- Thermoforming trials on coated paper samples for paper-based food packaging applications
- Testing of novel materials in respect to biodegradability, food contact safety (migration test) and potential impact on paper recyclability

Team

The **BIO-SUSHY** project is a collaboration between 14 partners from 7 EU countries and 1 EU-associated country: 6 RTDs, 5 SMEs, 1 large company, 1 university, and 1 national association.

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