SUSTAINABLE SURFACE PROTECTION BY GLASS-LIKE HYBRID AND BIOMATERIALS COATINGS

Dry powder lignin-based coatings for electrostatic spray applications – paper-based food trays

BIO-SUSHY

Ivana Burzic

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WOOD K PLUS

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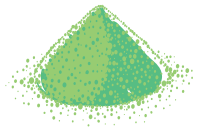
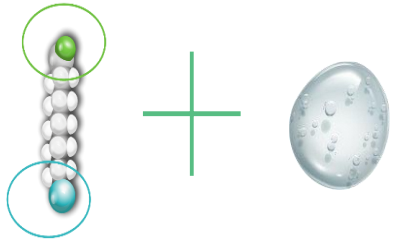
BIO-SUSHY Objectives

Develop 3 PFAS-free bio-based coatings



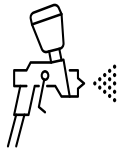
Thermoplastic bio-based **powder**

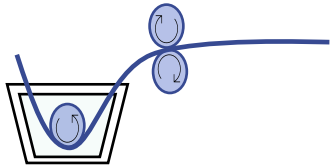


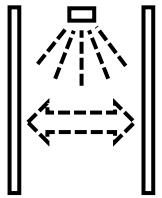
Hydro/oleophobic **additives**

Water-based **hybrid sol-gel** organic

Solvent-based **hybrid sol-gel** inorganic







BIO-SUSHY Methodology Based on 3 pillars

R&I COATING DEVELOPMENT

MODELLING

SAFE AND SUSTAINABLE BY DESIGN

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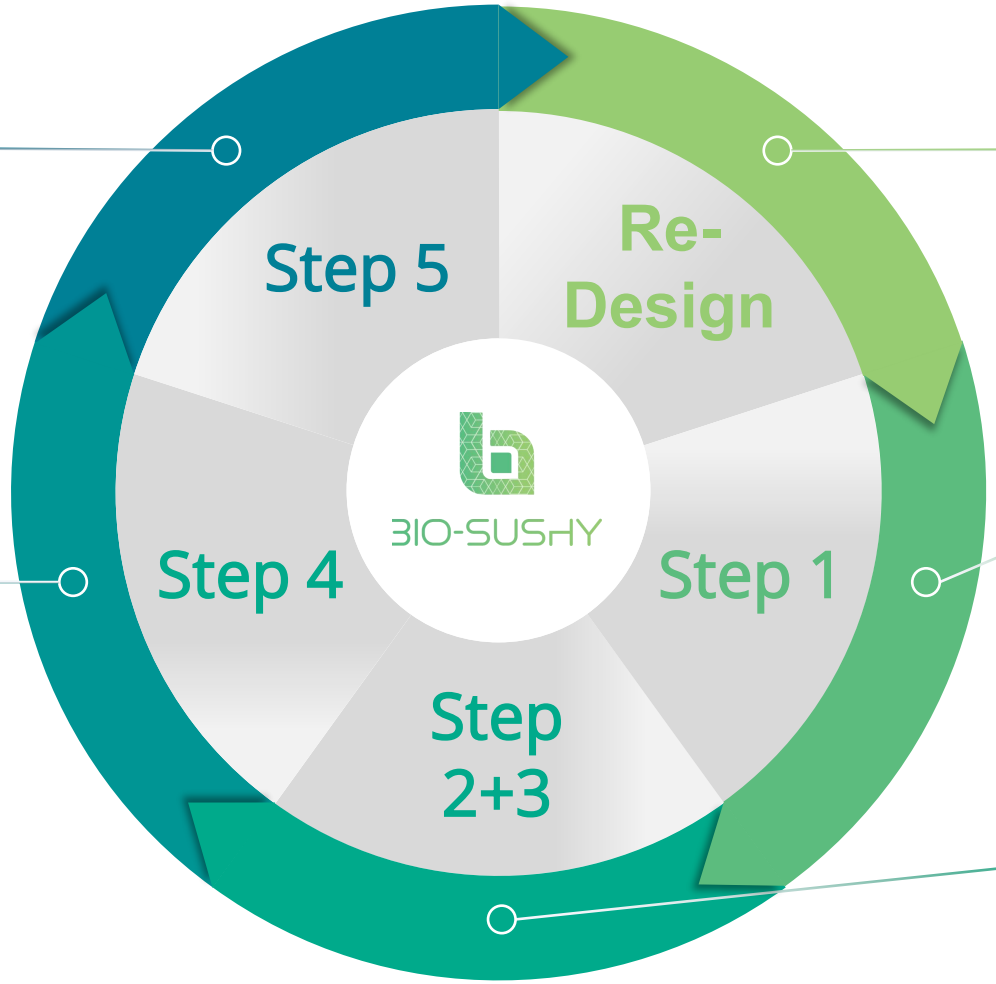
The 5 steps SSbD framework

- 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

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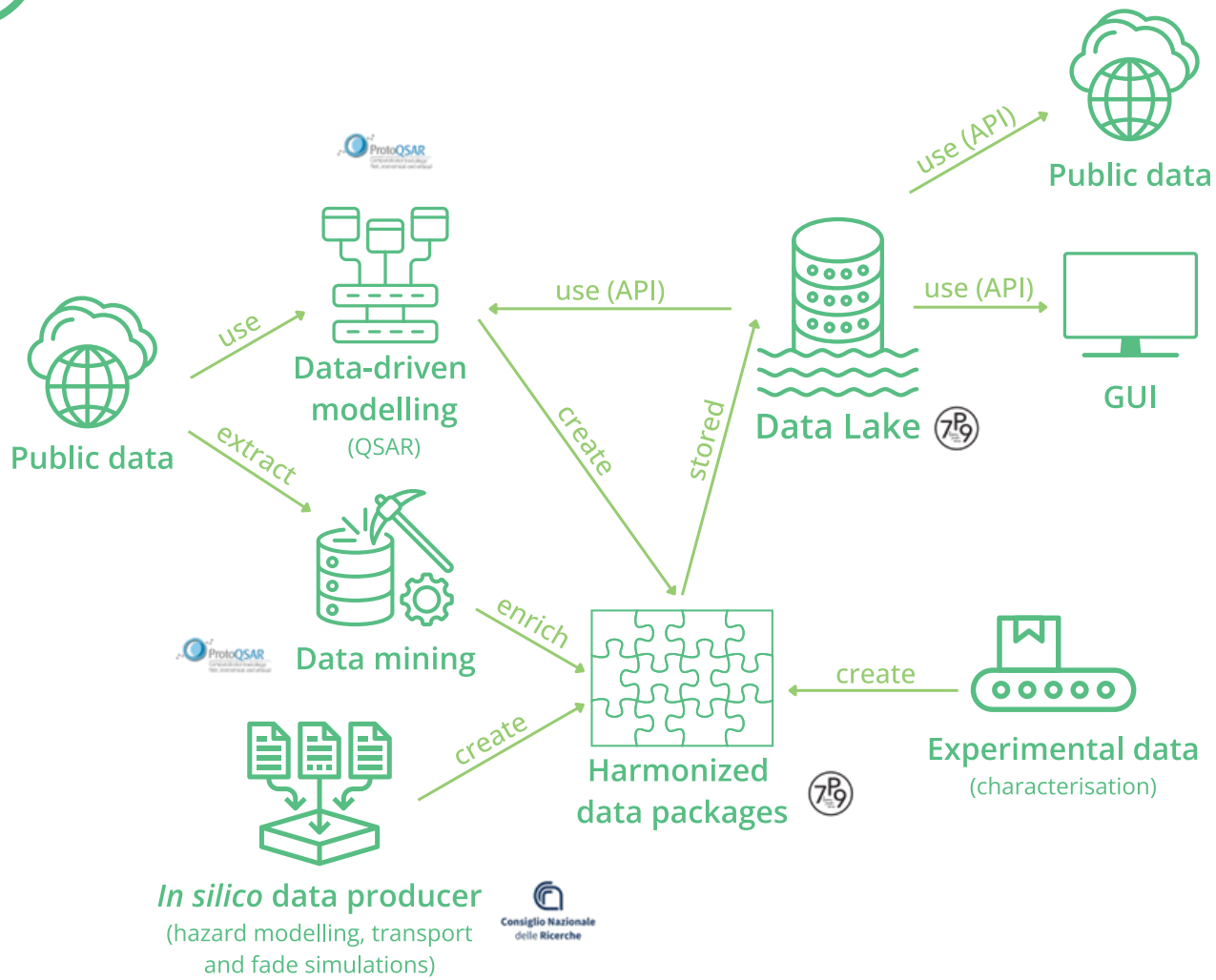
Modelling



- 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

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R&I Coating Development

- 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

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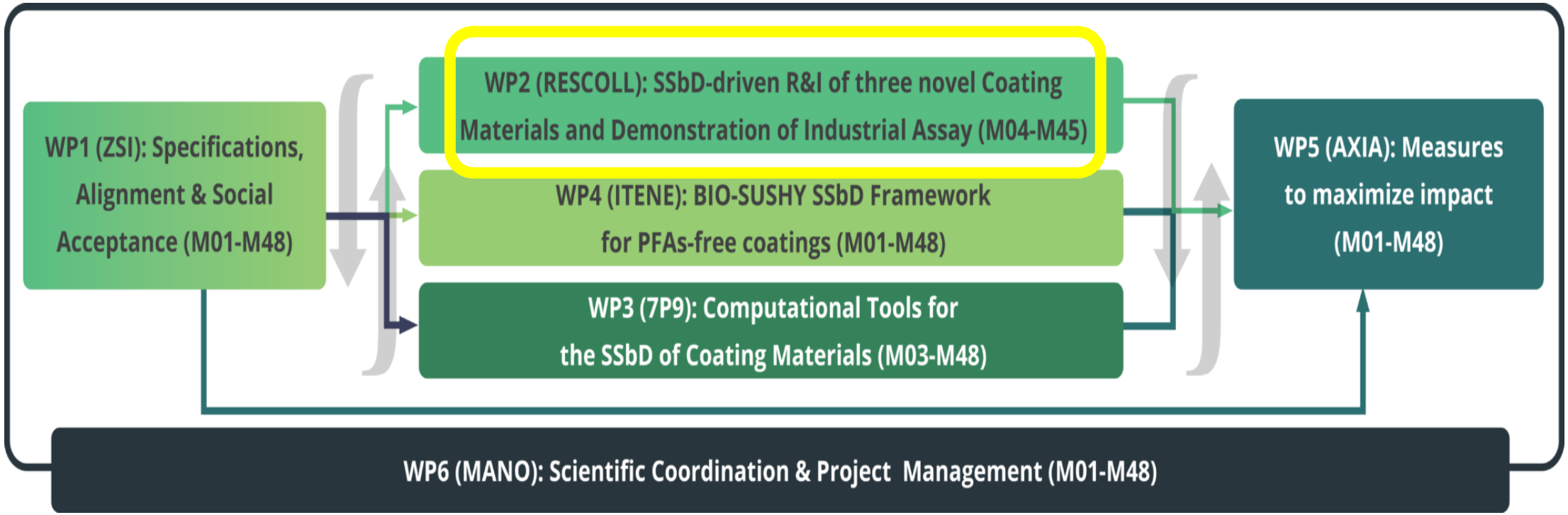
Wood K plus role in BIO-SUSHY



- Development and validation of organic coating materials for spray coating applications on paper and cellulosic substrates for food packaging
- Close cooperation with BIO-SUSHY partners dealing with Safety & Sustainability Framework (SSbD) Framework

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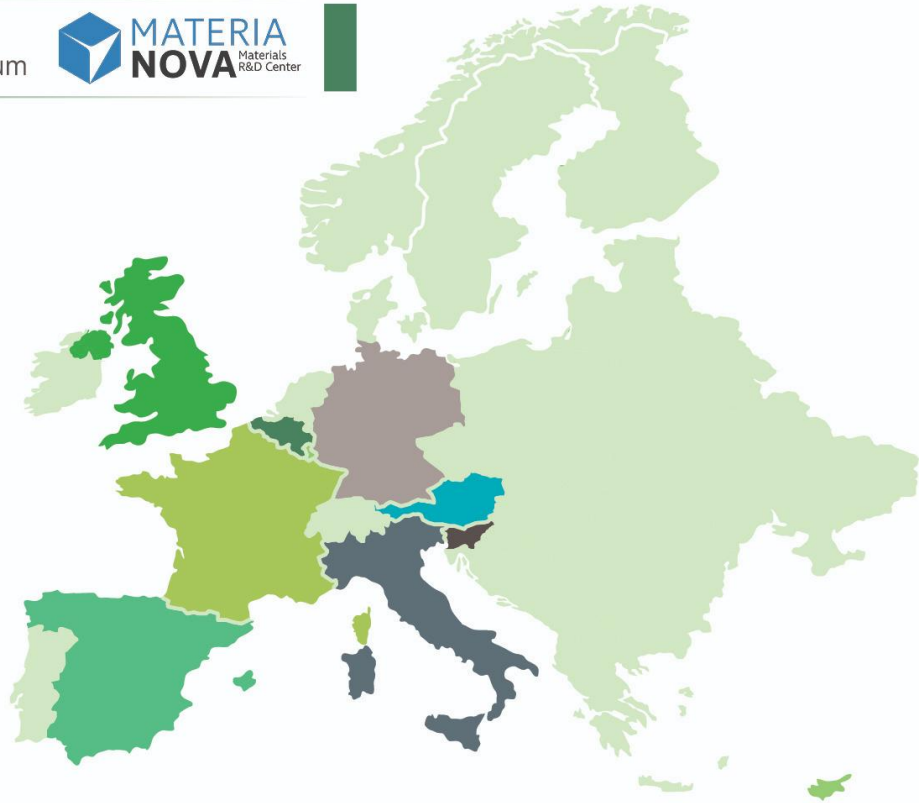
Team

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.

BIO-SUSHY COORDINATOR:
Materia Nova, Av. Nicolas Copernic 3, 7000 Mons, Belgium



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FOOD PACKAGING

BIO-SUSHY

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FOOD TRAYS CASE STUDY

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

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

Based on:

- WP2 R&I Coating development
- WP4 SSbD

- **Thermal resistance**
- Low impact on **price**
- Water and oil repellence with **100% replacement of PFAS**
- **Validation tests**: food contact & migration tests on food trays
- No element that could impact the **recyclability/compostability**
- Limited release of components (screening of leachates using biomembrane sensor), cytotoxicity testing
- Development of **bio-based thermoplastic powder** coating coatings based on safe compounds – Exposure assessment (Step 1, Step 2, and Step 3)
- Sustainability assessment (Step 4 and 5)

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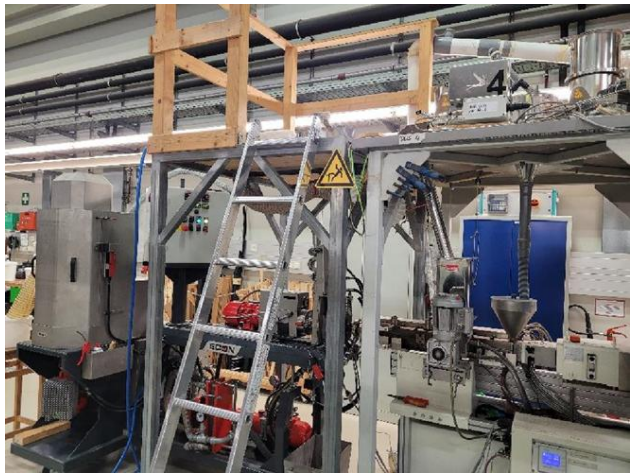
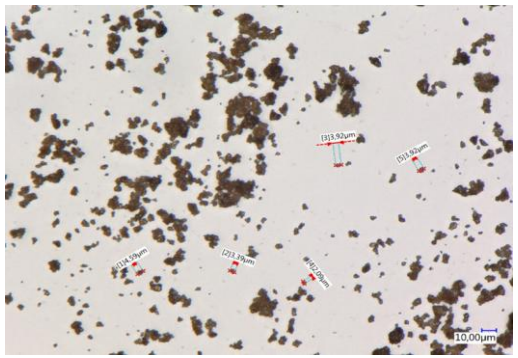
Dry Powder coating preparation



PBS, PHAs D-lignins, different chemistries and feedstocks, waxes

1. • Compounding Mixing different components, polymers additives
2. • Granulation (extrusion coating)
   • Grinding (dry powder coating)
3. • Granulate powder characterization
4. • Dry powder application - spray
5. • Thermoforming
6. • Coated paper characterization



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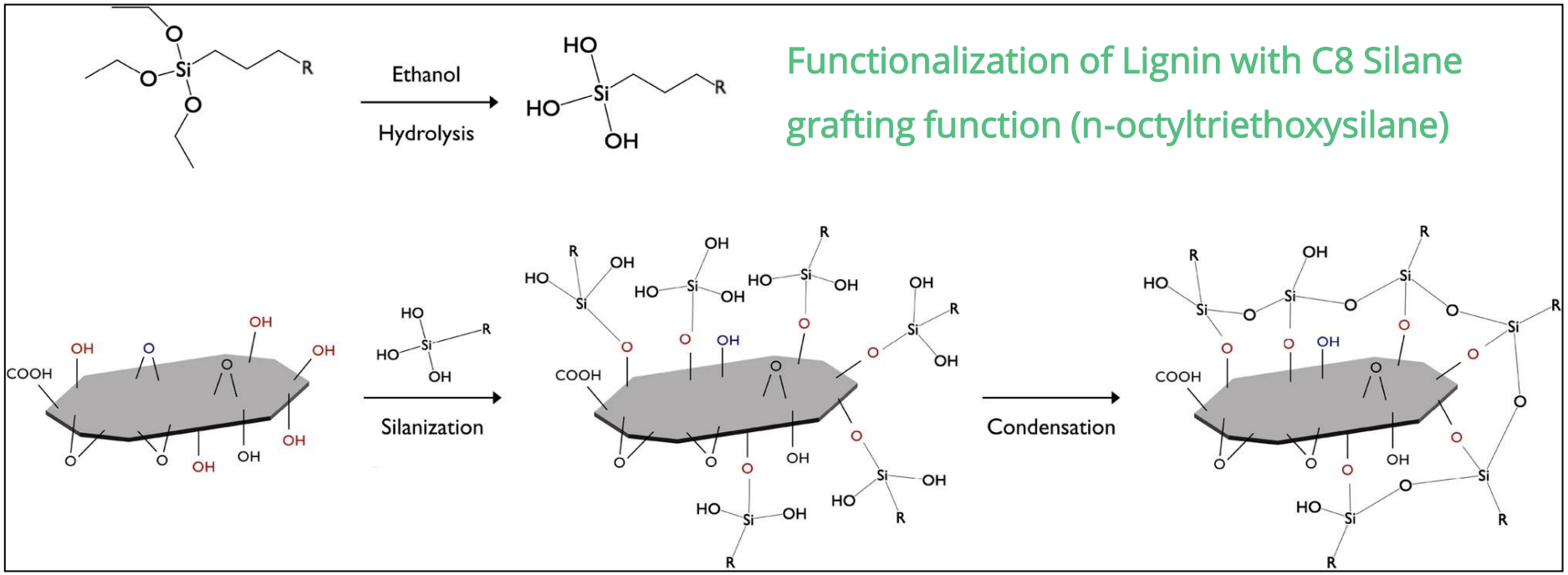
Potential of lignin as coating material (single component) and as an additive for coatings food trays application

- Kraft lignin UPM BioPiva have been selected and modified by alkoxysilane with a long alkyl chain has been chosen to chemically modify the lignin to provide water repellency.
- This modification also improves its compatibility with non-polar matrices.



Functionalization of Lignin with C8 Silane grafting function (n-octyltriethoxysilane)

Powder-coated paper substrate using uncondensed lignin

Powder-coated paper substrate using modified lignin

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Dry Powder coating applications on Airlaid cellulosic substrates for dry forming activities

Airlaid material and paper were coated with thermoplastic powder coating formulations and finally thermomoulded to sheets and tested

Figure: Airlaid coated substrate samples from left to right: PBS/Lignin (80/20); PBS (2nd picture from left); Carnauba wax; PHA

Figure: PBS/Lignin Type 3 90/10 paper substrates

PHA/Lignin Type 2 80/20 paper substrates

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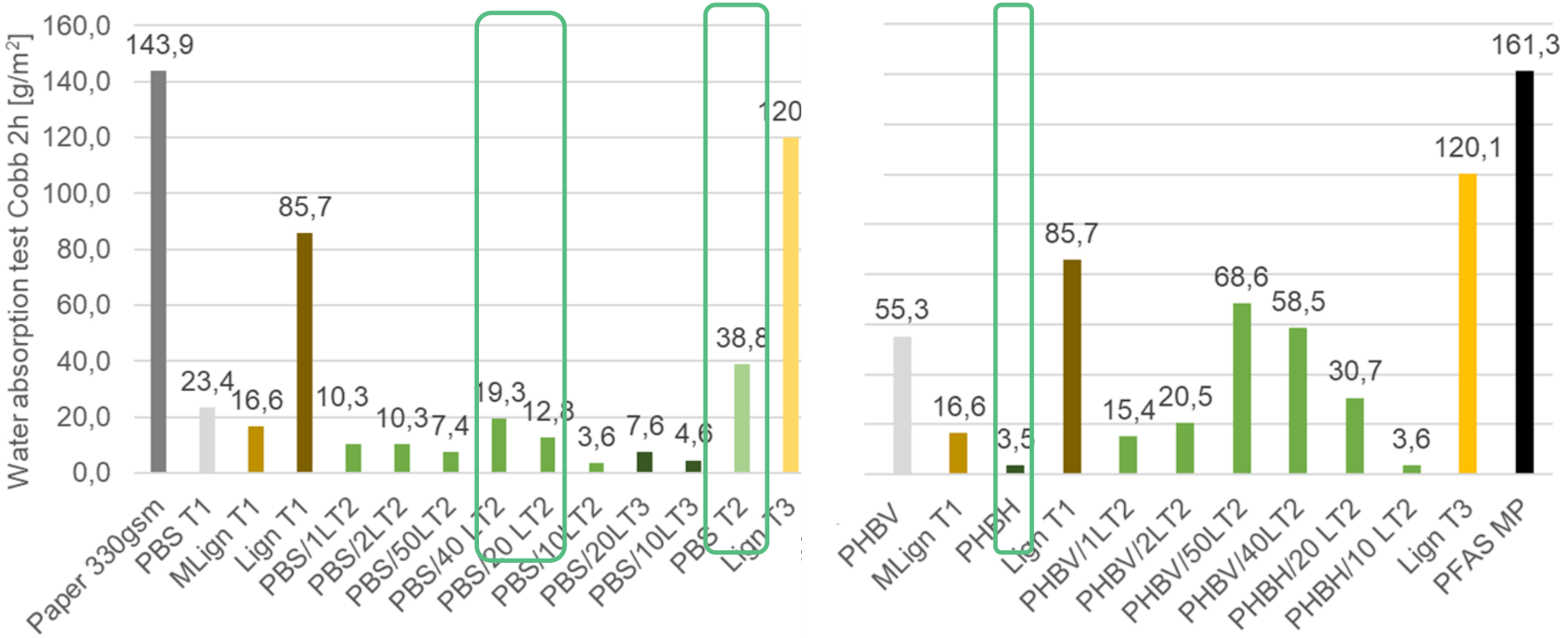
Dry Powder coating applications on paper substrates – coated papers characterization – Cobb test results



For thermoforming trials 2nd series PBS-Type 2, PHBH and PBS based formulations with Lignin Type 2 were selected. Next thermoforming trials will cover PHBH based formulations with Lignin Type 2.

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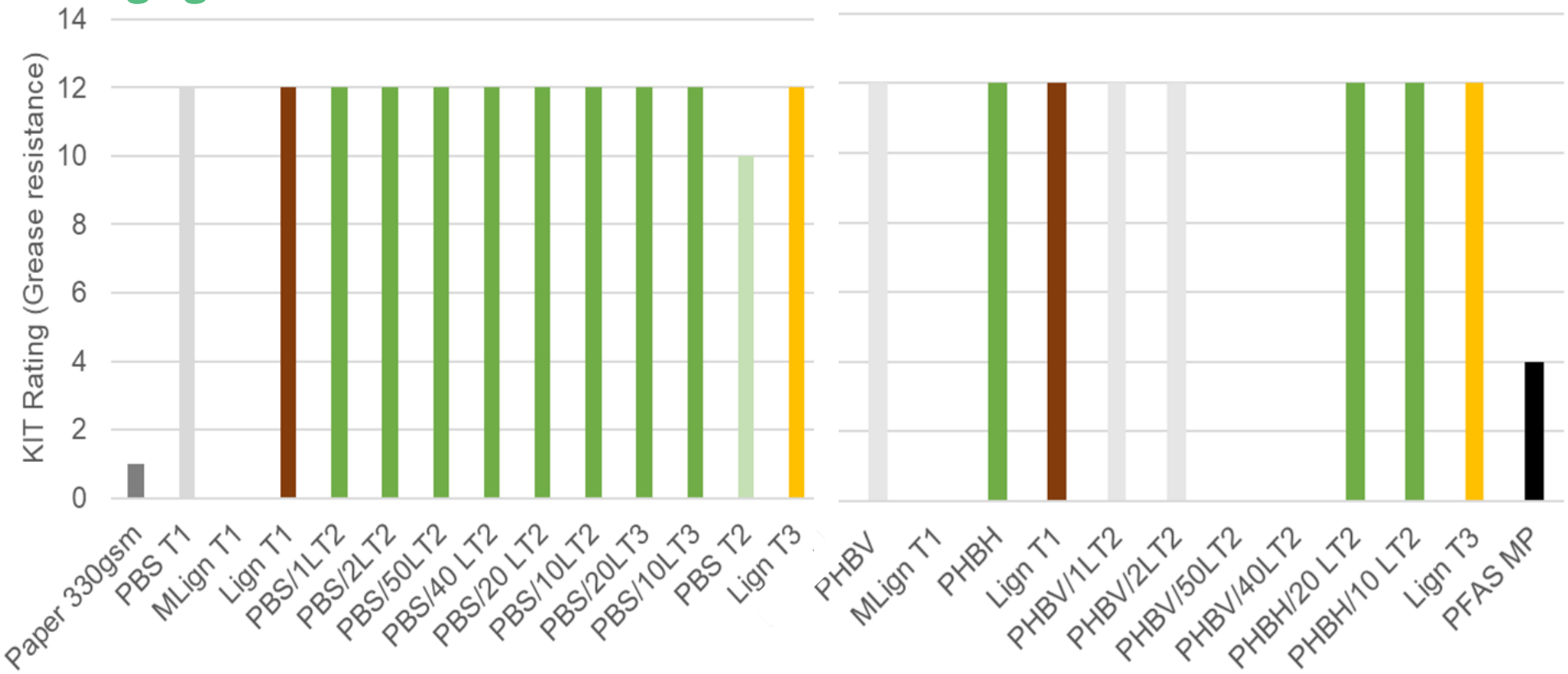
Dry Powder coating applications on paper substrates – coated papers characterization – KIT rating –grease resistance



- Excellent grease resistance for different powder coating formulations (PBS based left, and PHA right).
- Incorporation of lignin may be considered as an advantage to reduce bioplastic content (either PBS or PHA) keeping in mind values obtained for Cobb test.

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Thermoforming results – Ecozema – end user

- Good thermoforming processing of PBS/lignin and PHA/lignin formulations coated on paper

- Excellent grease resistance for different shown thermoformed paper-based food trays (KIT rating 12, PHBH, PBS/lignin, PHA/lignin)
- Cobb Test values in the range 3,5 g/m^2

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Coating selection based on achieved KPIs and SSbD evaluation

KPIs	BIO-SUSHY Status M36
Reaching hydrophobicity/oleophobicity with 100% of replacement of PFAS compounds and in adequation with the final uses	Hydrophobicity achieved for: PBS/Lignin Type 2 and PHBH/Lignin Type 2 (80/20 blending ratio) compounds with Cobb value 3 g/m^2 and KIT rating (grease resistance) of 12 achieved
% Bio-based : 25-80 % depending on the coating formulation	For PBS/lignin Type 2 - 80% of bio-based content achieved; For PHBH/Lignin Type 2 - 98 % bio-based content achieved.
Satisfying performance requirements of the food trays application	Successful thermoforming trials of PHBH alone, PBS (2nd type) and PBS with high (40wt%) and lower (20wt %) Lignin Type 2 content
Production cost: formulation composition (components, additives) application process (application method, curing) will be optimised to limit the production cost increase to be max 20% of the current production	Not yet evaluated

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BIO-SUSHY powder coatings - next steps

- **Industry Collaboration:**
- Scalability: Technologies compatible with existing industrial lines – extrusion coating – roll to roll dry powder and/or extrusion coating - planned in May 2026
- Thermoforming trials on coated paper samples for paper-based food packaging applications – further testing of 2 selected upscaled coatings in real world paper & fiber-based packaging
- Further optimization of coated surface area linked to particle size distribution and grinding step
- Testing of novel coating materials in respect to biodegradability – results till end of 2027 ☺
- food contact safety (migration test) and potential impact on paper recyclability

- **LCA insights:**
- Reduced environmental impact – ongoing update of LCA results and sensitivity analysis
- Social benefits: S-LCA insights
- Consumer acceptance and willingness to pay

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THANK YOU!

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