

FlexFunction2Sustain

Open Innovation Ecosystem for Sustainable Nano-Functionalized Plastic and Paper Surfaces and Membranes



This project has received funding from the European Union's Horizon 2020 research and innovation programme under [grant agreement n°862156](#)



A photograph of a beach heavily littered with plastic waste, including numerous discarded plastic bottles, fragments of plastic, and other debris. The waste is scattered across the sand, extending from the foreground towards the water's edge. The water is visible on the right side of the frame.

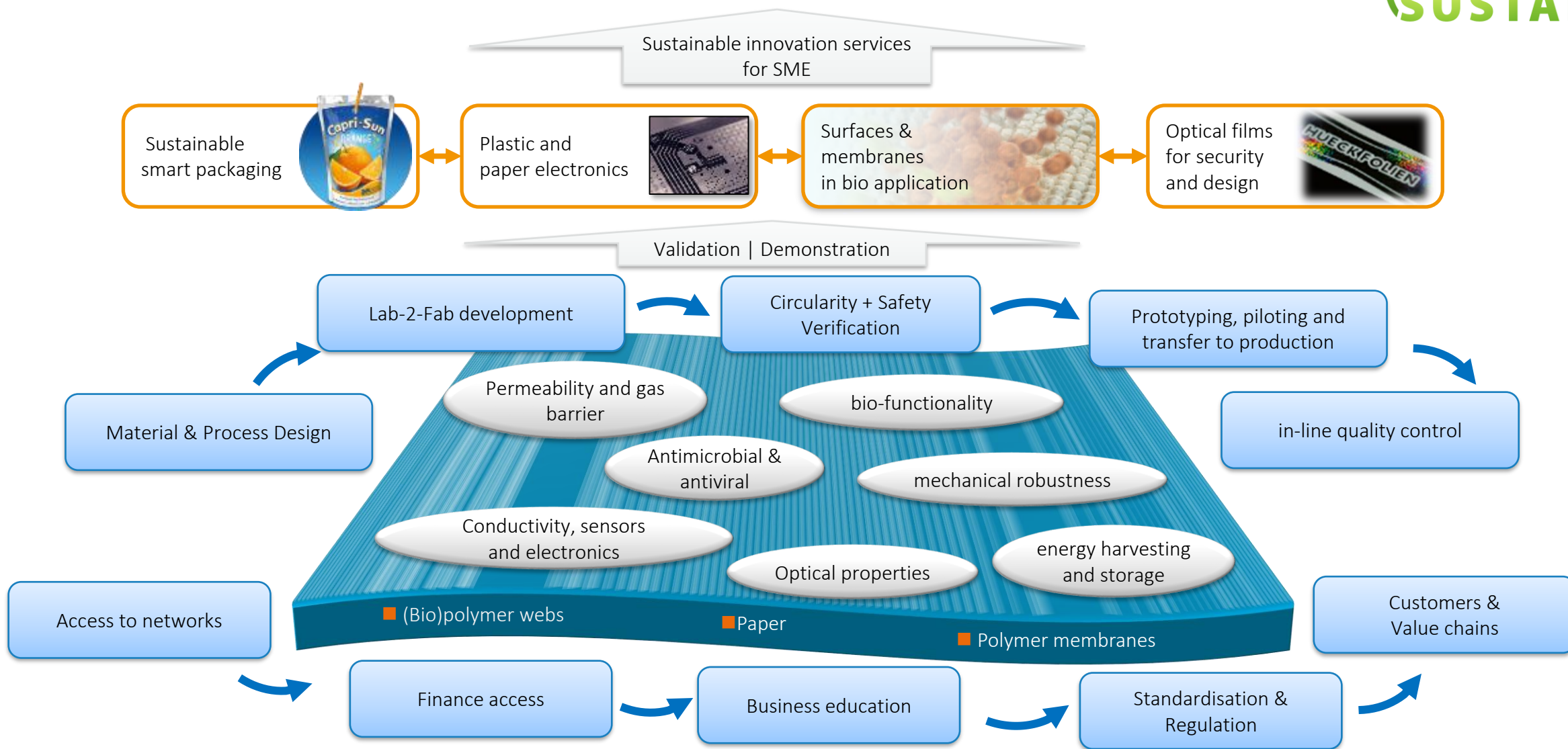
FlexFunction2Sustain boosts innovation for sustainable and smart plastic and paper products

➔ drastically reduce plastic waste

➔ get ready for the digital age

making use of
nano-functionalization of novel plastic and paper surfaces

FlexFunction2Sustain OITB Concept

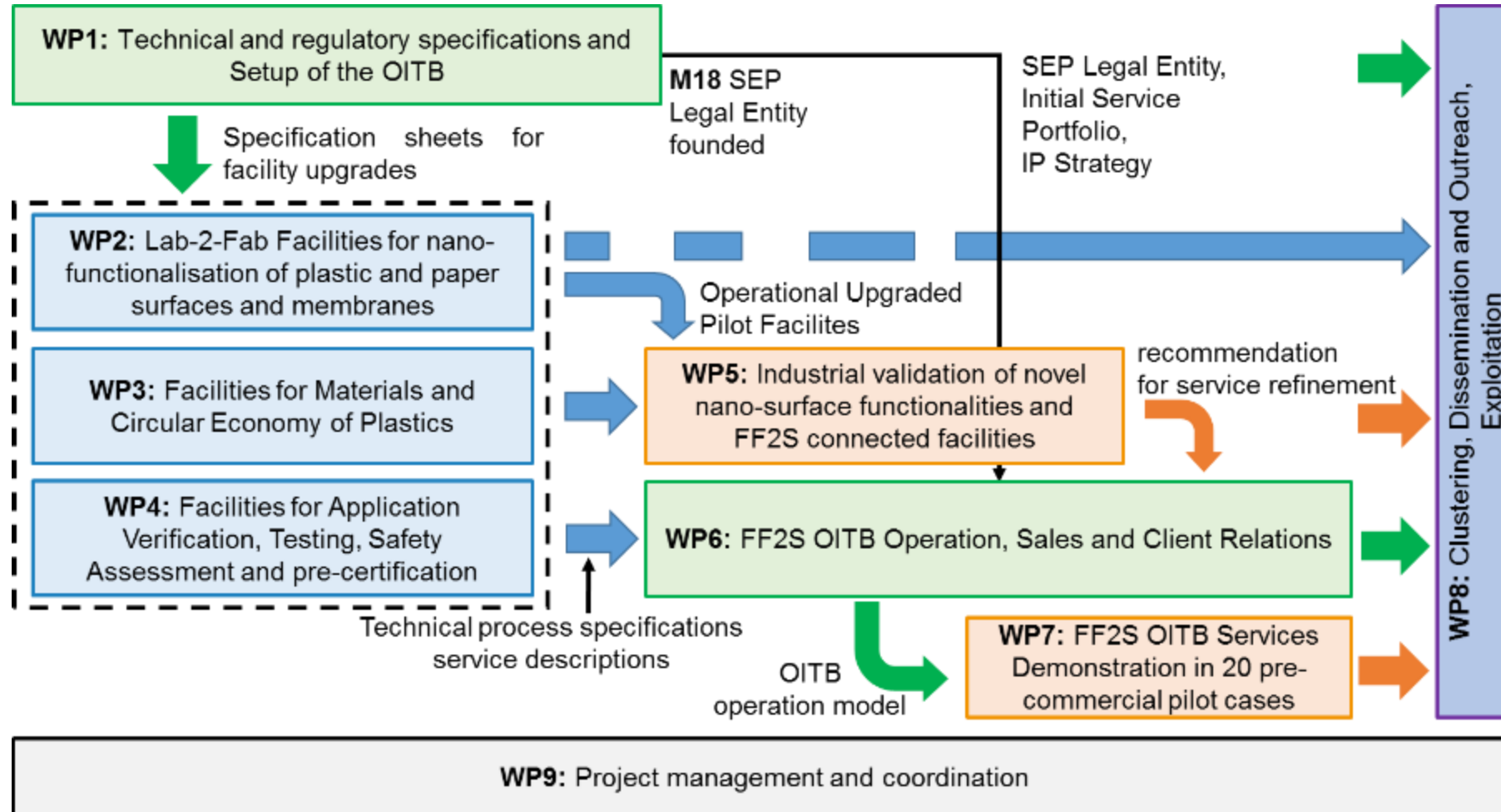


Achievements M18 – M24



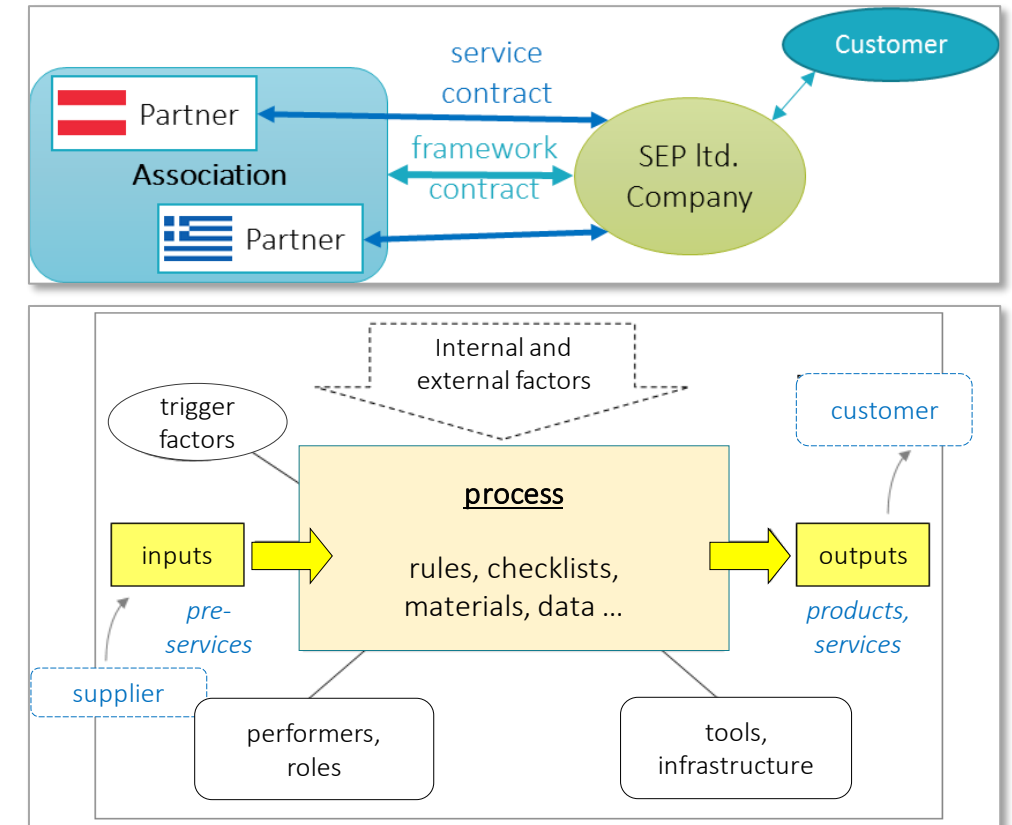
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Our work plan towards a sustainable Open Innovation Ecosystem ...



WP1: M19 – M24 achievements

- OITB Business & Sustainability Plan:
three level business model:
Members ⇔ association ⇔ [SEP]
- OITB Structure: Non-profit French 1901 association:
as collaborative network of experts
- SEP ⇔ OITB Interaction: framework / “franchise” contracts
with independent for-profit companies!
- OITB Standard Operation Procedures:
Completed Process Set for Implementation within WP6
- Association Statues Approved!
- Association Name:



European Sustainable Nanotechnology Solutions Association - ESNA

- **Foundation date: ≈ before 28th June 2022**
(formal steps at member facilities to be completed)

Lab-to-Fab nano-surface treatment



Roll-to-roll vacuum coating



Atmospheric pressure coating,
printing and surface treatment



R2R micro- and nanostructuring



Printed electronics pilot lines

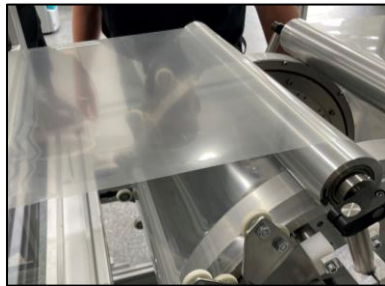
- from sheets to roll
from about $2 \times 2 \text{ cm}^2$
up to $> 1000 \times 0.6 \text{ m}^2$
- all major thin film technologies
evaporation, sputtering, slot-die coating, corona treatment, nanoimprint lithography, ...
- small-series production capacity available
 $10\,000 \text{ m}^2$ and more

WP2: M12 – M18 achievements

36 machine upgrades at 8 partner sites

Objectives: Enable processing of biopolymers; increase process reliability and productivity; complete process chain

- Status:**
- Feasibility checks and mechanical design of all upgrades completed
 - Prototypes developed, tested and improved
 - Many upgrades already installed or currently in installation
 - Some upgrades: Considerable delays due to shortage of electronic components [4 – 12 months]
 - **New WP2 leader: Harmen Rooms (hrooms@coatema.de)**



R2R ALD prototype evaluation at Coatema R&D Center. [FHG-IVV; COA]



Setup of UV-NIL module in the printed electronics pilot line. [AUTH; COA]



Coating of polymer film (left) and paper (right) at FhG-IVV.

WP3: M19 – M24 achievements

Upgrade of the REMIX Pilot line

- Setting up of a Near Infrared optical sorting machine
- Report delivered to PRE for the Recyclclass accreditation of the REMIX line for PP flexible film recyclability evaluation



Upgrade of the BIODEGRADIX Pilot line

- Implementation of OK Home compost and OK Marine environment tests for the corresponding TÜV Austria label
- Pre-audit by TÜV Austria (December 2021)



Biodegradation respirometers

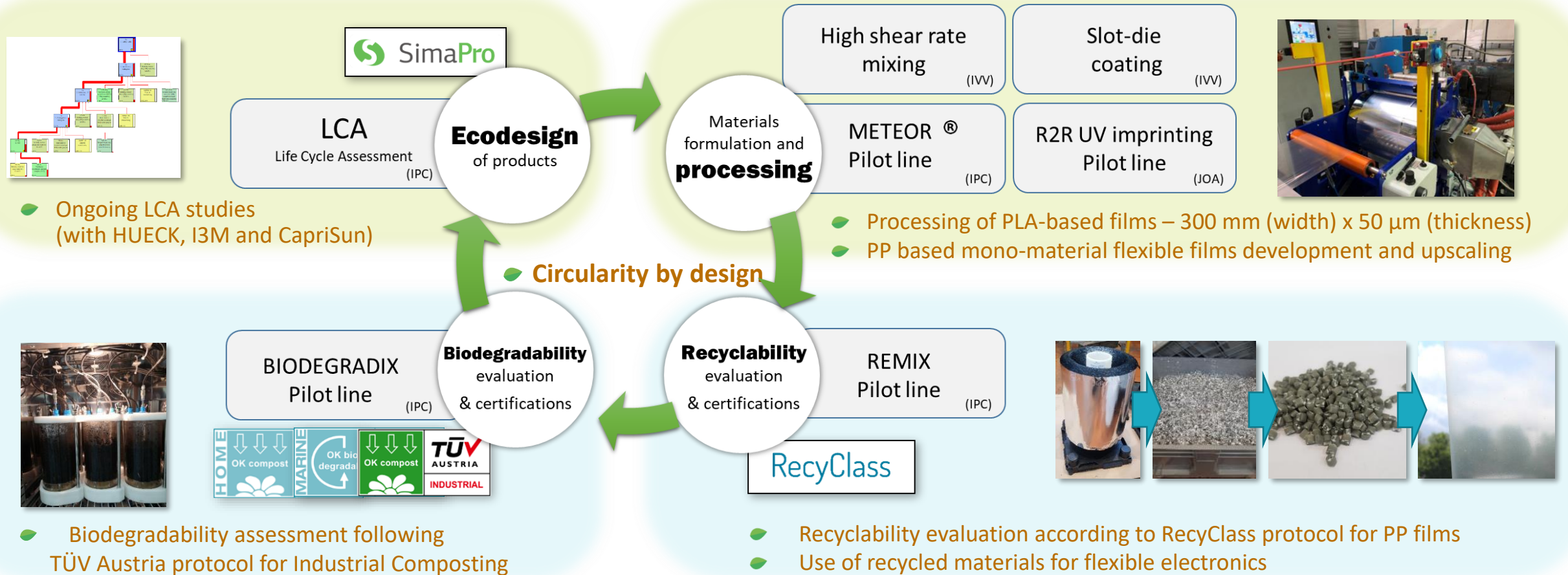


Ecotoxicity tests



WP3: Circular Economy of Plastics

Upgraded facilities and upgrading in progress



WP4: M19 – M24 achievements

Long-term activity of antimicrobial surfaces

Surface roughness assessment and defect density
(SEM, AFM, WLI, 3D Confocal Laser Scanning)

Surface chemical analysis
(XPS, EDX)

Antimicrobial activity
(antibacterial, antiviral)

Accelerated ageing
(controlled irradiance, climate chambers)

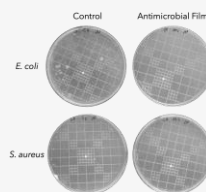
Surface roughness assessment and defect density
(SEM, AFM, WLI, 3D Confocal Laser Scanning)

Surface chemical analysis
(XPS, EDX)

Antimicrobial activity
(antibacterial, antiviral)

Light cycle
Irradiation: 0.55 W/m²
T: 89 ± 3 °C
RH: 50 ± 5 %

SAE J2412
Darkness cycle
Irradiation: 0 W/m²
T: 38 ± 0.3 °C
RH: 95 ± 5 %



Paper-packaging performance in applications

Gas and water barrier
(WVTR, OTR, Cobb)

Surface and crosssection characterisation
(SEM)

Optical properties
(Optical spectroscopy)

Mechanical properties
(Tensile index, break point, puncture resistance)

Food Shelf-life
(Microbial growth, chemical analysis, colour)

Mechanical properties
(Tensile index, break point, puncture resistance; post storage)



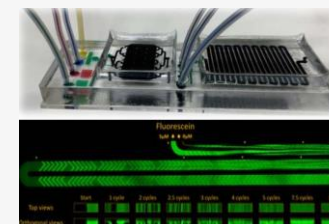
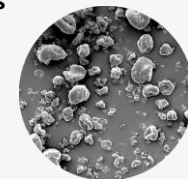
Safety and compliance assessment of bio-based packaging materials

Physicochemical characterisation
(SEM; TEM; DLS; FTIR; Solubility; Dispersibility of particles)

Migration Studies and general compliance with EU legislation
Regulation (EU) No 10/2011
Regulation (EC) No 282/2008
CoE Paper and Board FCMs Guidelines (2021)
EFSA Guidance for NPs presence in food
EFSA Guidance for NPs risk assessment in food

Bioaccessibility
(INFOGEST invitro digestion protocol + gut-on-a-chip for screening of NMs)

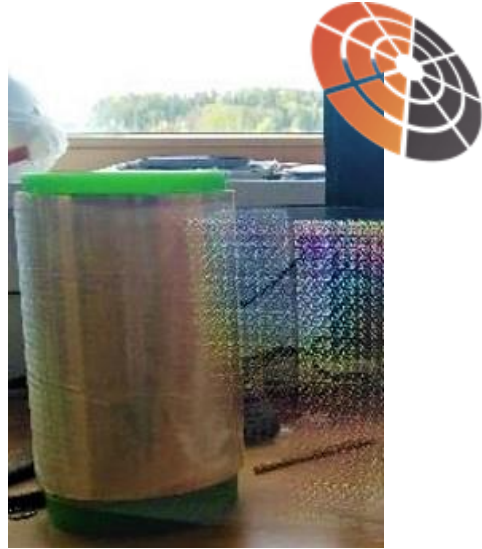
Toxicological profile
Cytotoxicity and genotoxicity NPs using in vitro cell models (Caco-2 and HT29-MTX cell lines derived from human intestinal epithelium) as well as cell viability, membrane integrity and reactive oxygen species (ROS) generation.



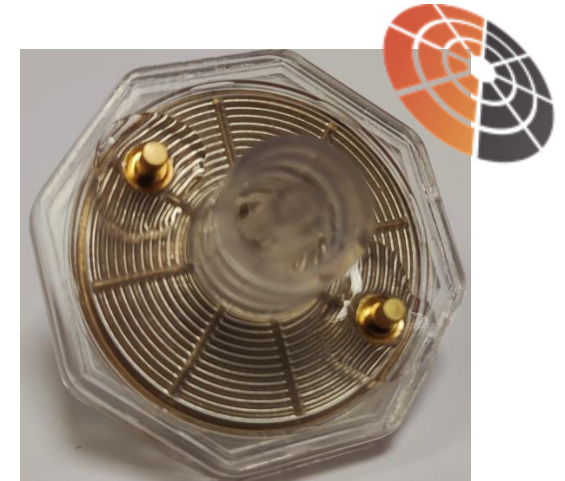
- Workflows for in-application performance of novel FlexFunction2Sustain materials
- Workflows for safety and compliance assessment

WP5: M19 – M24 achievements

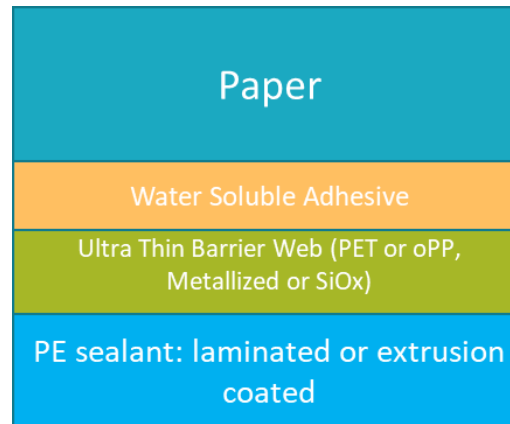
Task 5.1: cellulose based film (TÜV Austria: OK Compost Home) with optically active structures obtained through a R2R-UV-NIL process using a bio-based resin (*selected as excellent innovation by the EC*)



Task 5.3: Switchable syringe filter with gold coated PA membrane (*selected as excellent innovation by the EC*) used for biomolecules separation tests

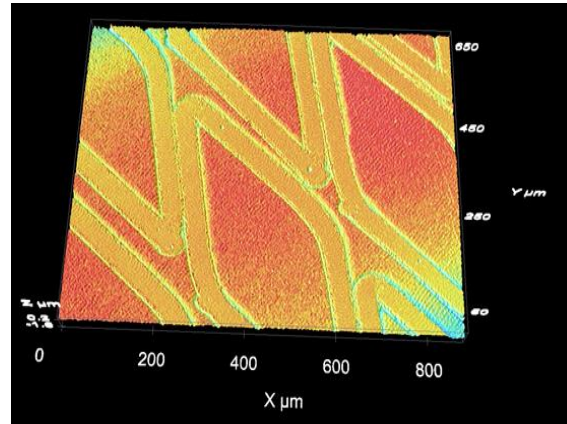


Task 5.2: multilayer structure for marine degradable shampoo sachet targeting a very thin barrier film

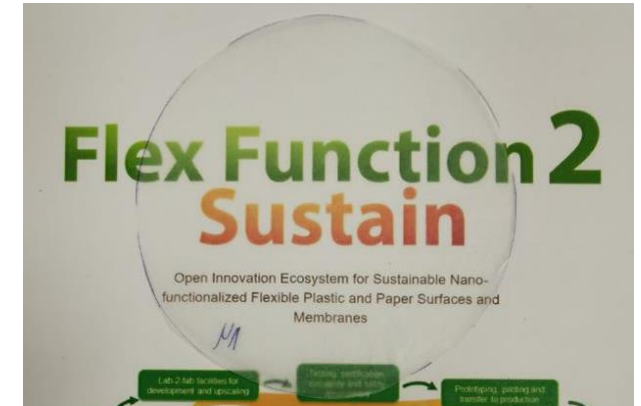


WP5: M19 – M24 achievements

Task 5.4: Confocal micro-scope image of the laser scribed sample for electrodes for touch screen



Task 5.5: Semi-transparent coated paper for food packaging produced by ultrasonic spray coating (circular shaped sample on top of FF2S flyer)



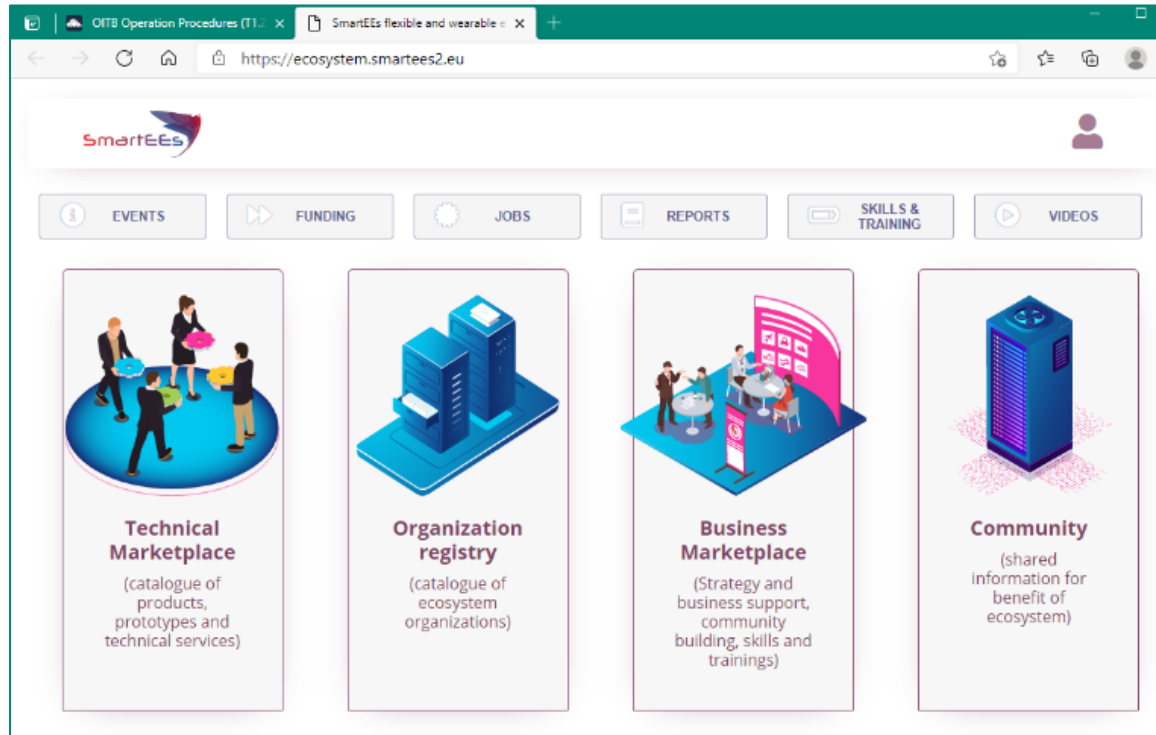
Task 5.6: Results from the mechanical characterization of the recycled PP laminates (metalized, SiO_x, nanolacquer) for monomaterial drink pouches



Cast film extrusion of recycled PP granulates (50 r-PP : 50 virgin PP)

E-modulus	550 MPa
Tensile Strength	23 MPa
Elongation	12%
Transparency	> 90%

WP6: OITB Operation and Implementation

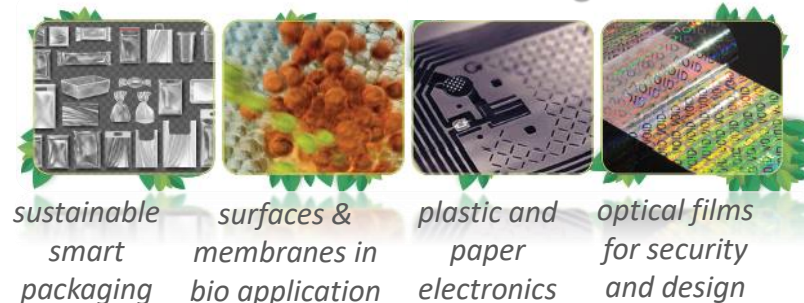


Ecosystem management platform (example from SmartEEs project - www.smartees.eu)

- **Ecosystem Management Platform**
 - ➔ database about network, services, community
 - ➔ in development!
- **Quality Assurance in Service Delivery**
 - ➔ increase efficiency and reduce liability risk
 - ➔ QM processes ready for implementation
- **OITB ↔ Customer Relation Management**
 - ➔ Selection of CRM [SuiteCRM; EspoCRM; ERPNext, Dolibarr...]
 - ➔ 75 customer/partner contacts established
- **IPR and Innovations landscaping**
 - ➔ IP policy established (Del. D1.7)
 - ➔ IP Working Group established
- **OITB Service Portfolio**
 - ➔ Collect technical services for merging to OITB Catalogue
 - ➔ Association Working Group “Business Development”
- **Investor Relations**
 - ➔ Investment Models discussed
 - ➔ investor targeted actions in preparation

WP7: Open Call

Target markets



- **Launched:** Sep 2021
- **Up and running:** all systems and processes for the Call opening, evaluation and selection of Pilot Cases
Helpdesk is now operational and answering requests for information
- **First cut-off results:** 4 Pilot Cases (out of 5 submitted) selected and the JIA negotiation process is ongoing

Why:

Access to all major nano-functionalisation techniques for plastic and paper surfaces

Customized support through a unique and complete set of services

Who:

SMEs & start-ups

EU Member States & associated countries

When:

1st cut-off:

28th January 2022

2nd cut-off:

29th July 2022

3rd cut-off:

27th January 2023

How much:

2.25 M €

overall budget

up to €130K

financial support per
Pilot Case

70%

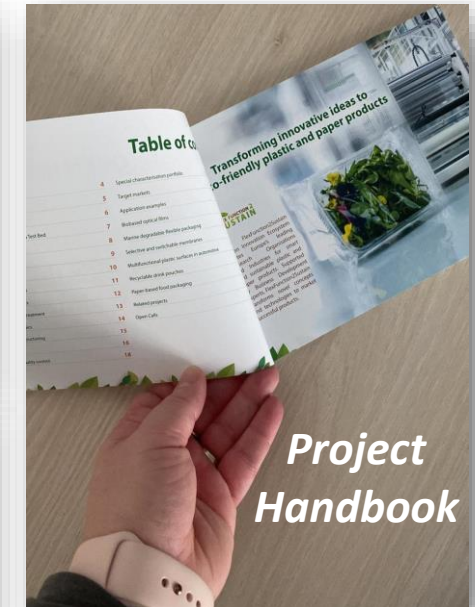
covered by FF2S

WP7: Open Calls selected projects

Proposal number	Acronym	Proposal full name	Company name	Country
20220125-0011	IDOLES	Improvement of durability by optimizing Low Energy Surface	Infrascreen	Switzerland
20220126-0017	FunFlex	Surface functionalization of Circular flexible food packaging	LEYGATECH	France
20220131-0018	SustainPack	Sustainable Packaging	HPX Polymers	Germany
20220128-0016	DCC	Dispersion Coating Compostable	Cartiera Rivignano	Italy

WP8: M19 – M24 achievements

- Visual Identity and Dissemination of the Project and OITB Idea
 - FF2S in Press and Media announcing the project outcomes
 - Webpage updated & Dissemination materials printed
- Clustering with other OITB & NanoSafetyCluster
 - Regular bilateral exchange: NGM, SNMT, NewSkin, MDOT..
 - 2nd OITB Stakeholder event at INDTech 2022 Conference (Grenoble, France, 27-30 Jun 2022) – in planning with SNMT
- Interaction with thematic associations and intermediaries
 - OE-A Working Group Encapsulation
 - EUPC, LINPRA, NanoSafetyCluster → EAB Members
- Standardisation and Regulation Activities
 - 3 standardisation projects with direct FF2S participation
 - Contributions to standard projects on biodegradable plastics
- FlexFunction2Sustain Open Calls
 - Call promotion to get in touch with innovative companies
 - Webinars organised by FF2S partners for the local markets



Open Call webinar



IndTech OITB Village

June 28-30, Grenoble

Exhibition arena

Networking sessions

Workshop: OITB Best Practices



Book your corner @ IndTech OITB Village:
events@flexfunction2sustain.eu | events@safenmt.eu

FlexFunction2Sustain Consortium



SONNENBERG HARRISON



Thank You for listening!



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