

Flexfunction2Sustain – an unique R&D service for nano- functionalized plastic and paper surfaces and membranes

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11 October 2022, Athens



A photograph of a beach heavily littered with plastic waste, including numerous water bottles, plastic bags, and other debris. The trash is piled up along the shoreline, extending into the water. The scene is brightly lit, suggesting a sunny day.

FlexFunction2Sustain boosts innovation for sustainable and smart plastic and paper products

➔ to reduce plastic waste

➔ get ready for the digital age

using

nano-functionalization of novel plastic and paper surfaces

OPEN INNOVATION ECOSYSTEM
FOR SUSTAINABLE
NANO-FUNCTIONALIZED
PLASTIC & PAPER
SURFACES & MEMBRANES



FLEX FUNCTION 2 SUSTAIN

- FlexFunction2Sustain project aims at creating an **Open Innovation Test Bed (OITB)** for nano-functionalisation technologies that enable sustainable and smart plastics and paper based products. The ecosystem will support innovative SMEs and industries by drastically reducing the time-to-market for novel concepts, ideas and products.
- Open Call for Pilot Cases – **next and last cut-off: 27 January 2023**
 - Objective: Test Services and Procedures and **Create Success Stories**
 - What you get: Discounted services **up to 100% subsidized support**
 - Available budget: **2.25 M€ for approx. 20 projects**

Target markets



sustainable surfaces & smart packaging
plastic & membranes in paper bio application
optical films for security & design
plastic films for architecture applications
smart plastics in automotive application



Partnership



Fraunhofer FEP, Fraunhofer IAP, Fraunhofer IVV, JOANNEUM RESEARCH MATERIALS, BL NanoBiomed, INL, HOPE-A, Capri-Sun, amcor, Coatema, GEMIFO, Gesellschaft für Mittelstandsförderung mbH, CRF, P&G, SONNENBERG HARRISON, i3, Your Companion Life Science Filtration, AMIRES, HUECK FOLIEN, Itfn Nanotechnology Lab, IPC, SOHAE MC.

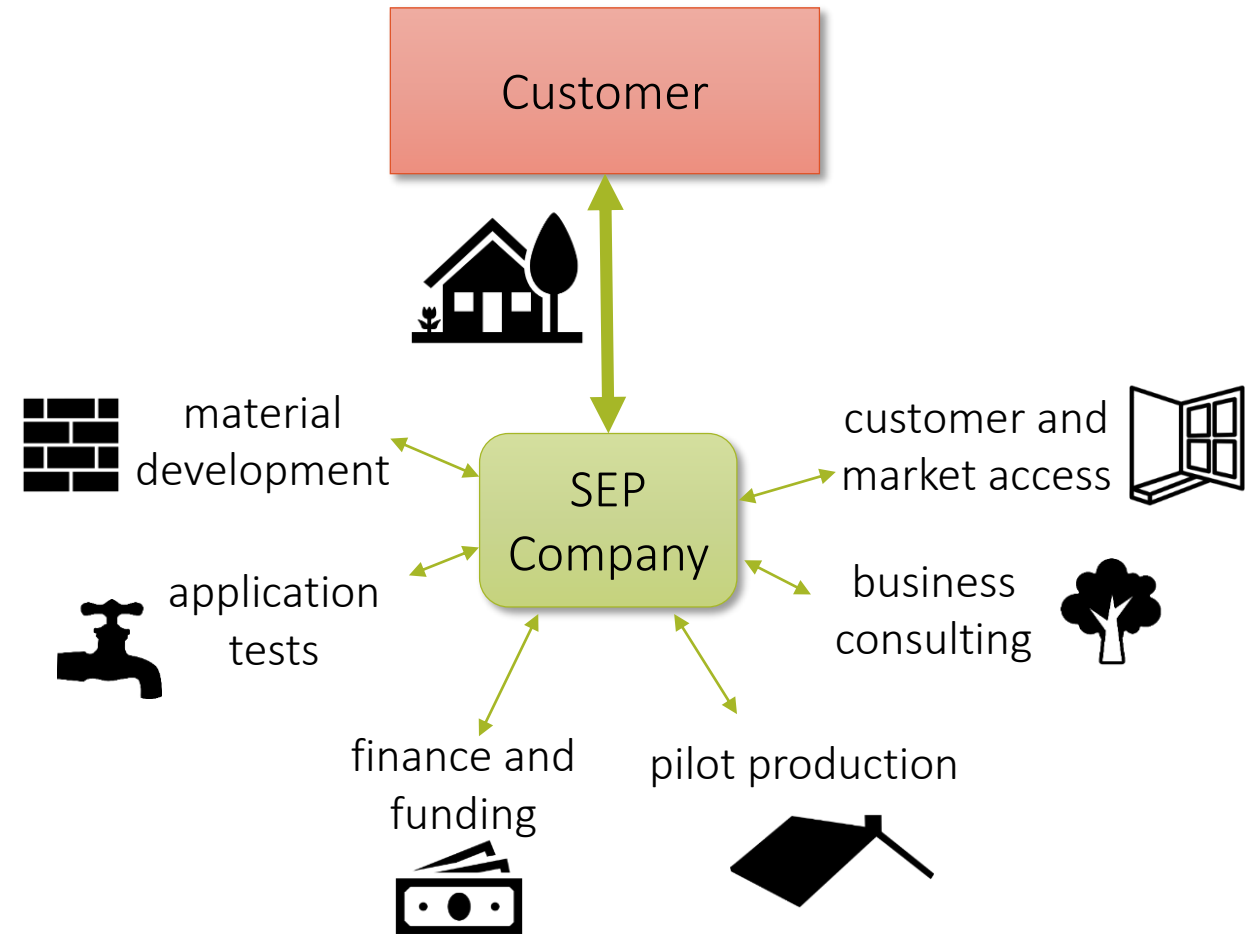
www.flexfunction2sustain.eu

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



How we work ...

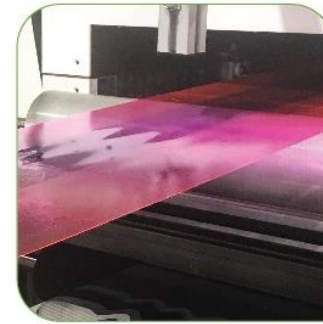
- Open Innovation Test Bed (OITB) is an ecosystem with a set of entities providing common access to physical facilities, capabilities and services
- Main objective of the OITB is to provide users (innovative Start-Ups, SMEs and industries) an easy access to holistic innovation boosting services through a Single Entry Point (SEP)
 - Full Innovation Service from whole EU (technology + business + finance)
from a single source, in your language!
 - SEP selects Technology & Services
based on customer needs
 - SEP designs, plans and coordinates complex innovation projects
as general contractor



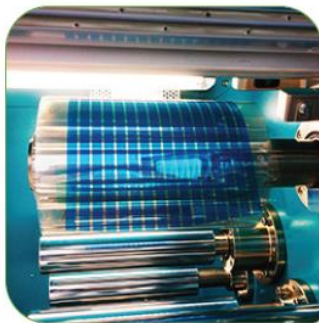
FlexFunction2Sustain Approach



**CIRCULARITY BY
DESIGN**



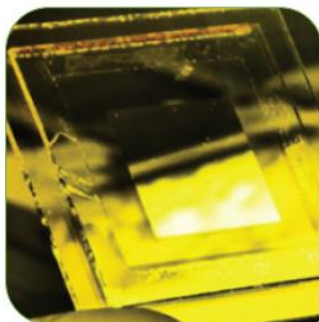
**ROLL-TO-ROLL
ATMOSPHERIC
PRESSURE COATING &
SURFACE TREATMENT**



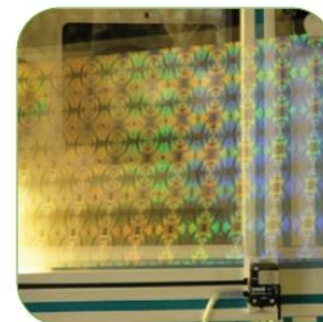
**PRINTED AND FLEXIBLE
ELECTRONICS**



**VACUUM ROLL TO ROLL
COATING AND SURFACE
TREATMENT**

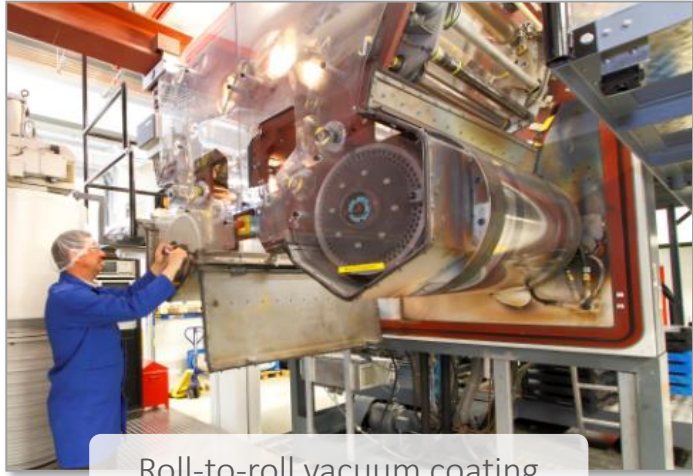


**FUNCTIONAL
CHARACTERISATION
AND APPLICATION
VERIFICATION**



**ROLL-TO-ROLL
NANOIMPRINT
LITHOGRAPHY**

Lab-to-Fab nano-surface treatment



Roll-to-roll vacuum coating



Atmospheric pressure coating,
printing and surface treatment

- 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

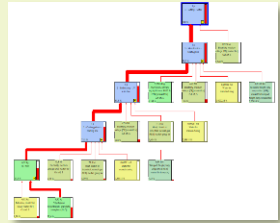


R2R micro- and nanostructuring

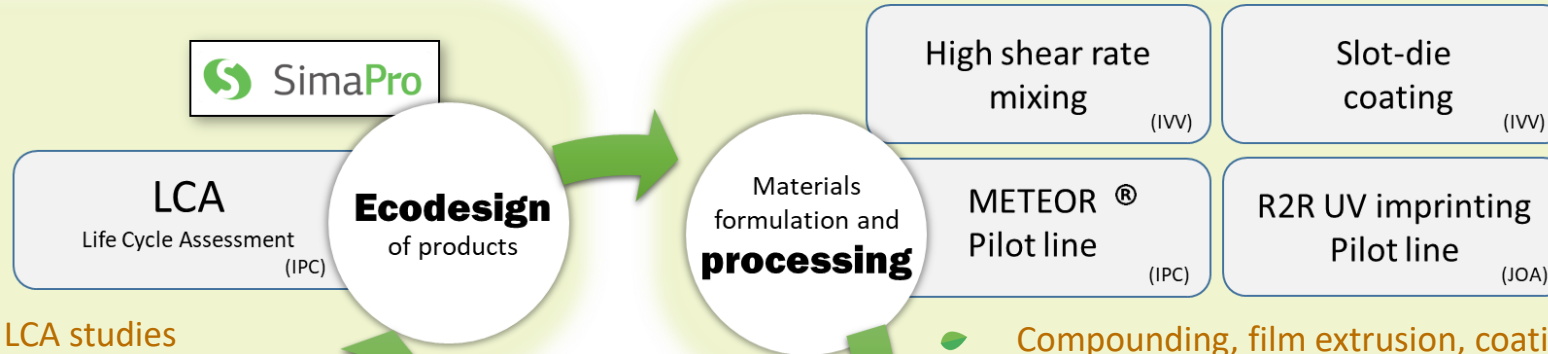


Printed electronics pilot lines

Circular Economy of Plastics



- Fully qualified LCA studies

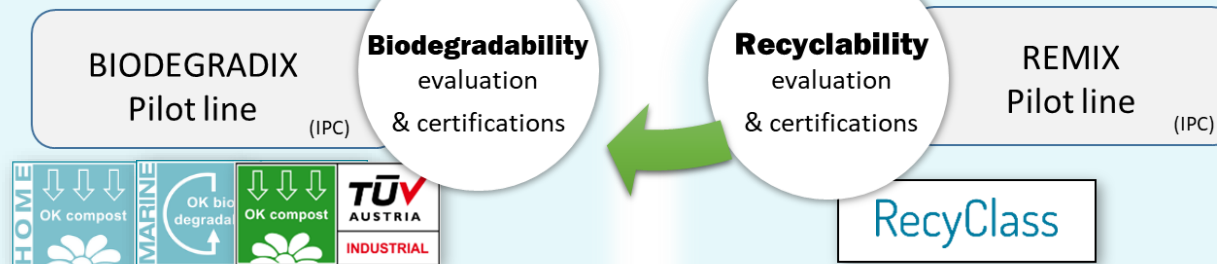


- Compounding, film extrusion, coating and nanopatterning

Circularity by design



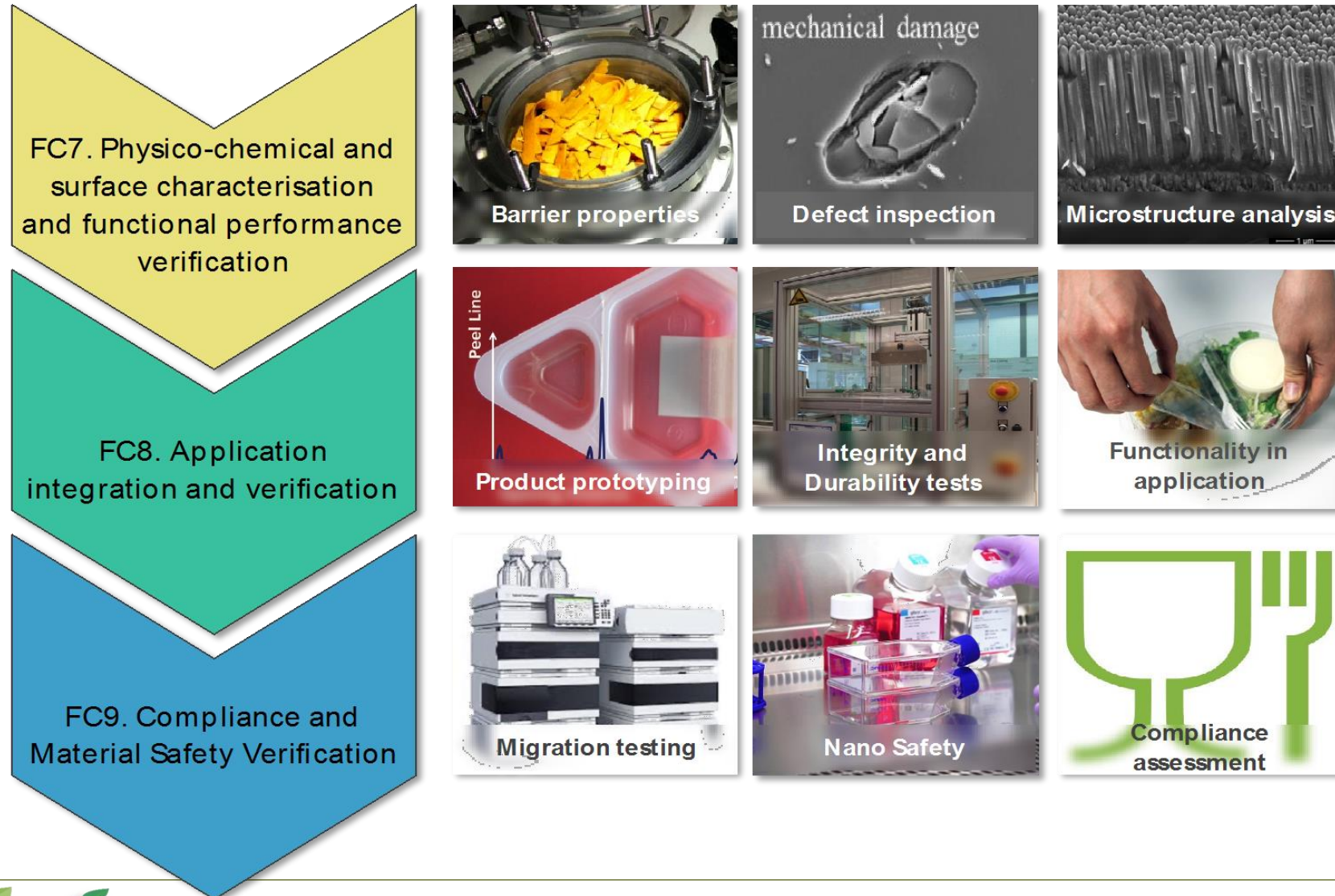
- Biodegradability assessment following TÜV Austria protocol for Industrial Composting



- Recyclability evaluation according to RecyClass protocol for PP films



Characterisation & Verification Facilities



Characterisation & Verification - Examples

Catalogue available at: <https://flexfunction2sustain.eu/wp-content/uploads/2021/07/Catalogue-physicochemical-and-functional-characterization-v1-F.pdf>

Catalogue of physicochemical and functional characterization services

novel specialized characterisation @ FlexFunction2Sustain

The catalogue at a glance

- Use Cases of the FlexFunction2Sustain project (p. 3)
- Catalogue of Services (p. 4)
 - Services from upgraded facilities: methodologies beyond the state of the art (pp. 4-5)
 - Full catalogue of physicochemical and functional characterisation services (pp. 6-20)
 - Barrier testing (pp. 6-7)
 - Testing of electrochemical properties (pp. 8-10)
 - Assessment of mechanical properties, integrity, and durability (pp. 10-12)
 - Optical properties characterisation (pp. 13-14)
 - Surface and microstructure analysis (pp. 15-21)
 - Thermal and rheological properties (pp. 22-23)
 - Test specimen preparation (p. 24)

Services from Upgraded Facilities: methodologies beyond the state of the art

Mechanical testing with inline WVTR characterization

- Coupling of optical calcium test for WVTR with mechanical bending test in device geometry
- Sensitivity down to $10^{-4} \text{ g}/\text{m}^2/\text{d}$

Combined gas barrier and mechanical testing

Large area 3D Confocal Laser Scanning Microscopy

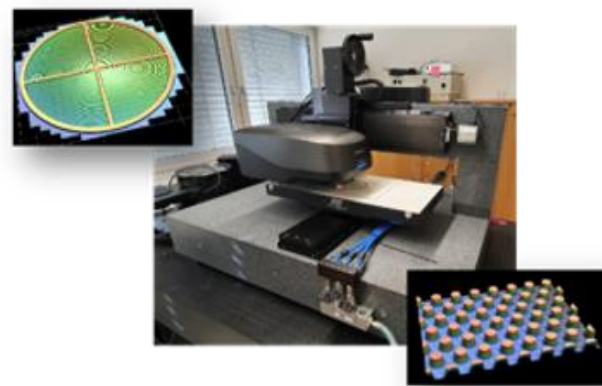
- Surface profiling, defect density characterisation
- Sample processing up to $300 \times 600 \text{ mm}^2$

Gas barrier testing

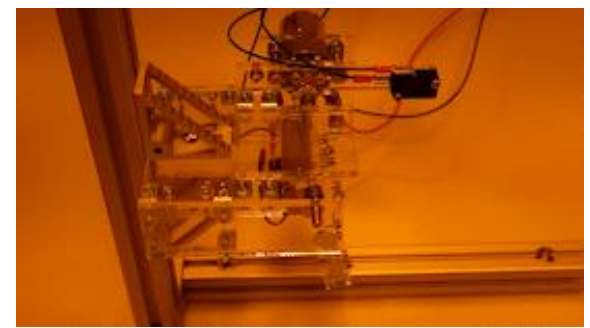
| Functionalities | Equipment | Technical specifications | Application examples |
|-------------------------|--------------------------------------|---|---|
| Optical Calcium testing | Heater/Vapor Transmission Test, WVTR | Temperature range: 25 °C - 120 °C (10 °C to 120 °C in 5 °C steps) | Determine the water vapour transmission rate of flexible, fully recyclable, non-metallic barrier materials for plastic packaging (LDPE, PET, PEN, etc.) |
| Barrier testing | Mocon Ox-Tran 2/20 | Temperature range: 25 °C - 120 °C (10 °C to 120 °C in 5 °C steps) | Determine the water vapour transmission rate of paper-based packaging materials (cellulose, PLA, etc.) |

Specimen preparation

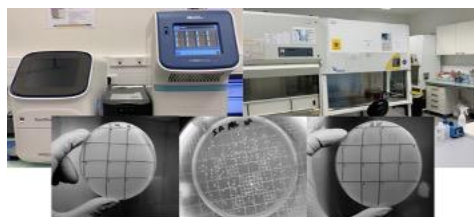
| Functionalities | Equipment | Technical specifications | Application examples |
|----------------------------|--------------|--|---|
| Cross section polishing | Jeol SM-0101 | Up to 1 mm preparation width | Based on beam preparation of polished cross-section of multilayers |
| Microtome cross-sectioning | MT8000 | Recommended sample size: $\sim 1.2 \text{ cm}^2$ | Determination of adhesion strength (cross-sectioning) using SEM, EDS, XRF |



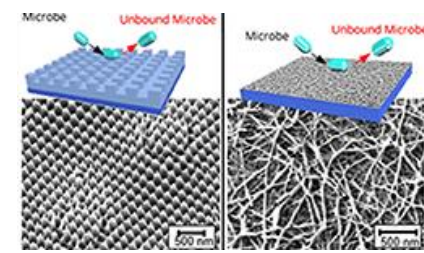
Large area ($300 \times 600 \text{ mm}^2$) surface profiling by 3D Confocal Laser Scanning Microscopy @ JOA



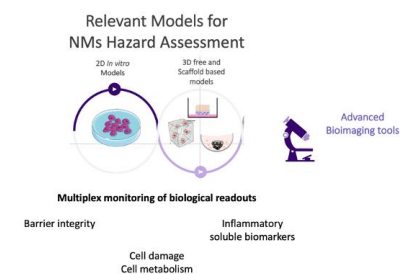
Combined optical calcium test for WVTR + mechanical bending test in device geometry @ FHG-IAP



Anti-COVID activity testing @ INL



Upgrading Microbiology Labs @ AUTH and @ INL for antimicrobial/antifouling surfaces



Workflows for safety and compliance assessment – ongoing

An Example OITB project ?

- Request: Is a novel biopolymer formulation suited for food packaging?



- Definition of product specifications (SEP, INL, FHG-IVV, customer)

- Film Extrusion (FHG-IVV or IPC)

- Gas Barrier Coating Tests (FHG-FEP | AMCOR)

- Lamination (AMCOR)

- Food contact verification (INL)

- Biodegradability/Compost Test (IPC)

- Piloting | Yield and quality verification | cost assessment (AMCOR & Co.)



sustainable smart packaging
surfaces & membranes in bio application
plastic & paper electronics
optical films for security & design
plastic films for architecture applications
smart plastics in automotive application

Open Call for Pilot Case Projects

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 and large industries

When:

1st cut-off:

28 January 2022

2nd cut-off:

12 August 2022

3rd cut-off:

27 January 2023

Selected cases:

3 cases selected

5 cases selected – to be announced soon

Your Case!

Q&A:



helpdesk@flexfunction2sustain.eu

<https://flexfunction2sustain.eu/>



OITB is living!

Current Industrial Use Cases

- 6 Cases pre-defined in the project

- Biobased Optical Films for labelling of consumer goods and surface design (Hueck Folien, Austria)
- Marine degradable shampoo sachets (Procter & Gamble, Germany)
- Selective and switchable water filter membranes (i3 membrane, Germany)
- Multifunctional scratch resistant surfaces in automotive (Centro Ricerche Fiat, Italy)
- Sustainable paper-based food packaging (Sonae MC, Portugal)
- Recyclable mono-polymer drink pouches (Capri Sun, Germany)

- Open Call Pilot Case Projects with external companies

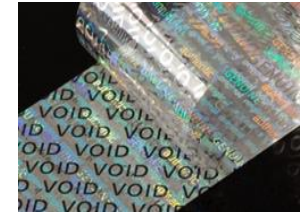
- 1st cut-off selected proposals:

- Improvement of durability by optimizing Low Energy Surface (Infrascreen, Switzerland)
- Surface functionalization of Circular flexible food packaging (LEYGATECH, France)
- Sustainable Packaging (HPX Polymers, Germany)

- 2nd cut-off: 5 Cases selected – to be announced soon

- 3rd cut-off: deadline 27 January 2023

- **Your Case!**



Case Study: Flexible Electronics on Recycled Films



IPC

Fraunhofer IVV

Fraunhofer FEP

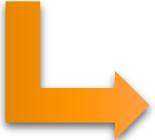
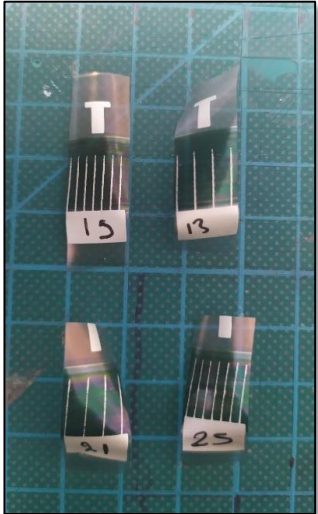
Roll-to-roll transparent electrode deposition



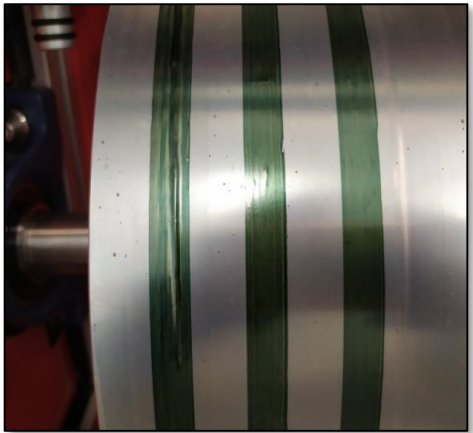
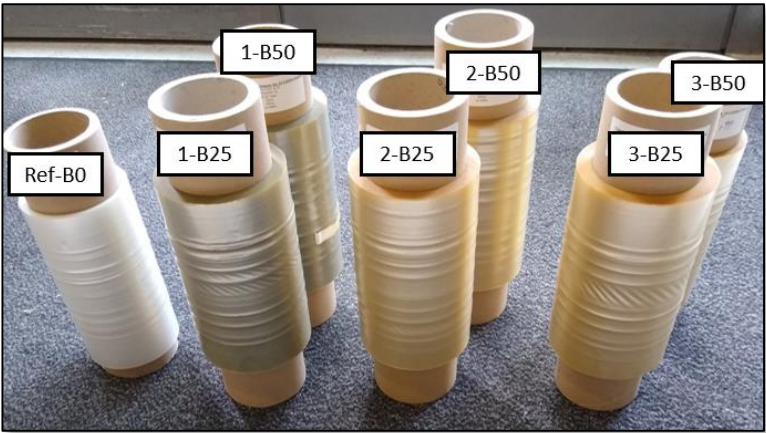
Roll-to-roll OPV stack deposition



oet



Film extrusion from recycled PP/PET granulates



✓ functional organic solar cells on recycled PET

1st try: PCE ≈ 0.9 %

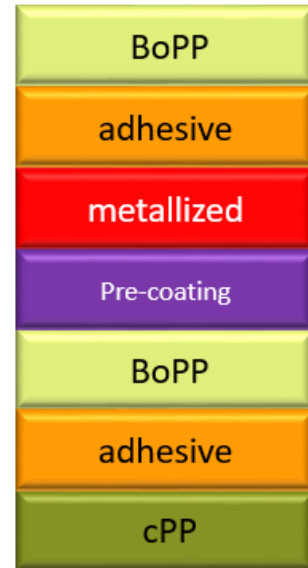
<https://flexfunction2sustain.eu/sustainable-and-smart-becomes-real-worlds-first-organic-photovoltaic-cell-on-recycled-material-made-by-eu-consortium-flexfunction2sustain/>

Case Study: Recyclable Packaging Films

state-of-the-art
multi-material
multilayer-laminate



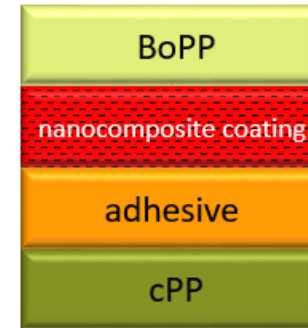
metallized BoPP
mono-material
multilayer-laminate



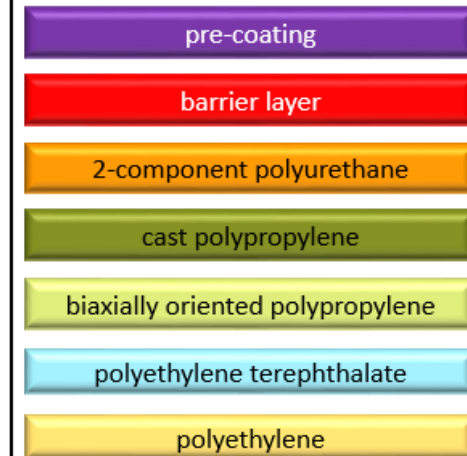
SiO_x deposited BoPP
mono-material
multilayer-laminate



coated BoPP
mono-material
multilayer-laminate



legend



| | OTR 23°C/50% rh | WVTR 38°C/90% rh |
|-------------------------|--|-----------------------|
| unit | cm ³ /(m ² ·d·bar) | g/(m ² ·d) |
| State-of-the-art | <0.05 | <0.00005 |
| Metallized BoPP | 0,05 | 0,7 |
| SiO _x / BoPP | 0,07 | 0,6 |
| Coated BoPP | 0,01 | 2,3 |

Outlook

- **Open Call for Pilot Case Projects**

- 3rd and last cut-off: 27 January 2023

- To establish a sustainable OITB for the time after the EU funded project:

- Non-profit association by the OITB partners:

ESNA – European Sustainable Nanotechnology Solutions Association

- to be announced soon
- Association will install Single Entry Points (SEP) as your local contact

Thank You for listening!

Contact:

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