



H2020-NMBP-HUBS-2019

FlexFunction2Sustain

**Open Innovation Ecosystem for Sustainable Nano-functionalized
Flexible Plastic and Paper Surfaces and Membranes**

Starting date of the project: 01/04/2020
Duration: 48 months

= Deliverable D8.10 =
Project handbook

Dissemination level		
PU	Public	x
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 862156

DISCLAIMER

Any dissemination of results reflects only the authors' view and the European Commission, or the European Health and Digital Executive Agency (HaDEA) is not responsible for any use that may be made of the information Deliverable D8.10 contains.

Executive Summary

In accordance with *Work Package 8 Clustering, Dissemination and Outreach, Exploitation* and *Task 8.3 Dissemination Activities and building the FF2S Identity and Brand*, we present herein, Deliverable D8.10 *Project Handbook*. The primary aim of that commercial promotional material is to explain the idea behind the Open Innovation Test Bed (OITB) as well as to highlight the core competencies and unique products and services of the Ecosystem as a whole. The Handbook includes facilities clusters' specifications and indicates the main technological values benchmarked against others. In addition to that, six application examples are presented to demonstrate how technical services of the OITB can be combined to solve complex industrial problems involving smart nanotechnologies and materials, thereby demonstrating the technical ability of the OITB.

Deliverable 8.10 "*Project Handbook*" represents a public deliverable and will therefore be available for download from the project website (<https://flexfunction2sustain.eu/>). The handbook is regarded as a brochure towards potential customers. The handbook is also used as a tool for dissemination and as such it will be disseminated across all media channels. In addition to that, the Handbook will be printed and distributed at any event where the FlexFunction2Sustain project will be presented.

Table of Contents

1. INTRODUCTION.....	5
2. CONTENT OF THE PROJECT HANDBOOK.....	5
2.1. TEXT OF THE PROJECT HANDBOOK.....	5
2.2. ACKNOWLEDGEMENT	6
2.3. VISUAL IDENTITY	7
2.4. GENDER EQUALITY	7
2.5. UPDATES.....	7
2.6. COPY OF THE PROJECT HANDBOOK.....	7
3. USE OF THE PROJECT HANDBOOK	7
3.1. FLEXFUNCTION2SUSTAIN WEBSITE.....	7
3.2. SOCIAL MEDIA	7
3.3. E-MAIL MARKETING	8
3.4. EAB MEMBERS	8
3.5. DISSEMINATION EVENTS.....	8
4. CONCLUSIONS	9
5. DEGREE OF PROGRESS.....	9
6. DISSEMINATION LEVEL.....	9
APPENDIX.....	10

1. Introduction

As specified in *Task 8.3 Dissemination Activities and building the FF2S Identity and Brand*, in this Deliverable *D8.10* we present the contents of the FlexFunction2Sustain Project Handbook (hereinafter Handbook) and how it will be used to promote the FlexFunction2Sustain Open Innovation Test Bed (OITB) for sustainable nano-functionalised flexible plastic and paper surfaces and membranes.

The primary aim of that commercial promotional material is to explain the idea behind the Open Innovation Test Bed (OITB) as well as to highlight the core competencies and unique products and services of the Ecosystem as a whole. The Handbook includes facilities clusters' specifications and indicates the main technological values benchmarked against others. In addition to that, six application examples are presented to demonstrate how technical services of the OITB can be combined to solve complex industrial problems involving smart nanotechnologies and materials, thereby demonstrating the technical ability of the OITB.

The Handbook will be prepared in printed form as well as in electronic form which will be available for download through the FlexFunction2Sustain website (<https://flexfunction2sustain.eu/>). The project will actively seek and maintain contact with the European and international research community, other relevant EU projects and will look to stimulate engagement from end-user markets. Therefore, it is also possible to use the electronic version for further networking and Ecosystem building/management.

The Handbook will be updated whenever new relevant information is available as well as when the use-cases and pilot-cases can be discussed publicly in more detail. Additional capabilities matured during the project will be included to later versions of this handbook.

2. Content of the Project Handbook

As in all print media, the Handbook will be used to convey the OITB's messages and objectives under the following principles:

2.1. Text of the Project Handbook

Chapter	Objectives of the content
Introduction	<p>The chapter introduce the idea of the Open Innovation Test Bed as an Ecosystem with a set of entities providing common access to physical facilities, capabilities and services. It also underlines the fact that the main objective of the OITB is to provide users an easy access to holistic innovation boosting services through a Single Entry Point – the industry's access point to OITB services.</p> <p>The chapter provides answers to the following questions:</p> <ul style="list-style-type: none"> - What is an Open Innovation Test Bed? - What the FlexFunction2Sustain OITB Mission and Vision are? - What the benefits and advantages of the OITB are or why should I use such an OITB? - How to approach the OITB ?
Services	<p>The section's goal is to convey the message that the FlexFunction2Sustain OITB is prepared to support the client at any point in the innovation chain by integrating technological, business development and verification/pre-certification services to a holistic offer. Visualization of the services at a glance is presented.</p>

Core competences and members	<p>FlexFunction2Sustain OITB's partners cover the whole range of services to provide the industry innovative solutions in the field of nano-functionalised materials covering:</p> <ul style="list-style-type: none"> - Efficient structures for EU wide collaboration between R&D and industry - Technology and innovation rating and evaluation - Lab-to-fab facilities for boosting technologies - Pilot manufacturing facilities for all major nano-surface modification techniques - Business development, intellectual property expertise and investor relations - Knowledge gathering and preservation for sustainable plastics
Technical facilities	<p>FlexFunction2Sustain OITB will offer complementary technical facilities to provide innovative SMEs and industries with services along the whole innovation chain. The chapter aims at introducing the technologies available in the Ecosystem with pictures and short specifications. They are arranged by categories covering the following facility clusters:</p> <ul style="list-style-type: none"> - Atmospheric pressure processes - Vacuum coating and surface treatment - Facilities for printed electronics - Surface nano- and micro structuring - Circularity of plastics - Characterisation and quality control
Application examples	<p>The chapter aims to show how the FlexFunction2Sustain's technical facilities, and the performances of novel nano-functionalised surfaces will be demonstrated and validated by Europe's leading companies. It explains which problem the industrial partner was facing, the solution found by the OITB to answer it and the targeted services to develop the solution.</p> <p>Presented industrial validation in 6 application examples, as follows:</p> <ul style="list-style-type: none"> - HUECK Folien: <i>Biobased optical films</i> - P&G: <i>Marine degradable flexible packaging</i> - i3Membrane: <i>Selective and switchable membranes</i> - CRF: <i>Multifunctional plastic surfaces in automotive</i> - Capri-Sun: <i>Recyclable drink pouches</i> - SONAE MC: <i>Paper-based food packaging</i>
Related projects	<p>FlexFunction2Sustain interacts with relevant regulatory and standardisation bodies and other Open Innovation Ecosystems. The sections provide information of those interactions and clustering activities.</p>
Open Calls	<p>The section is addressed to all potential customers who would like to access the FlexFunction2Sustain OITB offering within its Open Call and includes the steps of the process along with the respective deadlines for application.</p>
Contacts	<p>Contact points</p>

2.2. Acknowledgement

As in all FlexFunction2Sustain print media, the EU emblem is displayed on the front and back pages of the Handbook. Additionally, the text “*This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement n°862156, project FlexFunction2Sustain*” is also included.

2.3. Visual identity

In the Handbook is used the logo and visual identity which have been created and used in all dissemination activities and tools to aid in branding and increasing the visibility and awareness of FlexFunction2Sustain project. The logo chosen as the best graphical representation of the project idea is shown on Figure 1. The project logo will be complemented in a later stage with a family of commercial logos for the OITB, the Single Entry Point company and certain products/trademarks of the FlexFunction2Sustain OITB. The aim is to create a corporate identity and brand for the OITB.



Figure 1 FlexFunction2Sustain logo

2.4. Gender equality

As in all print media, the Project Handbook uses gender-neutral texts and display a balance of female/male imagery.

2.5. Updates

The Handbook will be updated whenever needed to highlight results and progress of the OITB. Updates will be announced via posts on the website and social media.

2.6. Copy of the Project Handbook

A copy of the current version of the Handbook (version 1, July 2021) is attached to Appendix of this document.

3. Use of the Project Handbook

The FlexFunction2Sustain Handbook will be used to advertise and promote the OITB's core competences, technology, pilot line services, and results across all media channels, as follows:

3.1. FlexFunction2Sustain website

The FlexFunction2Sustain project website <https://flexfunction2sustain.eu> is online (see deliverable *D8.7 Project website launched, public and partner restricted part*) and is the main entry point to the project for all target groups. Thus, the Handbook will be available on the website and downloadable in a PDF format.

3.2. Social media

Social Media such as LinkedIn, Twitter, etc. will be considered to address the potential impact especially to the younger generation and to enable feedback from various audiences. Social media will be considered as a communication channel to advertise the Handbook and periodic updates with links for direct downloads and to the FlexFunction2Sustain website for all target groups.

3.3. E-mail marketing

The electronic version of the Handbook will be attached to follow-up emails to SMEs and any other stakeholders who have expressed interest in the FlexFunction2Sustain services at online dissemination meetings.

3.4. EAB members

The External Advisory Board members within the project will specifically be requested to support the dissemination of the Handbook by spreading the material through their professional and personal networks.

3.5. Dissemination events

Due to the COVID-19 pandemic, since March 2020, all dissemination events have been online. While this situation continues, the electronic version of the Handbook will be made available to attendees of online events as well as email attachments for follow up correspondence with any stakeholder who has expressed an interest in the FlexFunction2Sustain project.

When normality returns after the COVID-19 pandemic, printed versions of the Handbook will be used to promote the FlexFunction2Sustain project at face-to-face events.

4. Conclusions

In this report, we have detailed the contents of the FlexFunction2Sustain Handbook and how it will be used to promote the Open Innovation Ecosystem for nano-functionalised flexible plastic and paper surfaces and membranes.

The Handbook will be updated regularly during the whole course of the OITB establishment as new information becomes available and will be available in a printed as well as an electronic format for integration into the FlexFunction2Sustain website and for networking and Ecosystem building/management.

5. Degree of progress

The Project Handbook represents the final output of Work Package 8 and is therefore 100% fulfilled.

6. Dissemination level

The Deliverable *D8.10 Project Handbook* is public and will, therefore, be available for download from the project's website and will be distributed at different events.

Appendix

The Project Handbook is attached in this section.

Get in touch with us:



Dr. John Fahlteich

Project Coordinator

Fraunhofer Institute for Organic Electronics,
Electron Beam and Plasma Technology FEP

Email: John.Fahlteich@fep.fraunhofer.de



Anastasia Grozdanova

Project and Dissemination Manager

Amires s.r.o.

Email: grozdanova@amires.eu

Find out more about the project:

FlexFunction2Sustain
<https://flexfunction2sustain.eu>

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



Table of contents

Words from the coordinator	4	Special characterisation portfolio	19
What is an Open Innovation Test Bed?	5	Target markets	20
Benefits and advantages for SME	6	Application examples	21
FlexFunction2SustainOpen Innovation Test Bed	7	Biobased optical films	22
Services at a glance	8	Marine degradable flexible packaging	23
How to approach the OITB ?	9	Selective and switchable membranes	24
OITB technical competences	10	Multifunctional plastic surfaces in automotive	25
Core competences and members	11	Recyclable drink pouches	26
Atmospheric pressure processes	12	Paper-based food packaging	27
Vacuum coating and surface treatment	13	Related projects	28
Facilities for printed electronics	14	Open Calls	29
Surface nano- and micro structuring	15		
Circularity of plastics	16		
Characterisation and quality control	18		



Transforming innovative ideas to eco-friendly plastic and paper products



The FlexFunction2Sustain Open Innovation Ecosystem unites Europe's leading Research Organisations and Industries for smart and sustainable plastic and paper products. Supported by Business Development Experts, FlexFunction2Sustain transforms novel concepts and technologies to market successful products.



Words from the coordinator

The FlexFunction2Sustain Initiative aims at creating an Open Innovation Test Bed (OITB) for nano-functionalisation technologies that enable sustainable and smart plastics and paper-based products. The OITB envisages new business opportunities in replacing glass and metal with nano-functionalised plastic or paper surfaces in various products, enabling reductions in weight and cost and mechanical flexibility gains.

FlexFunction2Sustain OITB is a unique ecosystem of research, technology and business development partners to set-up a combined offer of complementary services for boosting innovation. Customers will be able to gain access to a pan European innovation network through a Single Entry Point without the need to speak multiple

languages or to understand the law in multiple countries. This model allows the most appropriate technology selection and shaping among whole technological portfolio available in the EU. Users can expect optimum cost, time-to-market, reliability and performance.



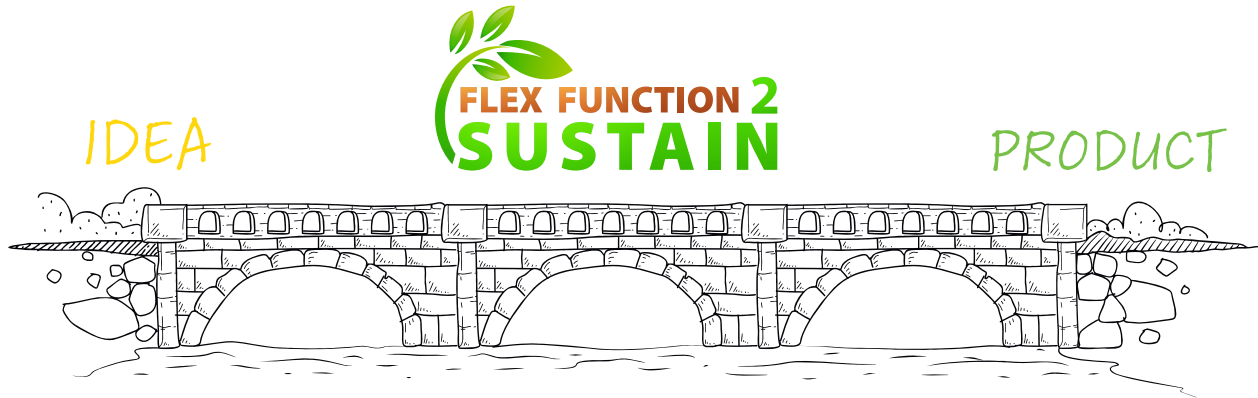
Welcome to the
FlexFunction2Sustain OITB!



*Dr. John Fahlteich,
Project Coordinator*

A handwritten signature in blue ink that reads "John Fahlteich".

What is an Open Innovation Test Bed?



An Open Innovation Test Bed is an ecosystem with a set of entities providing common access to physical facilities, capabilities and services. The main objective of the OITB is to provide users an easy access to holistic innovation boosting services through a Single Entry Point – the industry's access point to OITB services.

The OITB supports the innovative Start-Ups, SMEs and industries in material and product design, in process and product development, in product verification and certification, with pilot and small series production services and with accessing new markets and business opportunities. Integrating all these services to a complete, all-round offer will substantially reduce the time and cost to progress through the innovation chain from an idea to a successful product.

Benefits and advantages for SME

Why should I use an OITB?

Holistic services from a single contractor - Single Entry Point (SEP)

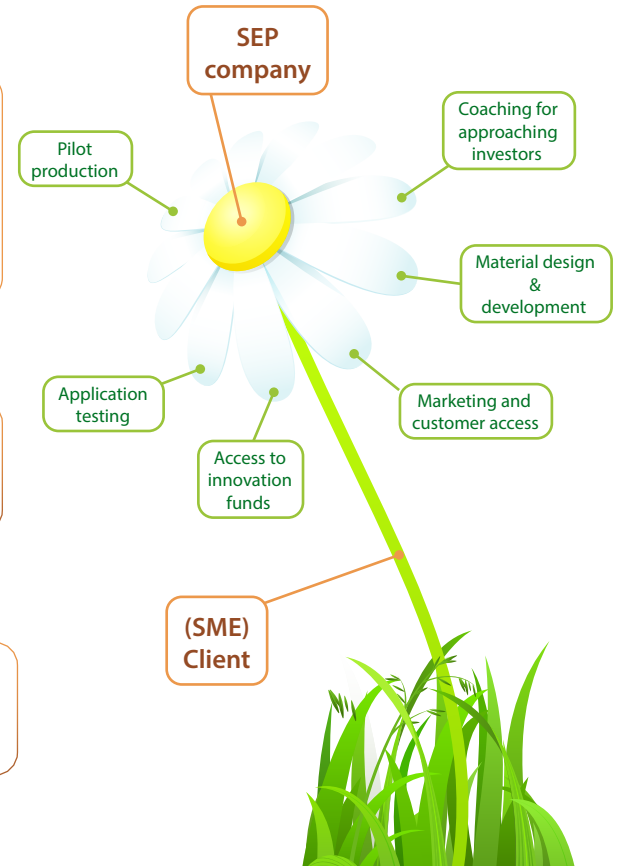
One contract – multifold services focused on customer needs
Innovation services from more than 10 European countries delivered in either your native language or English
Renowned experts assemble best-suited, “best value for money” services for your innovation
Single Entry Point does all management and process tracking

Integrated business services, coaching and finance access

Link to investors and access to R&I funds
Consulting for accessing new markets and creating new business models

Customer-friendly liability and warranty terms

SEP acts as fully responsible general contractor
Reduce risks in complex innovation processes with multiple partners involved



FlexFunction2Sustain Open Innovation Test Bed

Objectives, Vision and Mission

Our objectives

Position as leading supplier for technical and business innovation services for nanotechnology in plastic and paper processing industry

Support Start-Ups, SME and industry in the whole Single European Market in turning their ideas to market successful products

Establish a successful and sustainable business; maintain and grow the OITB ecosystem and portfolio

Support solving societal challenges through education, standardisation and regulation advice



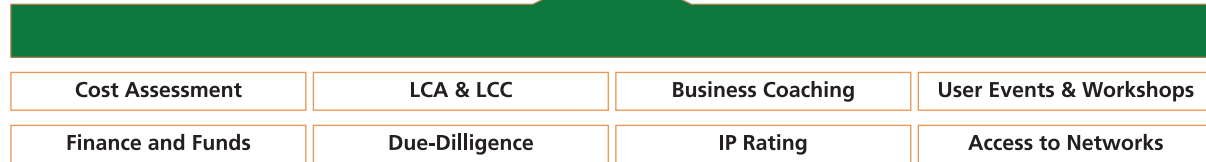
Mission: We drastically reduce plastic waste in the world through enabling innovations using novel nano-functionalised plastic and paper surfaces.



Vision: We are the leading alliance for testing and boosting innovations worldwide in nanotechnology for environmentally friendly and smart plastic and paper products.

Services at a glance

Business and Finance Community



Fundamental
Research

Material Develop-
ment and Design

Prototypes and
Demonstrators

Testing
Validation

Machine
Design

Pilot
Production

Technology
Transfer

Pre-
Certification

Commertia-
lization

Research & Development

Demonstration

Deployment / Upscaling

Market Accumulation

Standardization

Regulations: Fulfill and Suggest

Dissemination to Society

Identify Challenges → Funding Topics

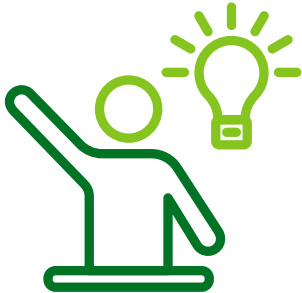
Regional Development

Government

How to approach the OITB ?

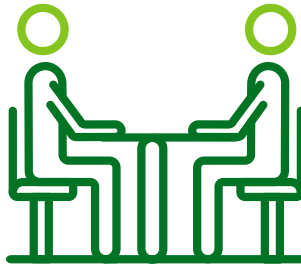
Open the door to more business with your ideas

FlexFunction2Sustain offers a one-stop-shop for all requests for services that will be managed by the Single Entry Point company with multiple regional offices distributed all over the European Union.



Client

Product idea or technical challenge



For-profit

Single Entry Point



FlexFunction2Sustain

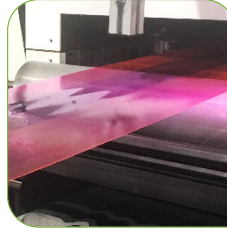
OITB Services

The Single Entry Point manages all relationship between the client and the OITB members in order to offer an easy access of clients to our services.

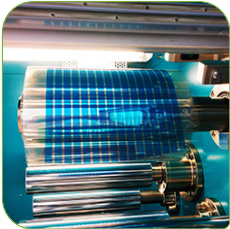
OITB technical competences



**CIRCULARITY BY
DESIGN**



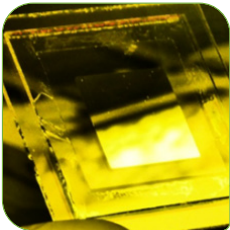
**ROLL-TO-ROLL
ATMOSPHERIC
PRESSURE COATING &
SURFACE TREATMENT**



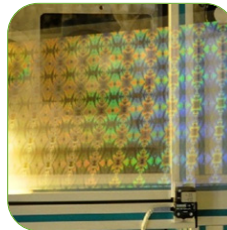
**PRINTED AND FLEXIBLE
ELECTRONICS**



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



**FUNCTIONAL
CHARACTERISATION
AND APPLICATION
VERIFICATION**



**ROLL-TO-ROLL
NANOIMPRINT
LITHOGRAPHY**

Core competences and members

OITB members are leading European institutes and companies, which combine their competencies, expertise and infrastructure to provide the industry innovative solutions in the field of nano-functionalised materials.

The OITB core competences cover:

- Efficient structures for EU wide collaboration between R&D and industry
- Technology and innovation rating and evaluation
- Lab-to-fab facilities for boosting technologies
- Pilot manufacturing facilities for all major nano-surface modification techniques
- Business development, intellectual property expertise and investor relations
- Knowledge gathering and preservation for sustainable plastics

Fraunhofer
FEP

Fraunhofer
IAP

Fraunhofer
IVV

Coatema®
Coating Machinery GmbH

GEMFO
Gesellschaft für
Mittelstandsförderung mbH

SH
SONNENBERG HARRISON

Germany

I P C

France

Portugal

INL
INTERNATIONAL SPECIAL
NANOTECHNOLOGY
LABORATORY

AMIRÉS

Czechia

Switzerland

amcor

Austria

JOANNEUM RESEARCH
MATERIALS

Greece

ARISTOTLE UNIVERSITY
OF THESSALONIKI

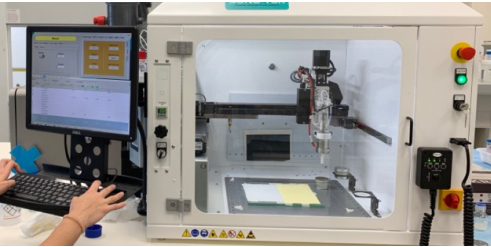
Itfn
nanotechnology

HOPE-A

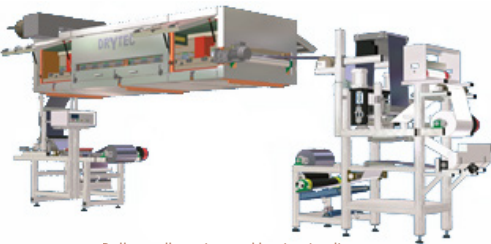
Nano Biomed
Innovative Capital to explore

oet

Atmospheric pressure processes



SonoTekexacta coat ultrasonic spray system at INL



Roll-to-roll coating and lamination line at Fraunhofer IVV



Multifunctional capable coating machine for gravure coating and slot-die coating of paper and plastic at Coatema

Specification table :

- Roll-to-roll and sheet-to-sheet process on lab and pilot scale
- Substrates: plastic webs, paper and metal foils
- Sample size roll-to-roll: 550 mm web width and 500 mm working width
- Sample size sheet-to-sheet: 360 x 360 mm
- Coating technologies: intermittent and continuous slot-die coating, ultrasonic spray coating, doctor blade, engraved roller, 3-roller coating system, 5-roller coating system, kisscoater, commabar, reverse commabar and fouldard
- Printing technologies: rotatory screen printing, inkjet printing and flexo printing
- Deposition of material in dust free environment
- Deposition of materials and lamination in inert atmosphere
- Aligned multi-layer printing using registration
- In-line metrology and thickness control tools
- Drying technologies: roller based horizontal and arched hot air convection dryer, hot air flotation dryer, UV-, IR- and NIR-dryer
- Process speeds: 0.1 – 80 m/min



Vacuum coating and surface treatment

Fraunhofer FEP



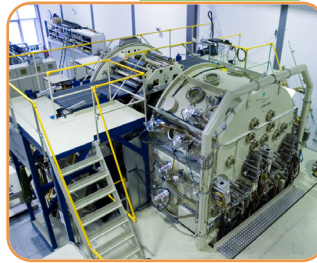
A4 sheets
1 process

Fraunhofer FEP



200 mm
3 stations

Fraunhofer FEP



650 mm width
5-6 stations

AMCOR



715 mm ... 2000 mm
width

Specification table:

- Processes: Magnetron sputtering, PECVD, high-rate evaporation, atomic layer deposition
- Substrates: plastic film, paper, biodegradable polymer webs, metal foils, polymer membranes
- Contactless, defect free winding
- One pass multilayer deposition (up to 6 layers)
- Web speed range from 0.1 to 600 m/min with roll lengths up to 1000 m
- In-line evaluation of transmittance, reflectance, sheet resistance and surface defects
- Nano-composite coatings with high-purity nanoparticles by gas-phase aggregation in PECVD matrix (Sheet-to-sheet process)

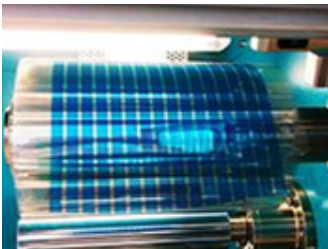
Facilities for printed electronics



Panoramic view into the cleanroom at Fraunhofer IAP with sheet-to-sheet pilot line for printed organic electronics devices



Roll-to-roll printed electronics pilot line at Nanotechnology Lab LTFN, Aristotle University of Thessaloniki, Greece



OET, Greece: Organic solar cell at the Aristotle University of Thessaloniki roll-to-roll pilot line

Specification table :

- Full process chain to make and integrate printed electronic devices and encapsulated modules
- Sheet-to-sheet processing on 150 mm x 150 mm
- Roll-to-roll processing on 300 mm web width
- Deposition techniques:
 - At ambient pressure: inkjet printing, gravure printing, slot-die coating, screen printing, laser patterning
 - In vacuum: thermal evaporation and OVPD deposition of functional organic semiconductors
- Machines installed in clean rooms (class 10 ... 1000) and processing in inert atmosphere
- Encapsulation techniques: Thin film encapsulation with atomic layer deposition; lamination of glass sheets or permeation barrier films
- Device examples: organic solar cells, organic light emitting diodes, printed sensors and wireless antennas

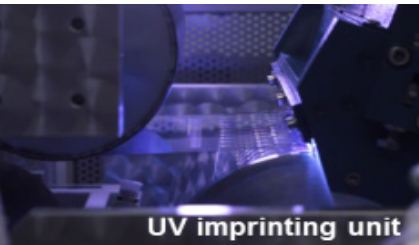
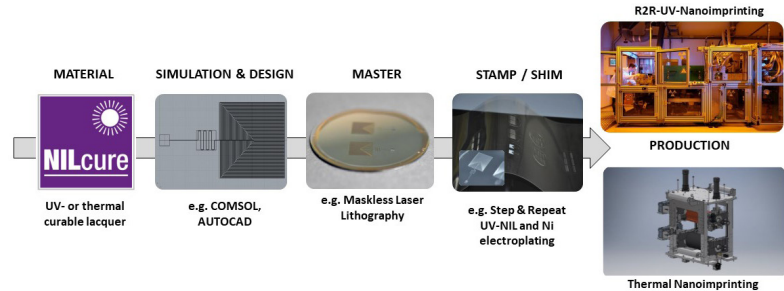


Sheet-to-sheet pilot line for printed organic electronics devices at Aristotle University of Thessaloniki

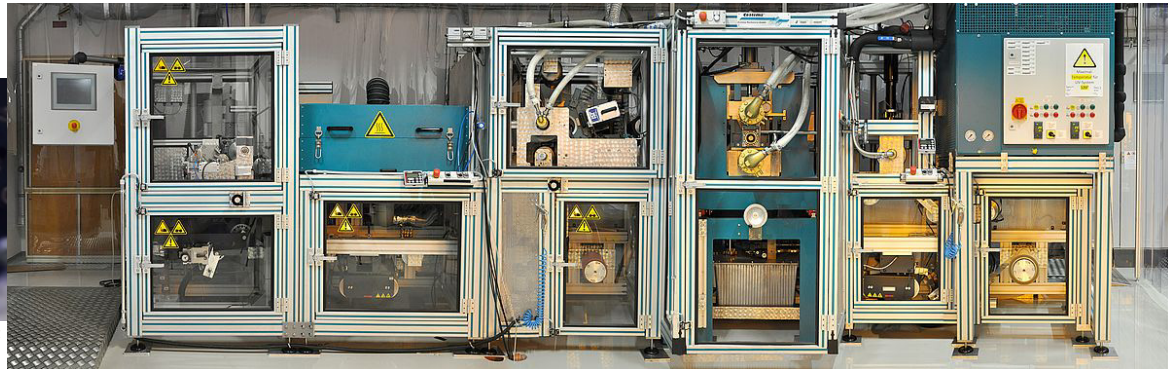
Surface nano- and micro structuring

Specification table :

- Lamination by UV-curing and/or thermal curing
- Web width 250 mm
- Web speed range: 0.5 - 30 m/min
- Dust protection by Laminar Flowbox, Click&Coat Box
- Circularity by design material concept: recyclable and/or biobased and/or biodegradable substrates and UV-lacquers
- Micro/nanopatterning by UV-nanoimprinting or hot embossing (max. 200°C)
- Direct patterning of polymer foil substrates or patterning of surface coatings based on tailored UV-lacquers on polymer foil substrate
- UV curing by UV-LED (max. 14 W/cm², 365nm or 395nm) or by Hg-Vapor Lamp



Coatema roll-to-roll nanoimprint
at JOANNEUM RESEARCH



Roll-to-roll machine for UV nanoimprint lithography at JOANNEUM RESEARCH

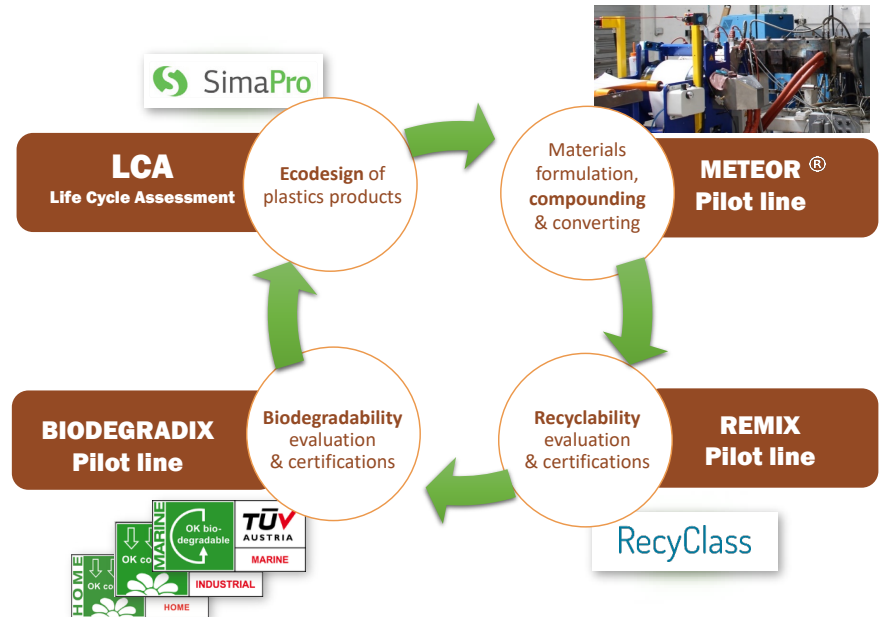
Circularity of plastics

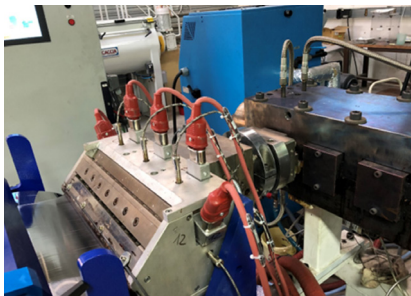
These facilities clusters are dedicated to supporting the development of a “Circularity by Design” service, that includes Life Cycle Assessment (LCA), and Eco-Design of materials and plastic products, towards pre-certification of recyclability, biodegradability, and compostability.

Life Cycle Assessment according to ISO 14040 & 14044

- More sustainable end-of-life scenarios
- Quantify benefits of sustainable products
- Assist suppliers and clients in eco-design decision making
- METEOR®: compounding and converting new formulations based on recyclable, bio-based, or bio-degradable materials
- REMIX / BIODEGRADIX: recyclability, biodegradability, and compostability testing following RecyClass and TUV Austria protocols

The combination of these pilot lines allows the implementation of a holistic Circular Economy approach in order to support the OITB clients in developing new environmentally harmless products.





METEOR® pilot line at IPC



Examples of converting steps: (top): blown film extrusion, film take-off station, (bottom): injection molding facility, tube and profile extrusion machine (at IPC)



BIODEGRADIX pilot line at IPC

METEOR® pilot line:

- Compounding and specific material formulations development with an efficient dispersion of additives while reducing the thermo-mechanical degradation of the material
- Film coextrusion, with a flat die, and film take-off station
- High temperatures, up to 350°C,
- Compounding process throughput range: from just a few kgs/h up to 100 kg/h
- Line speed - 1 to 20 m/min
- Films thickness range - 25 to 250 micron
- Films width - 300 to 330 mm

REMIX pilot line:

- Comprehensive qualification of plastic waste down to the complete technical datasheet of the recycled materials
- Allows working at semi-industrial scale with 100 to 200 kg batches
- Equipped with: shredding, flotation, washing, and drying machines for plastic flexible films, NIR sorting, electrostatic, and tribo-electrostatic sorting machines, extrusion and filtering machines
- Recycled materials can be converted back into films, sheets or containers, as needed, with the broad choice of equipment available at IPC

BIODEGRADIX pilot line:

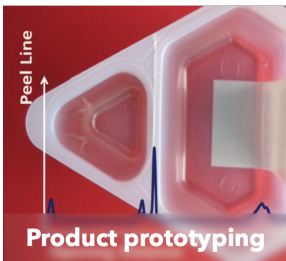
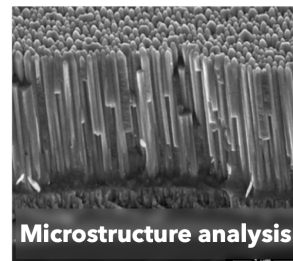
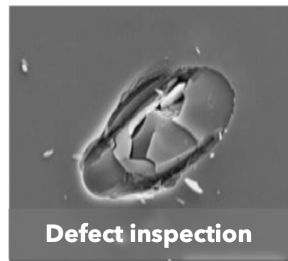
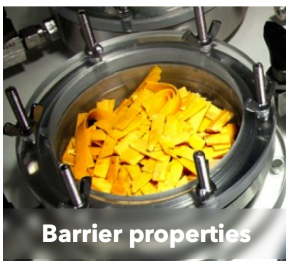
- Equipped with respirometers, up to 60 channels, to perform aerobic or anaerobic biodegradability tests, in compost or marine environment
- Equipped with two 12 Channel respirometers to perform aerobic or anaerobic biodegradability tests.
- IPC also has a range of cutting mills available for the shredding, grinding, or milling of different types of materials including rigid and flexible plastics.

Characterisation and quality control

**Physico-chemical and
surface characterisation
and functional
performance verification**

**Application integration
and verification**

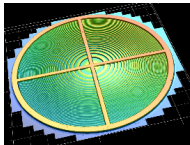
**Compliance and Material
Safety Verification**



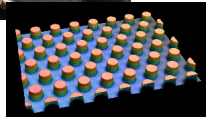
Characterisation and Verification Workflow

Special characterisation portfolio

Surface and structural characterisation

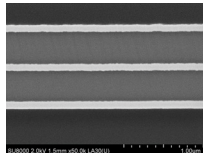
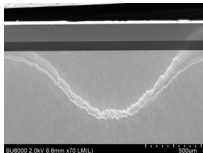


Large area confocal microscope



SEM cross-section imaging

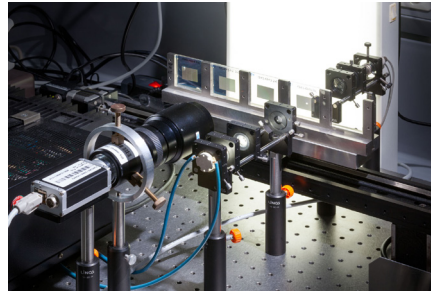
- Morphology and structure evaluation
- Defect detection



Functional characterisation testing

Mechanical testing with in-line WVTR characterisation

- Coupling of optical calcium test for WVTR with mechanical bending test in device geometry
- Sensitivity down to $10^{-6} \text{ g}/(\text{m}^2\text{d})$



Permeability down to $10^{-6} \text{ g}/(\text{m}^2\text{d})$

- Sempa HiBarSens 2.0 HT



Application approval and safety testing

Food packaging plant and food contact laboratory

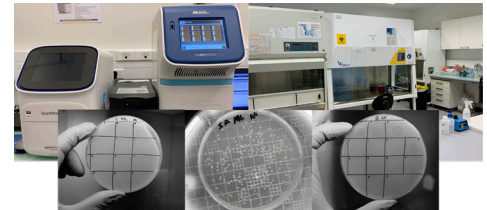
- Full FCM characterisation
- ISO 9001:2015 certified facility

Safety assessment

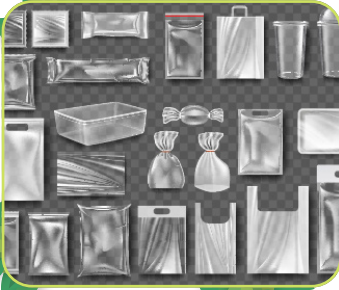
- Toxicological analysis of nanomaterials
- Imaging of nanomaterial-cell interactions (ISO 9001:2015 certified facility)

Rapid testing of antimicrobial surfaces

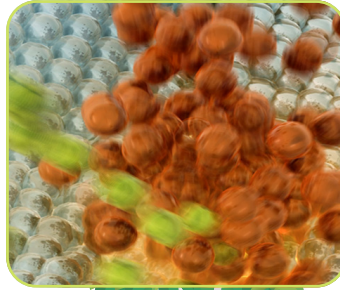
- Antiviral activity by qPCR/RT-qPCR



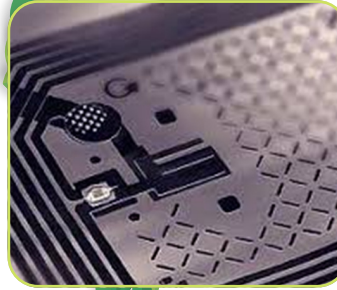
Target markets



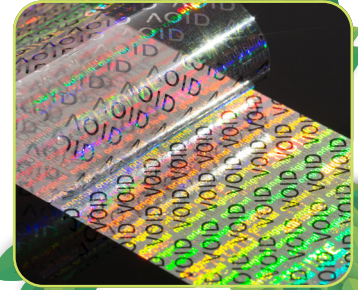
*Sustainable
smart
packaging*



*Surfaces &
membranes
in bio
applications*



*Plastic and
paper
electronics*



*Optical films
for security
and design*



Application examples

Research meets industry

FlexFunction2Sustain's technical facilities and the performances of novel nano-functionalised surfaces will be demonstrated and validated by Europe's leading companies within six industrial application scenarios.

Industrial validation in 6 use cases



Biobased optical
films



Marine
degradable
flexible
packaging



Selective and
switchable
membranes



Multifunctional
plastic surfaces in
automotive



Recyclable drink
pouches



Paper-based food
packaging

Biobased optical films

HUECK FOLIEN

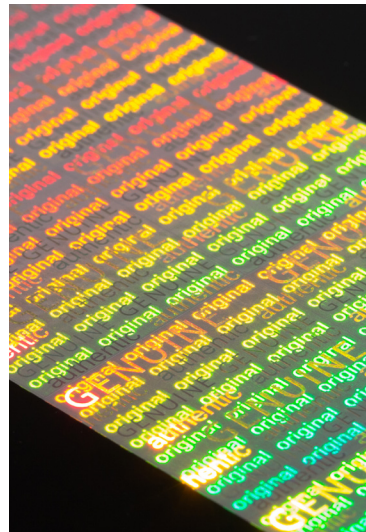
FlexFunction2Sustain is an important project in this context and supports us in a sustainable product development. In our state-of-the-art laboratories, a team of experts considers and researches the basic principles and solutions for individual customer requirements. Environmentally compatible raw materials are used according to technical possibilities. The use of so-called "bio-plastics" always finds place in discussions. We have been successfully using recycled PET for high-quality furniture surface films since 2019. Further products with recycling foils, especially for Labelling, are in development. As a manufacturing company, we bear a special responsibility for our environment. We therefore rely on energy efficiency and resource conservation. With our commitment to sustainability, we focus on careful management of limited resources.

Dr. Stephan Trassl
Project Manager Research

Objective: introduce bio-based or recycled substrates and bio-polymer based resins in optical films.

Optical temper-evident features on packaging are used to protect food and pharmaceutical products. Premium lamination films are used for the decoration of interior design. Both products are manufactured using synthetic (non-degradable) resins on plastic films. Today, no in-line process control for fidelity of optical structures is available, so that continuous quality control in a cost-effective roll-to-roll manufacturing is not available.

Thus, this application case will implement existing roller-based technologies for high throughput large area fabrication of optical films onto bio-degradable plastics. The use of bio-degradable resins will further improve compostability of valuable polymer material.



Our ambition is to achieve and demonstrate

- High throughput large area fabrication and continuous quality control of optical layers onto bio-based or recycled plastics through implementation of in-line process control with full LCA
- Bio-based resins based on biopolymers like cellulose, vegetable oils or polylactic acid maintaining their biocompatibility as well as printability and production speed
- Fully industry-compostable / biodegradable optical films onto bio-degradable plastics (TÜV Austria Certificate "OK compostable")
- In-line process control enables accelerated development times.



Lamination films by HUECK Folien

HUECK Folien optically variable feature imprinted into a bio-based resin on a biobased PLA-film substrate

Marine degradable flexible packaging

Procter & Gamble

The Procter & Gamble Company is a world leading supplier of consumer goods offering a wide range of products for personal health, personal care and hygiene. As part of a holistic, multi-faceted innovation strategy, we are continuously seeking and developing solutions that enable consumers to have more environmentally responsible product choices. Recently, a wide range of novel bio-based and marine-degradable polymers have emerged that are potentially suitable for sustainable packaging of our products in certain situations. FlexFunction2Sustain supports us in evaluating, and potentially selecting, marine-degradable polymers as a sustainable packaging solution when and where it makes sense and supported by sound environmental science. Relevant technical expertise in the FlexFunction2Sustain consortium covers not only degradability, but the whole packaging technology, accelerating the time to market for sustainable packaging solutions.

Pier-Lorenzo Caruso
Technology Manager

Objective: develop less environmentally persistent materials for flexible packaging

Currently, flexible packaging in Fast-Moving Consumer Goods (FMCG) requires H₂O permeation barrier and the mechanical strength needed to withstand the converting and sealing process without damaging the barrier. The starting point are non-degradable polymers based on mineral oil in combination with aluminium barrier. FMCG products may be stored longer than 1 year in state of the art storage, provided with sufficient moisture barrier performance.

Our ambition is to:

- Enable marine degradable flexible packaging based on marine degradable non-plastic materials
- Deliver a moisture permeation barrier
- Demonstrate sealing performance without losing moisture barrier performance
- Demonstrate shelf life of longer than 9 months (accelerated aging + real storage)
- Gain 3rd party certification for “marine degradable” packaging



Recyclable and marine degradable flexible packaging structure

Selective and switchable membranes

i3 Membrane

i3 Membrane aims at next generation membrane techniques as we believe that membranes can do more than just filter.

Combining the potentials of polymer membranes and conductive metal coatings, we strive for the creation of digital membrane chromatography solutions that enable higher product throughputs with lower buffer media consumption compared to the state of the art.

Being a use case partner in the FlexFunction2Sustain project, offers us the unique opportunity to get access to leading edge ultra-thin film technologies and co-develop new processes with technology leaders.

Dr. Florian Schmitt
CTO



Case 2: gold coated polyester membrane for particle analysis of pharma liquids (case 2)



Case 1: Membrane based syringe filter (left) and capsule filter (right) by i3 Membrane (basic design for case 1)

Objective: develop double-sided roll-to-roll coating of conductive layers on polymer membranes for electrically switchable filters in medical/biotech (case 1) and for particle analysis in pharmaceutical liquids (case 2).

Metal coated polymer membranes (Polyamide) have the ability to add digital properties by applying a voltage to adsorb and desorb charged biomolecules such as monoclonal antibodies. Active filter membranes increase market potential to e.g. syringe filters and other biotech filter applications (figure - case 1).

Gold coated polyester membranes are used in pharma industries for particle analysis of liquids. Covid19-related increasing demands for particle monitoring of active agents trigger efforts to achieve higher production throughputs for membrane metallisation (figure - case 2).

Polymer membranes turned out to be a challenging material for industrial high-volume coating technologies (roll-to-roll processing). Therefore, the State of the art is sheet-to-sheet production (5 membranes in 8 hours) with limited yield (75%). Electrically switchable membranes are not available on the market. Specific adsorption / desorption usually is done by time intensive pH-shift processes.

Our ambition is to:

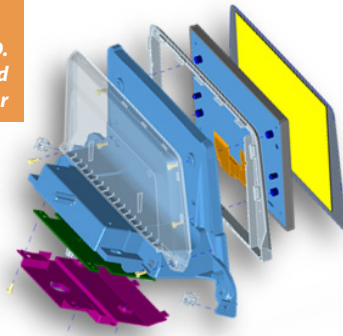
- Increase productivity to at least 50 membranes/8h by implementing a roll-to-roll process
- Increase yield to > 97% (apply in-line monitoring strategies)
- Optimise metal coating characteristics (e.g., mechanical stability) and membrane performance (e.g. flux)
- Develop a robust interconnection technology to apply electrical voltage to the membrane
- Application robust metal layers on ultra thin membranes under influence of electrical voltage and fluids

Information videos on I3M technology for [syringe filters](#) and [particle analysis](#)

FlexFunction2Sustain project perfectly matches Centro Ricerche FIAT's expertise and targets because surface technology and sustainability are key technologies for vehicle of the future. The first mission of the CRF is the promotion and the investigation of novel materials, technologies and systems for the automotive sector. Project FlexFunction2Sustain goes in such direction: improving technologies and materials suitable for display touchable surfaces and at the same time increase the sustainability of the component ensuring high quality in products and components. CRF involvement will target to investigation and application of sustainable transparent films for on board infotainment devices to achieve high quality components after aging. Using sustainable materials coming from recycling processes, we matches one of the main target of the future as the global sustainability.

Nello Li Pira, Ph.D.
Global Materials R&I and
Roadmaps Manager

Structure of central
instrument display



Multifunctional plastic surfaces in automotive

Fiat Research Center

Objective: development of display cover lens with touch functions, high quality optical output (anti-reflection, anti-glare, anti-fingerprint) and high mechanical-chemical robustness using sustainable materials.

Touch surfaces of car infotainment and entertainment display need to be combined with both electronics functions and optical clarity and scratch resistance / anti-fingerprint properties. On current components, anti-scratch surfaces are limited in the market to high-gloss effects. The introduction of optical functions as anti-reflection, anti-glare, anti-fingerprint is still challenging due to the limitation in materials availability, manufacturing processes as well as integration in targeted 3D geometry and high curvatures. The integration of printed electronics functionality (sensors; signage symbols and others) is also not available today.

Our ambition is to:

- Combine anti-scratch, anti-reflective and anti-fingerprint surface with electronic functions (capacitive or proximity sensors) on a flexible plastic surface to be integrated to complex 3D surfaces in car dashboards compliant to automotive standards
- The use of resins from recycled and recyclable materials will give us the opportunity to introduce sustainability notice within interior vehicle



Recyclable drink pouches

Capri Sun

Capri Sun as a world leading brand has clearly committed to become the world's most sustainable kids drink as part of the company's sustainability agenda. Therefore, our ambition is to seek and develop sustainable packaging solution made out of recyclable mono-material. To underline our efforts we are proud of being a use case partner of the FlexFunction2Sustain project, fulfilling the overall objective to set a new benchmark on the market when it comes to recyclable pouches assigned for beverage consumption. Within this consortium everyone can favor and benefit from partners strength and capabilities in this field.

Beatus Schehl,
Research & Development Director

Jakub Pedzinski, *Senior Packaging Innovation Manager*

Objective: development of a „Recycle Ready Pouch“ made from mono-material to facilitate recycling; introduce a recyclable polymer laminate with sufficient barrier and light blocking properties (thin film nanomaterials) for mono-material drink pouches.

Currently, there are highly mechanical stable liquid pouch for fruit juice with very good water vapour and oxygen barrier properties for a shelf life of longer than 6 months. State of the art is the usage of 3 layer laminates (PET/ALU/PE) that are practically impermeable to water vapour and oxygen and therefore, highly protective for the fruit juice allowing storage and shelf life longer than 1 year. However, the materials are not recyclable because of the use of 3 different materials.

Our ambition is to:

- Replace the drink pouches by fully recyclable mono-material laminate (using either polyolefin based polymers or biopolymers) in which the gas barrier performance is provided by thin film nanomaterials such as evaporated AlOx or PECVD deposited SiOx with a wet coated planarisation layer
- Demonstrate WVTR < 1 g/(m²d) and OTR < 10 cm³/(m²d) (both at 23°C / 50% r.h.) on 100 m long rolls
- Demonstrate assembly of drink pouches
- Demonstrate food-safety compliance and 100% recyclability (< 5 mass.% impurities)
- Demonstrate potential cost competitiveness with state of the art solutions



Paper-based food packaging

SONAE MC

Sonae MC as a leading food retailer is strongly committed to reduce the carbon footprint of its operations putting the people and the planet first. Particularly for plastics materials our ambition is to enforce a culture of reduce, reuse, recycle seeking to co-develop and test sustainable packaging solutions that address those criteria. To underline our efforts, we are proud of being a use case partner of the FlexFunction2Sustain project, fulfilling the overall objective to set new benchmarks on the market when it comes to packaging solutions (films, bags, trays, etc.) assigned for fresh and organic products, in a cooperative, science-based approach which allows the advancement of knowledge and its transfer to the market where our organization performs its role as a testbed for innovation.

Marlos Silva
Director of R&D and Incentives

Objective: development of paper-based food packaging that can act as an alternative to existing plastic packaging, ensure a better performance of paper packaging (when compared to existing paper-based packaging) and ensure a better recyclability/ biodegradability of paper-based packaging.

Currently, there are flexible paper with enhanced mechanical and barrier properties (against H_2O/O_2 , mineral oil, grease resistant) and active functions (e.g., antimicrobial or antioxidant) extending shelf-life of paper packed fresh food and helping replace plastic packaging for groceries. The synthetic waxes, plastics, or lacquer layers enhance barrier properties and enable direct food contact, but current coatings prevent recycling of package.

Our ambition is to:

- Develop new paper-based food packaging to be tested in selected food items
- Introduce “green” processes, e.g., electrohydrodynamic coating or ultrasonic atomisation for eco-friendly, active coatings based on nano-structured biopolymers, natural waxes and natural antimicrobial compounds
- Demonstrate hydrophobic/oleophobic, antibacterial surface on paper for extended shelf life of paper-packaged



Example of current plastic based fresh food packaging at SONAE



Selected food items and their current packaging

Related projects

INN-PRESSME

open innovation ecosystem for sustainable plant-based nano-enabled biomaterials deployment for packaging, transport and consumer goods

<https://www.inn-pressme.eu/>

OASIS

open access single entry point for scale-up of Innovative smart lightweight composite materials and components

<https://project-oasis.eu/>

SAFE-N-MEDTECH

safety testing in the life cycle of nanotechnology-enabled medical technologies for health

<https://safenmt.eu/>

TEESMAT

open innovation test bed for electrochemical energy storage materials

<https://www.teesmat.eu/>



NEXTGENMICRO-FLUIDICS

next generation test bed for upscaling of microfluidic devices based on nano-enabled surfaces and membranes

<https://www.nextgenmicro-fluidics.eu/>

NEWSKIN

innovation ecosystem to accelerate the industrial uptake of advanced surface nano-technologies

<https://www.newskin-oitb.eu/>

MDOT

medical device obligations taskforce

<https://mdot.eu/>

FORMPLANET

sheet metal forming testing hub

<https://formplanet.eu/>

INNOMEM

open innovation test bed for nano-enabled membranes

<https://www.innomem.eu/>

FlexFunction2Sustain interacts with relevant regulatory and standardisation bodies. The intermediaries include thematic scientific and industry associations such as EUPC, EPPN, EMMC, EMCC, Nanosafety Cluster and others. On the standardisation aspect, FlexFunction2Sustain contributes to new standards developments in specific topics, promoting the inclusion of the project outcomes in new or future standards that can be easily used by the European or international industry. Thereby, standardisation relevant results will be actively discussed with external stakeholders e.g. OE-A or the Plastics Recyclers Europe Association.

Open Calls

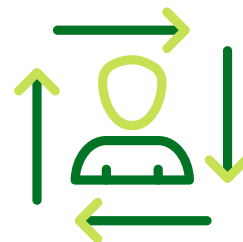
Get ready, get involved



A selection of up to 20 pre-commercial business cases utilising the FlexFunction2Sustain OITB offering will be made following two open calls in 28 January 2022, 29 July 2022, 27 January 2023.



Addressed to interested external companies, the call will aim at the provision of a subsidised support to the selected pilot cases.



The customer feedback from pre-commercial service demonstrations will be used to tune the OITB offering.



Find out more information on :

<https://flexfunction2sustain.eu/open-calls/>