This project has received funding from the Bio Based Industries Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement N° 745762.

Dr. Amaya Igartua
Coordinator of BIOSMART Project

TEKNIKER

BBI| 29/03/2021

BIOSMART

BIOMATERIALS FOR SMART FOOD PACKAGING

THE PROBLEM: FOOD LOSS AND WASTE GENERATION

In Europe, 88 Millions Tons of food are wasted each year

Equivalent to the 20 % of the food produced in Europe

Food lost along the value chain

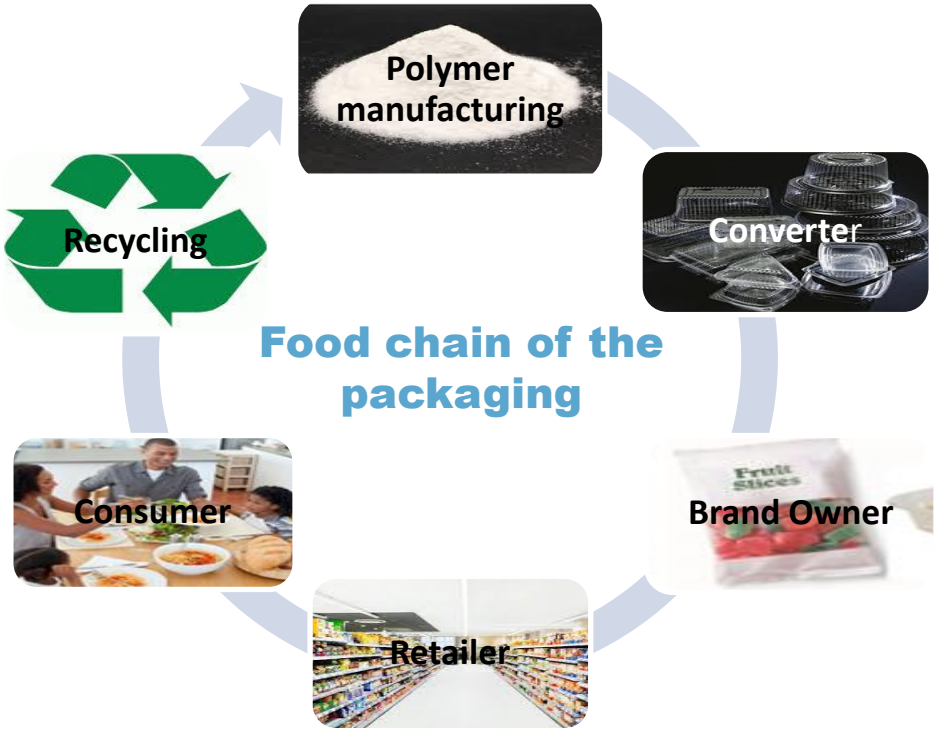
> 50% of the lost is in the food chain

97% of the food global residues are sent to the weir with a cost of **> 150 billions euros** degrading the soil in Europe in a **30-80%**

- 304 Mton CO_2 eq. (6% of the total Green house emissions)

http://www.eu-fusions.org/phocadownload/Publications/

CONCEPT AND CHALLENGE

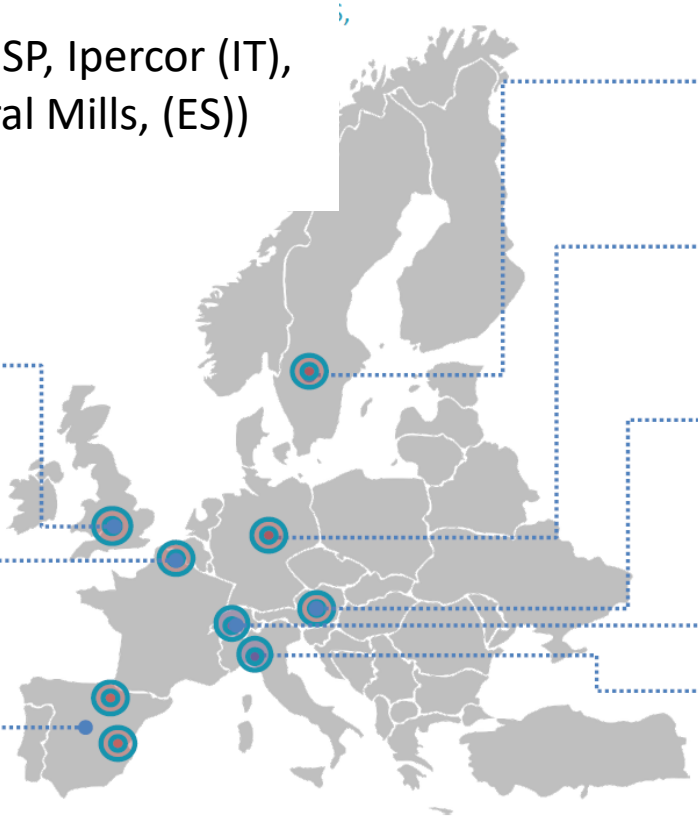


Actual packages: Light, high performance, multilayer, in some cases, difficult to recycle.

BIOSMART: Compostable or recyclable packaging from natural resources, with high mechanical performance and with enough barrier to accomplish the needs of the food.

The project address **all the food chain of the product in the design phase**

Advisory Board:
(Unilever (UK), Eroski, SP, Ipercor (IT), Naturworks (IT), General Mills, (ES))



UK
University of Reading

FRANCE
Université de Lille
Lipofabrik SAS

ESPAÑA
Tekniker
ITENE

SWEDEN
RISE

GERMANY
Wipak
Gea

AUSTRIA
Tecsense

SWITZERLAND
Haute Ecole de Fribourg

ITALY
Propagroup

OBJECTIVES

1

Development (TRL3-5) of packaging manufactured with materials from biomass:

- Biopolymers (PLA, PEA)
- Barrier coatings
- Hydrophobic surfaces
- Thermal regulation
- Antioxidants, antifungal and antimicrobial based lipopeptides
- Sensors indicating food quality

2

Mechanical properties of the PLA, developing biocomposites with nanoclays.

3

Implementation of several functionalities in different demonstrators

4

Reduction of the environmental impact increasing food shelf life and keeping food quality

5

Development of an **application** to define the materials functionalities, performance and the commercial needs..

BIOSMART FOOD PACKAGING

Tekniker MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE · ITENE RESEARCH CENTER · University of Reading · TECSENSE unique solutions in sensor technology · Université de Lille 1 SCIENCES ET TECHNOLOGIES

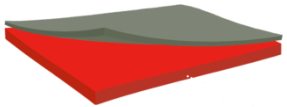
propa group · RI. SE · Lipofabrik · HEIA-FR HTA-FR · WIPAK · GEA

Sensors O_2, CO_2 and volatile amines

Reinforced mechanical properties

Antimicrobial properties

Barrier coatings Oxygen, water, UV



Thermal regulation

IMPROVEMENT OF MECHANICAL PROPERTIES

PLA reinforcement with nanoclays

- **Composite PLA+Nanoclays**
  - ✓ twin screw extruder
- **Processing with a structure of nanolayers(PLA+NC/PLA sealing layer)**
  - ✓ Coextrusion in line with 3 individual extrusión processes
- **Characterization**
  - ✓ **Resistance:** Young modulus increase 20 % and elongation to fracture 25 % (sheet) – 70 % (film).
  - ✓ **Keeping** thermal properties.
  - ✓ Improving **permeability** 20-30%.

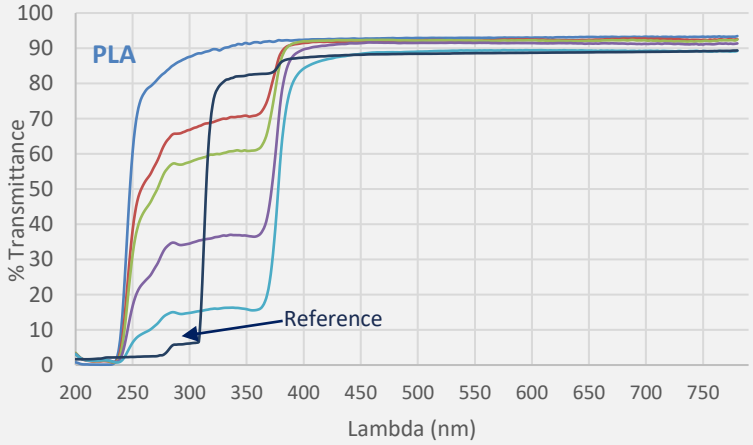
BARRIER COATINGS

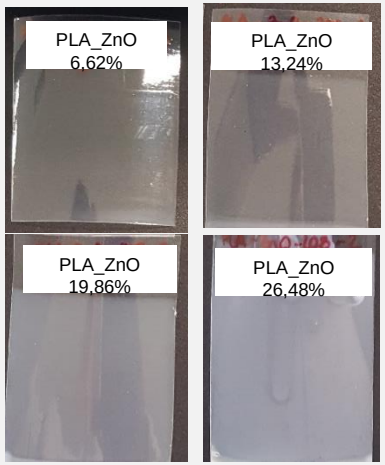
BARRIER TO WATER AND OXYGEN

- Biobased formulations, biodegradable with nanoclays on PLA or PLA nanoclays substrates
- Coatings with good adhesión and transparency
- Applications with rollers and gravure printing
- Coatings characterization of PLA with nanoclays:
  - Reduction 95 % OTR
  - Reduction 15% WVTR

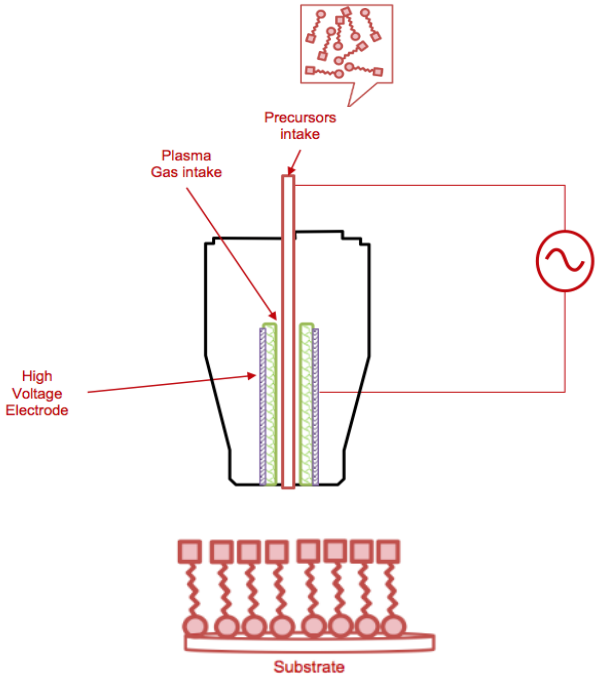
UV BARRIER

- Solgel Coatings with % ZnO
- Deep coating Applications with spray (for films and finished trays)
- Scalable UV barrier





PACKAGING WITH ANTIMICROBIAL PROPERTIES



Inmobilization by plasma of lipopeptides in the packaging

To generate antimicrobial surfaces linking lipopeptides by **Cold Atmospheric Plasma**

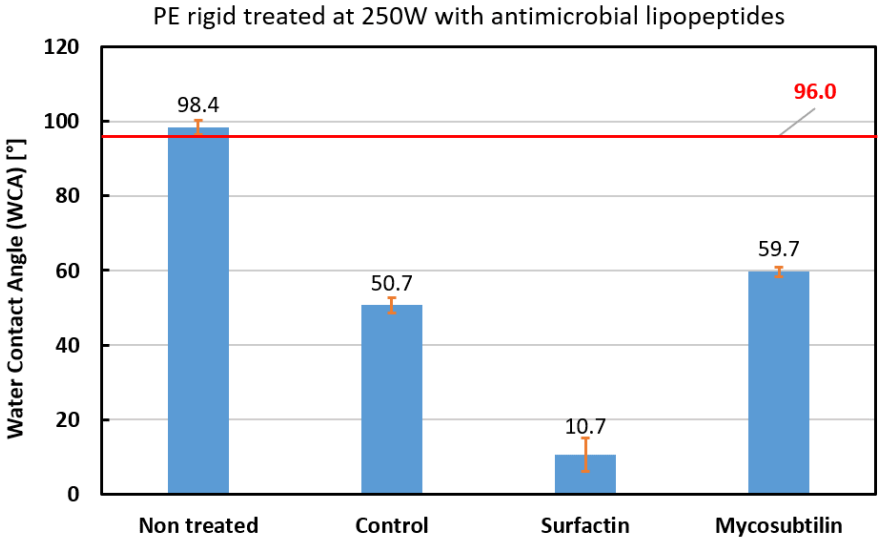
The plasma is generated by means of the use of specific precursors:

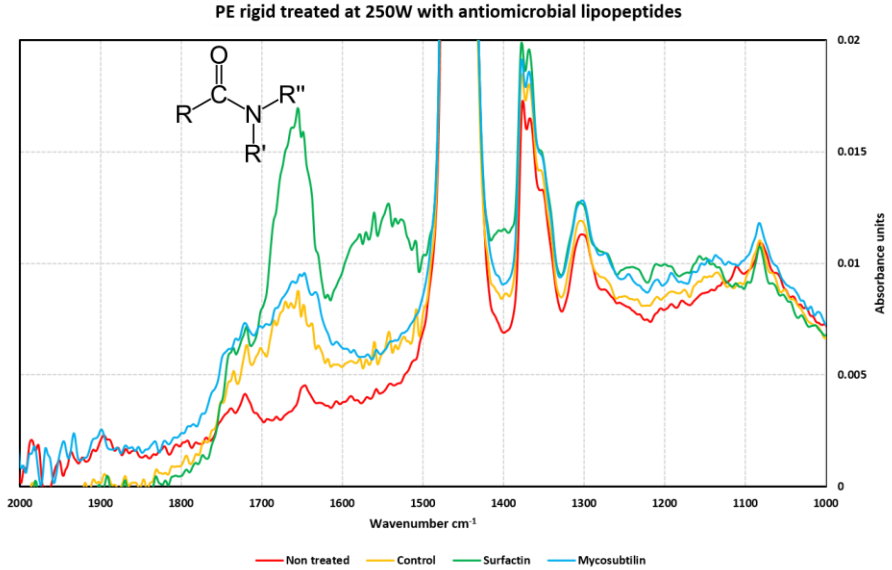
- A specific gas (N_2, Ar, He)
- Precursors able to link chemically to the surface

CHEMICALS		
SURFACTIN	MICROSUBTILIN	NISIN
Biosurfactant Antibiofilm Antiviral	Biosurfactant Antifungi	Antibacterial properties E234

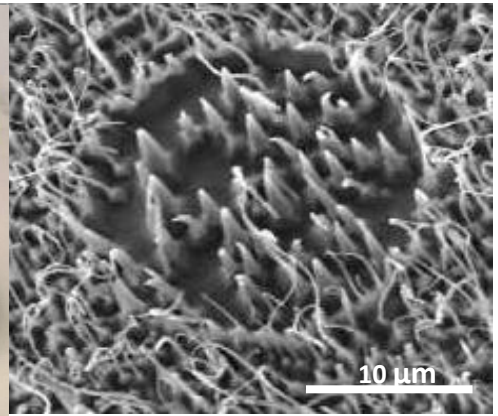
Surface characterization

- Change in the surface tension measured by contact angle
- Detection of functional groups (FTIR)
- Detection of the antimicrobial properties (Antibacterial tests, antifungi)

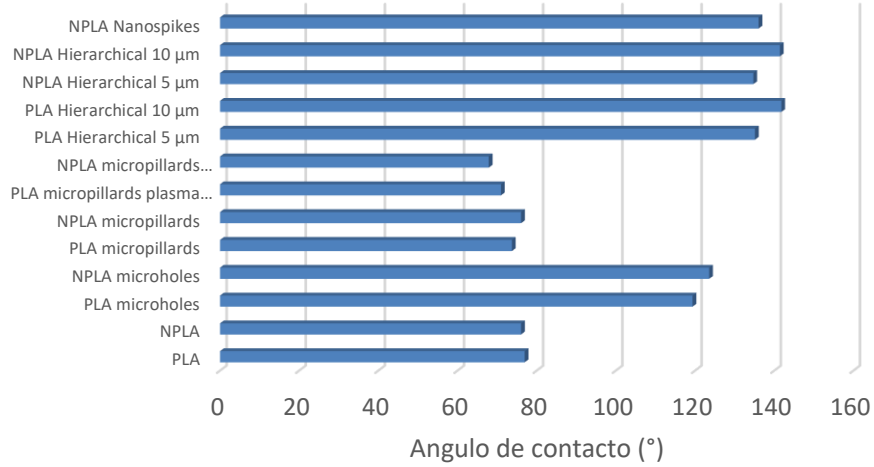




Topographies with superhydrophobic properties

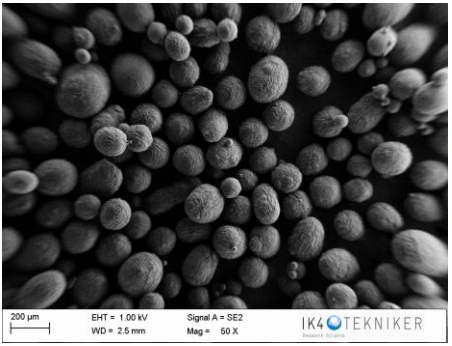


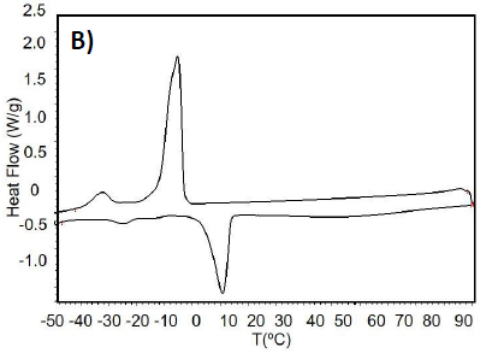
Replication of micro and nanostructures in flexible film to confer added properties to the polymers. The adhesión and proliferation of the bacteria decreases.

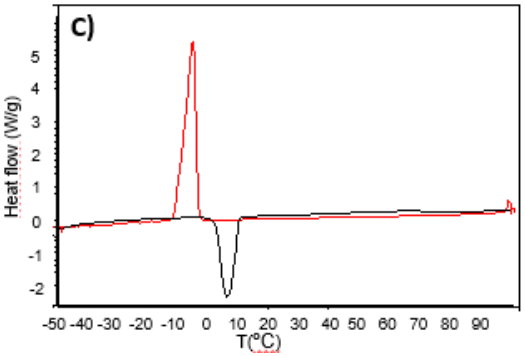


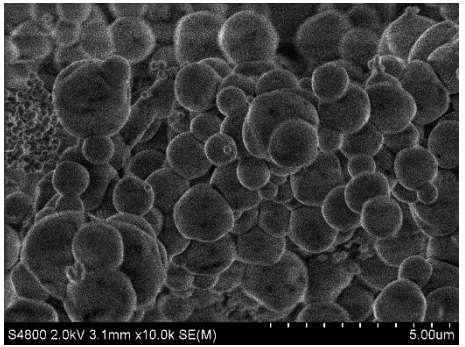
THERMOREGULATION
Encapsulation of phase change materials

- ✓ **To keep the cold chain (-5 a 10ºC) from the supermarket to home**
- ✓ **Using phase change materials (PCMs): Vegetable oils**
  These substances can absorb heat to change the phase from solid to liquid, in a certain range of temperature, keeping constant the temperature
- ✓ **Micro encapsulation of the PCMs to be embedded in the packaging**









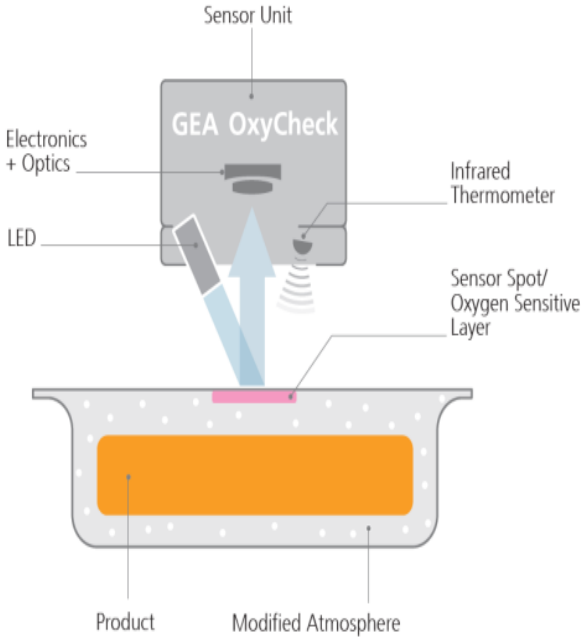
Organic encapsulation

ΔH_m(J/g)	T_m (°C)	ΔH_c(J/g)	T_c (°C)
-77	10	75	-8

Inorganic encapsulation

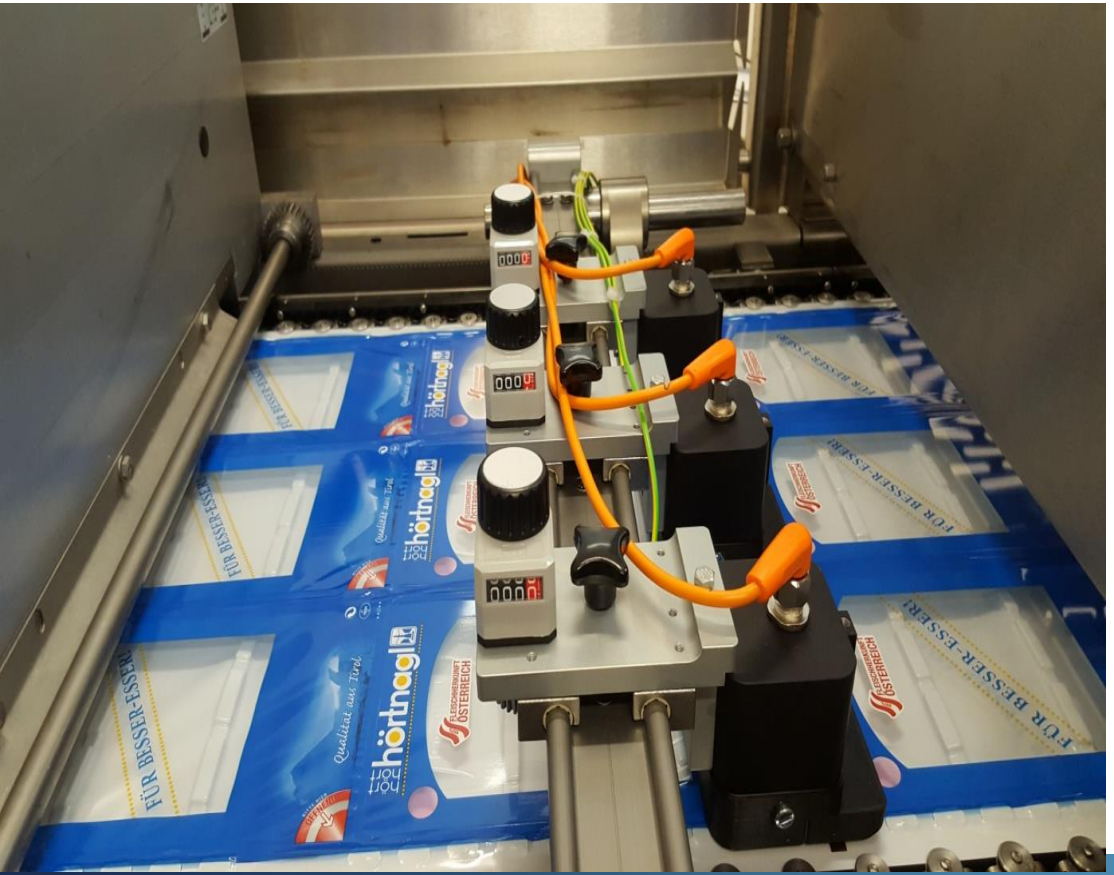
ΔH_m(J/g)	T_m (°C)	ΔH_c(J/g)	T_c (°C)
-142	8	137	-8

SENSOR de O_2 - Optomechanical



1. The **sensor** inside the packaging **absorb LED light.**
2. It is **detected** with a **wavelength that emits the sensor**. This change in function of the concentration of the oxygen inside the MAP packaging and this principle is used **to evaluate the concentration of the O_2 in the packaging.**

SENSORS: O_2, Volátil amines and CO_2



Non destructive control system, aplicable to control the 100% of the packages in line.

It is possible to avoid thrown away food packaging

The packaging with controlled atmosphere (MAP) measure <0,5% O_2

New: CO_2 sensors (trials in the GEA machine on going) and volátil amines (manual application) are developed at prototype scale.

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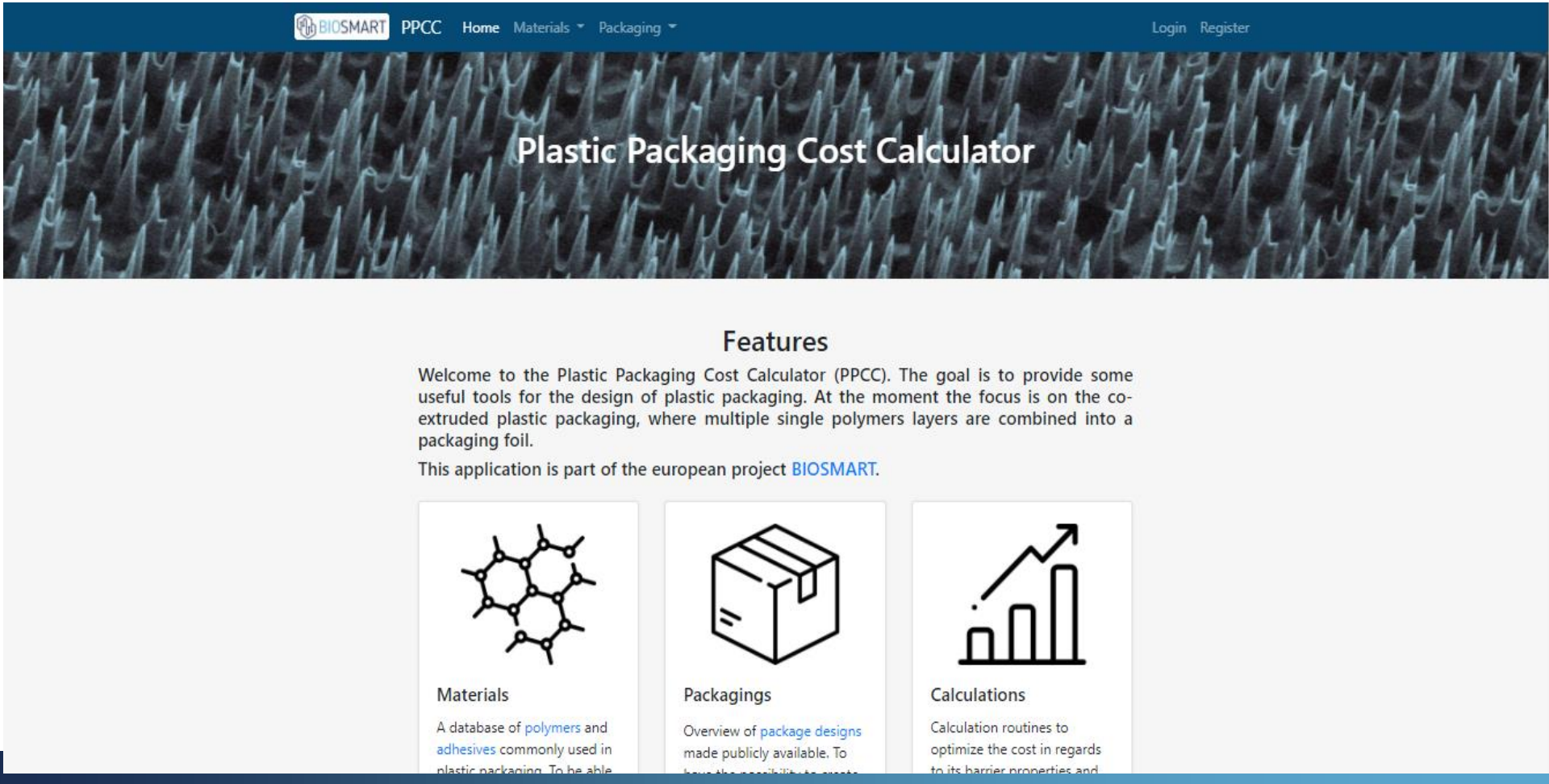
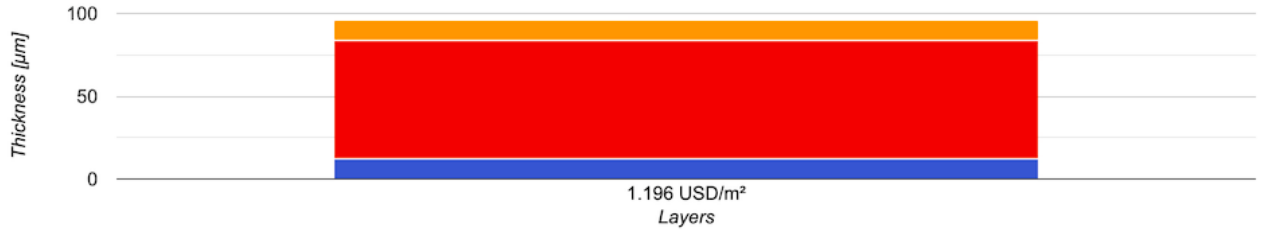
OPEN BETA VERSION: https://ppcc.picc.center/



SIMULATION OF Barrier Properties - App

Packaging Details | Compare to... | Gas Prediction | Help

Composition



Package Properties

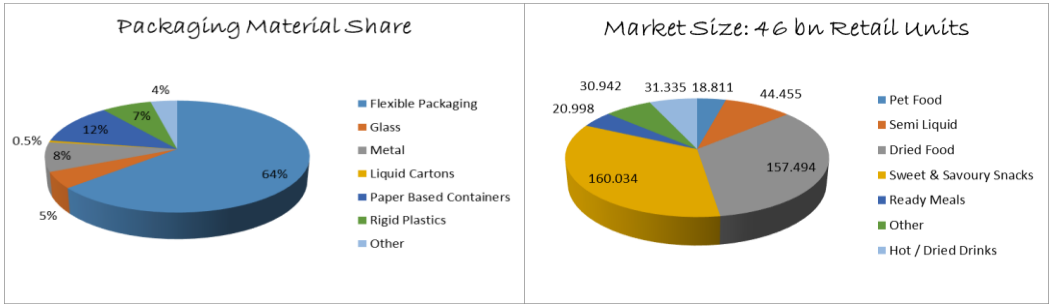
Currency: USD

Name	Thickness μm	Layers Number	Transmission Rates			Cost $\frac{USD}{m^2}$	Public	Actions
			Oxygen $\frac{cm^3*\mu m}{m^2*day*atm}$	Nitrogen $\frac{cm^3*\mu m}{m^2*day*atm}$	Water Vapor $\frac{g*\mu m}{m^2*day}$			
Packaging - Flex	96	3	1	0	2	1.196	Yes	

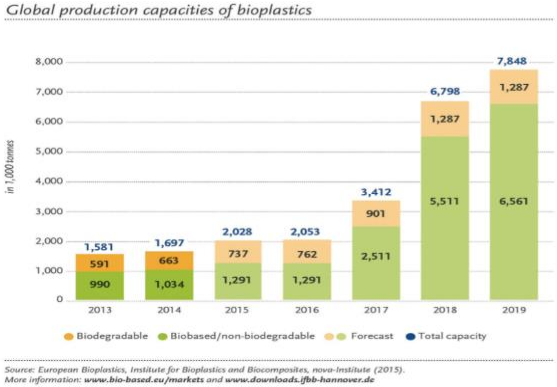
CONCLUSIONS

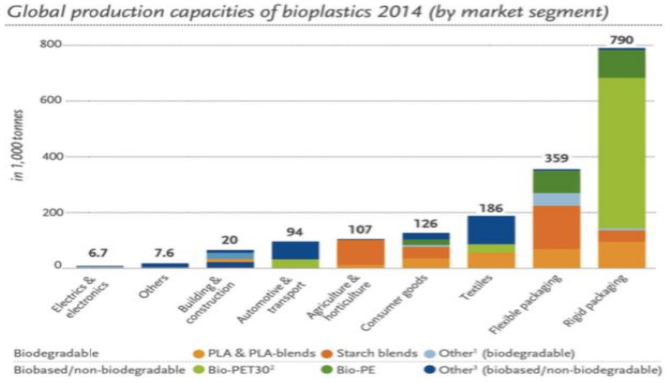
1. Different tecnologies are being **developed to give functionalities to the biobased packaging** to increase food shelf life inside the packaging:
    - **Copolymers** based in biomass
    - **Lipopeptides** with antifungal properties
    - **Textured surfaces** with superhydrophobic properties
    - **Barrier Coatings** (oxygen, water, UV)
    - **Thermoregulation**
    - **Gas sensors**
    - **App** to analyse the cost to introduce technologies in the market in the right moment.
2. **Preparation of functional prototypes** and scale up the most developed technologies.
3. To evaluate the **consumer point of view** of the packaging.

The Market size



*Representative example of the **processed food market** consisting of more than **46 billion retail units** representing **3.1 million tonnes** of plastics use (http://www.crugroup.com)*





*Global production capacity of **"bioplastics"** by market segments (showing importance of rigid and flexible packaging). Data (2014, **1,7MT)** are projected forward with a significant growth capacity (http://bio-based.eu)*

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BBI JU

Bio-based Industries Consortium

Horizon 2020 European Union Funding for Research & Innovation

BIOSMART

BIOMATERIALS FOR SMART FOOD PACKAGING

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Consejo asesor

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