Nestlé Good food, Good life

Sustainable Packaging @ Nestlé

Dr. Nico Galaffu, May 2025

Food Packaging

Research and Development

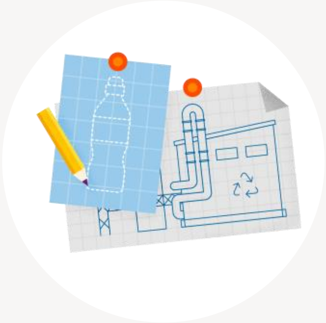
Nestlé’s Vision for Packaging Sustainability

NONE OF OUR PACKAGING ENDS UP IN LANDFILL OR AS LITTER

Our commitments for 2025

REDUCE

our use of **virgin plastics** by a third



DESIGN

more than 95% of our plastic packaging for recycling, while working toward 100% recyclable or reusable

ENGAGE

in the development of collection, sorting & recycling systems where we operate

Toward Zero Carbon Emission by 2050

Sustainability includes Ingredients, Manufacturing and Packaging

Product emissions from farm to fork

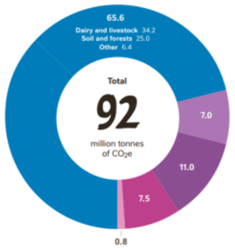
UPSTREAM		DOWNSTREAM
Suppliers to Nestlé	**Nestlé operations**	**Customers, consumers and end of life**

Agriculture	**Raw material suppliers**	**Manufacturing**	**Packaging**	**Logistics**	**Retail and business channels**	**Consumers**	**End of life**
Sourcing high-quality ingredients from suppliers, co-operatives and direct from farmers.	Sourcing materials and ingredients and transporting them to Nestlé.	Making products.	Packaging our manufactured products.	Storing and delivering our products around the world.	Offering and selling products to shoppers in stores.	Our consumers enjoying Nestlé's products wherever they are.	For products and packaging.

Nestlé's in-scope GHG emissions by operation (92 out of 113)
million tonnes of CO_2e, in 2018

Scope 3		
Sourcing our ingredients	65.6	71.4%
Scope 1, 2 & 3		
Manufacturing our products	7.0	7.7%
Scope 3		
Packaging our products	11.0	11.9%
Scope 3		
Managing logistics	7.5	8.2%
Scope 3		
Travel and employee commuting	0.8	0.8%

Figures have been rounded.



Sourcing our ingredients 71.4 %

Packaging our products 11.9 %

Manufacturing our products 7.7 %

Research and Development

Our packaging sustainability

FIVE PILLAR STRATEGY

Nestlé's five pillar strategy helps us on our journey to our long-term vision: that **none of our packaging** ends up in **landfill or as litter**.

LESS PACKAGING		BETTER PACKAGING	BETTER SYSTEM	
				
1	2	3	4	5
REDUCE	**REUSE & REFILL**	**REDESIGN**	**RECYCLE**	**RETHINK BEHAVIORS**
Reducing our use of **plastic packaging material** in general, and **virgin plastics** in particular	Scaling **Reusable and Refillable** systems to eliminate the need for **disposable packaging**	Pioneering **alternative packaging materials** to facilitate recycling	Supporting **infrastructure** that helps to shape a **waste-free future**	Rethinking behaviors of **Nestlé, retail partners** and **consumers**

Research and Development

① REDUCE

Reducing our use of packaging material

Packaging sustainability
FIVE PILLAR STRATEGY:
LESS PACKAGING

REDUCING PACKAGING COMPLEXITY

- Removing unnecessary plastic lids
- Eliminating plastic accessories
- Eliminating unnecessary plastic layers and films

INCREASING USE OF RECYCLED CONTENT

- Shrink films made of recycled material
- Recycled paper for non-food contact
- Bottles made from up to 100% recycled PET

② REUSE & REFILL

Scaling different models of packaging-free delivery systems

- Reusable containers
- Refill systems
- Single-dose dispensers
- In-store dispensers
- Bulk Home Refill Options

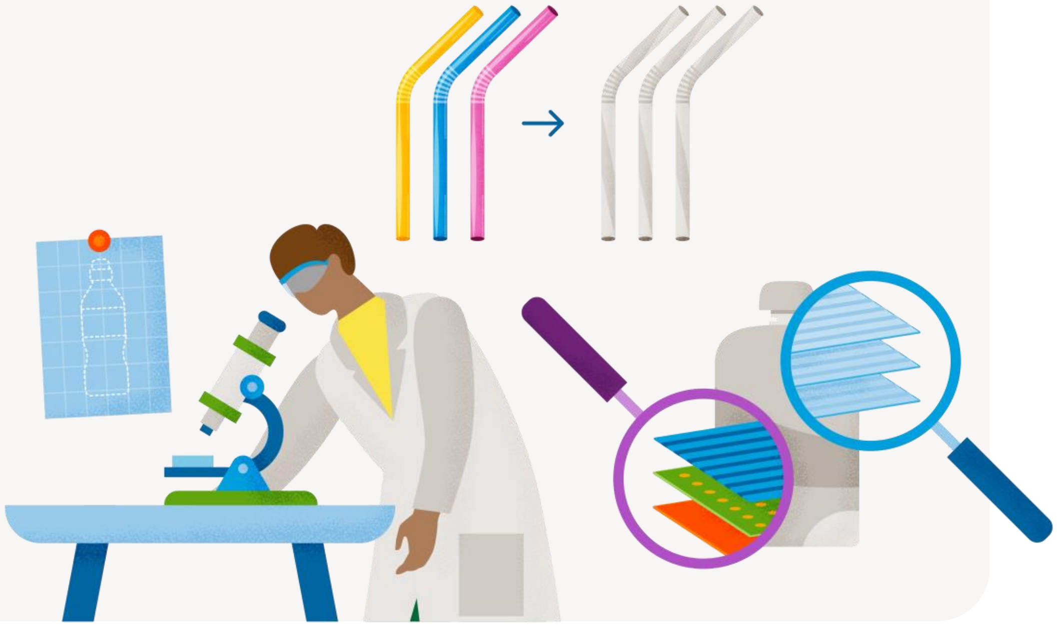
Research and Development

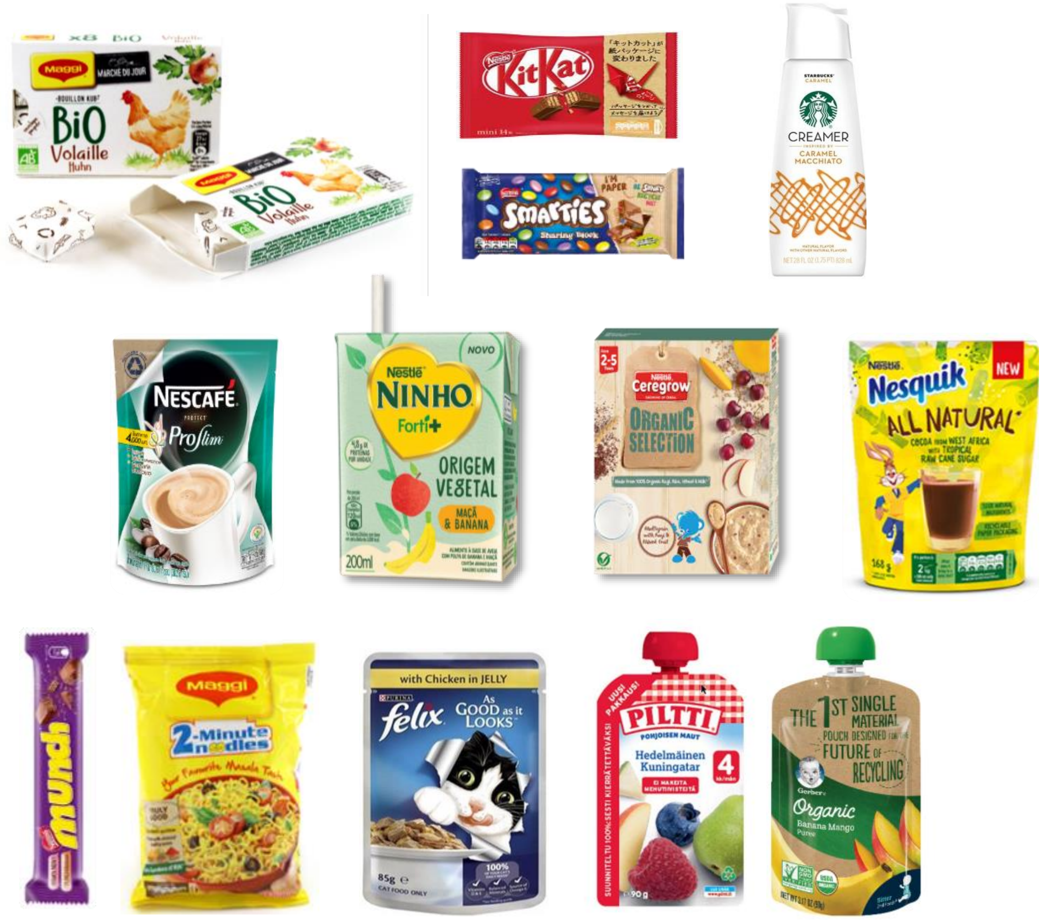
3 REDESIGN

Pioneering alternative materials to facilitate recycling

Packaging sustainability
FIVE PILLAR STRATEGY:
BETTER PACKAGING

Finding opportunities for paperization and the transition to mono-material polymers





3 REDESIGN

Pioneering alternative packaging materials

PACKAGING PAPERIZATION

- Replacing plastic with paper
- Creating packaging fit for local waste infrastructure
- Innovating for protection in hot and humid climates

COMPOSTABLE COFFEE CAPSULES

- Pioneering compostable paper-based coffee capsules
- Designed for municipal composting infrastructure
- Collaborating to create new supplier partnerships,
  paper technologies and manufacturing processes

Nestlé Institute of Packaging Science

- **40 scientists** conducting cutting edge research for **safety and performance** of new materials
- Redesigning multi-material to mono-material, high-performance paper barriers and recycled content
- Part of a larger ecosystem of our **global R&D network**

4 RECYCLE

Supporting infrastructure shaping a waste-free future

FOOD-GRADE RECYCLED PLASTIC MARKETS

- Venture fund supporting start-ups (~CHF 250 m)
- Creating markets with CHF 1.5 bn committed for food-grade recycled plastic purchasing
- Exploring opportunities for investment in innovation

PARTNERSHIPS IN INFRASTRUCTURE

- Engaging in over 215 waste collection, sorting, recycling and education projects and activities globally
- Supporting development of recycled plastics supply chain, driving local employment and workplace safety

Packaging sustainability
FIVE PILLAR STRATEGY:
BETTER SYSTEM

5 RETHINK BEHAVIORS

Rethinking behaviors in our operations, with partners and consumers

EMPLOYEE TRAINING ON PACKAGING SUSTAINABILITY

- Rolling out a sustainable packaging education and training program to over 290'000 employees
- Accelerating behavior change and helping the company meet its packaging objectives

DRIVING CONSUMER RECYCLING BEHAVIORS

- Products designed to engage consumers in recycling and reuse
- Collection points and mail in bags in multiple markets (Retail sites, Nespresso)

Research and Development

Our packaging sustainability journey

We are accelerating our actions on plastic waste and are committed to making a difference everywhere we operate. We are making progress and there is more to come.

2019

- Inaugurated **Nestlé Institute of Packaging Sciences** – a unique centre of R&D expertise

2020

- Committed **to reduce virgin plastic use by 1/3 by 2025**
- Published **Net Zero Emissions** roadmap

2021

- **Supporting waste collection programs,** like Project STOP
- Transitioned Smarties to **paper packaging globally**
- **Phased out** 4.7 billon plastic straws annually

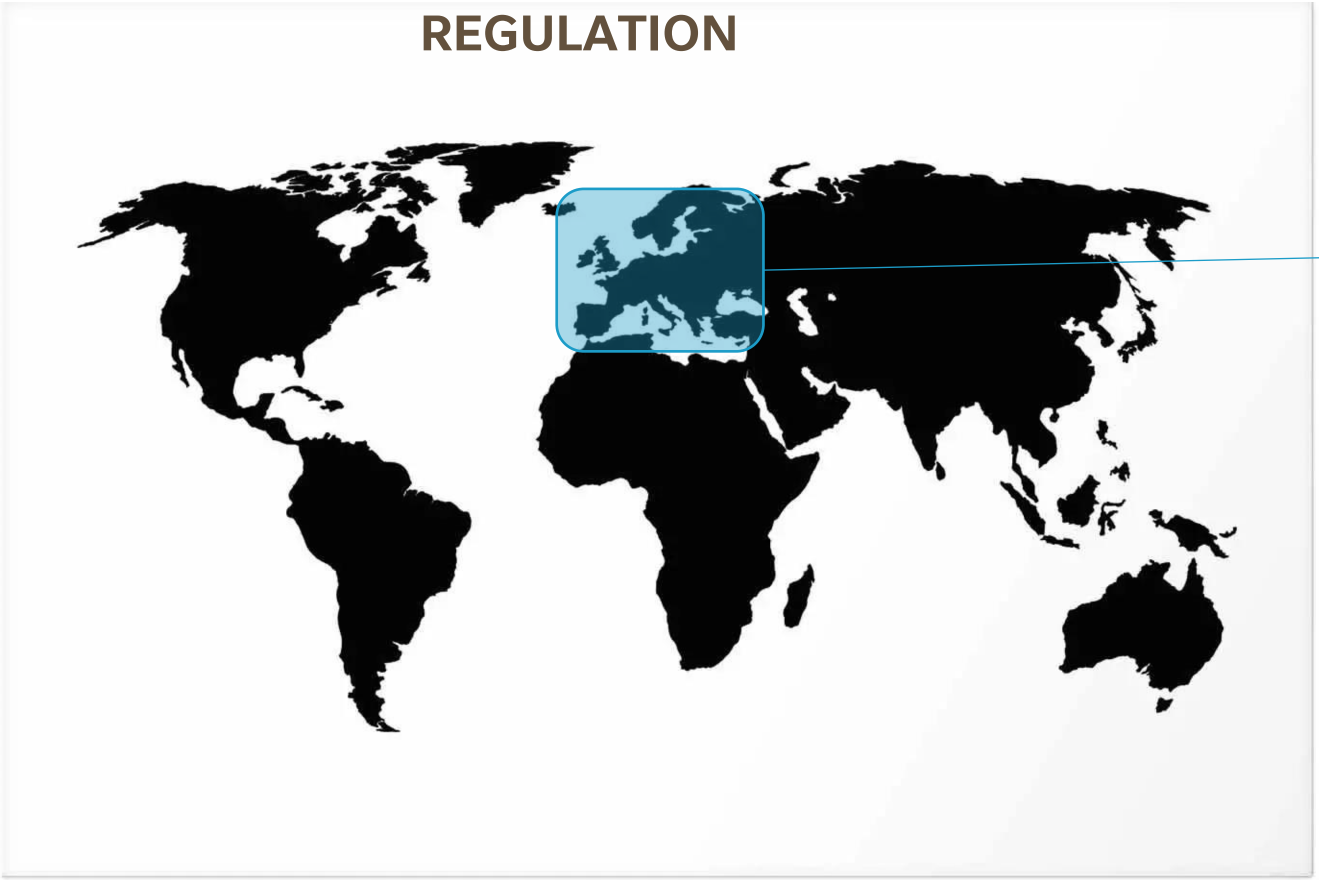
2022

- Conducted **20 Reuse pilots in 12 countries**
- Launched the **Fair Circularity Initiative** driving fair partnerships with wastepickers

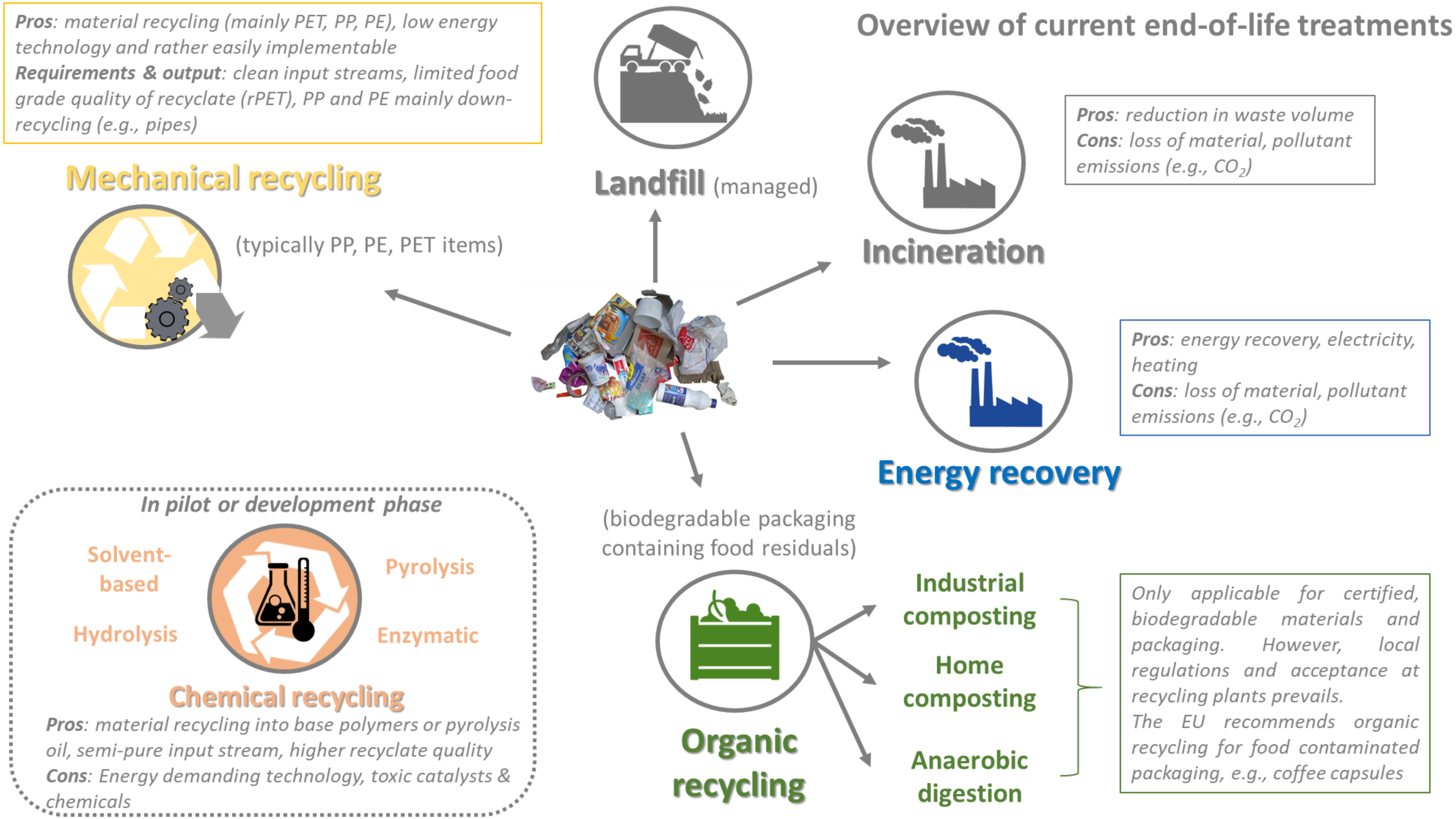
2023

- **Supporting 215 packaging waste collection activities** driving packaging neutrality

Packaging Regulatory



Packaging – Today's EOL treatment of packaging waste



Packaging and Packaging Waste Regulation (PPWR) – Europe 2024

Requirements

- **Minimization of packaging weight and volume** e.g., no double walls, false bottoms, and unnecessary layers, empty space ratio minimization for grouped, transport or e-commerce packaging up to max 40%.

- **Packaging format bans**:
  - Single use packaging in HORECA channel, e.g. individual portions.
  - No single use plastic grouped packaging in retail channel, e.g. plastic grouped packaging for bottles.

- **Recycled Content per unit** (SKU)
  - Single Use Beverage Bottles
  - Packaging (predominately made of PET)
  - Packaging (made of non-PET plastic)
  - Packaging for non-food/feed applications (exclusion medicinal and some medical devices)

These percentages are also valid for the plastic in paper packaging (paper laminate).

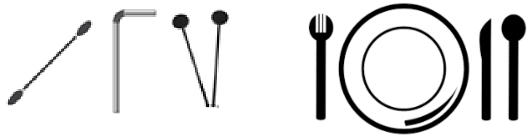
- Design for recycling; **five recyclability performance grades (A-E)**
  - Grade E (< 70%) packaging is considered not recyclable
  - Grade A (> 95%) packaging is considered recyclable

- **Packaging must be recyclable at** scale (sorting, collection and recycling available to at least 75% of population)

- **Composting is mandatory for very few applications** (Coffee Capsules, Fruit labels and Lightweight Bags)

Single Use Plastic Directive. Reg. 2019/914 - EU

items with available sustainable alternatives



→ **Market Bans**

items with no clear alternatives

→ **Prevention Measures** design requirements, consumption reduction, consumer information

→ **Better Waste Management** separate collection extended producer responsibility clean-up

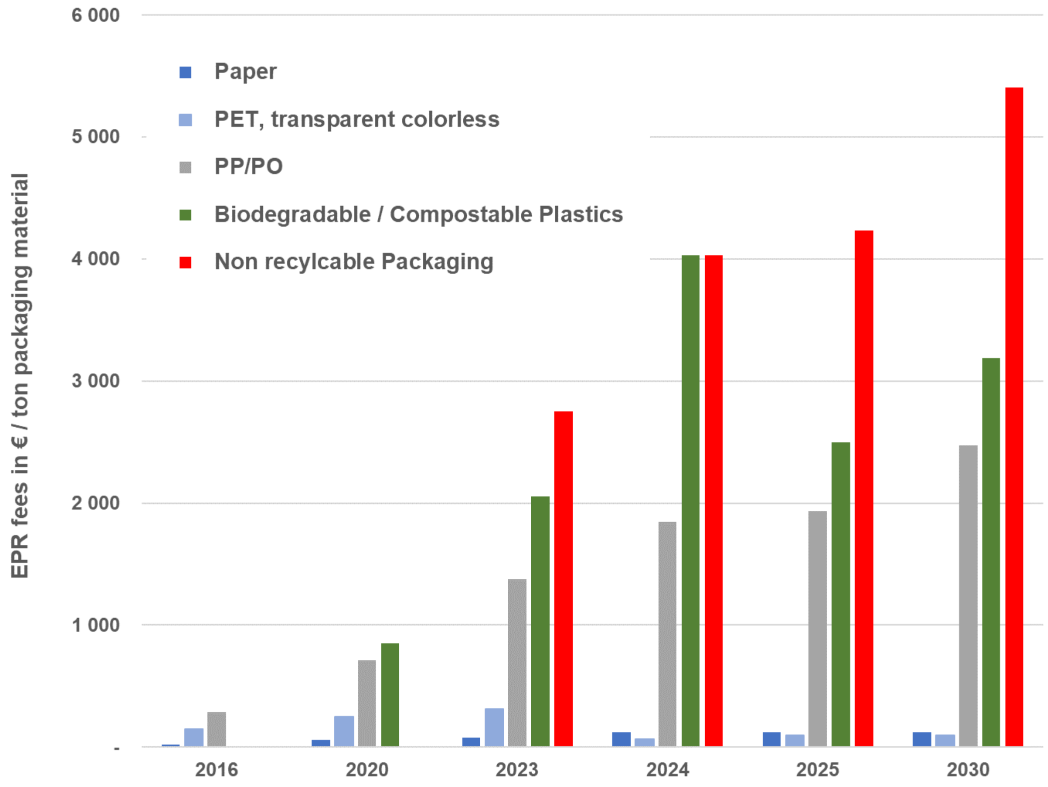
Proposed label on the product to inform consumer on presence of plastic

Research and Development

Single Use Plastic Directive 2019/904 – Europe 2019

Products in scope	SUP Category	Consequences
	Packets, wrappers	Higher EPR fees / Awareness raising*
	Beverage bottles including caps	Tethered caps / higher EPR fees / rContent / Awareness raising*
	Beverage container including caps	Tethered caps / Higher EPR fees / Awareness raising*
	Food container	Higher EPR fees / Consumption reduction** / Awareness raising*
	Cups for beverage	Higher EPR fees / Marking requirement / Consumption reduction**
	Cutlery, plates, straws, stirrers	Ban

EXTENDED PRODUCER RESPONSIBILITY (EPR) FEES OF DIFFERENT PACKAGING MATERIAL FOR BELGIUM, 2023



* Consumption reduction means that the member states should arrive to ban the use.
** Awareness raising means inform the consumer that plastic is in the packaging - no labelling defined yet.

Packaging Technologies

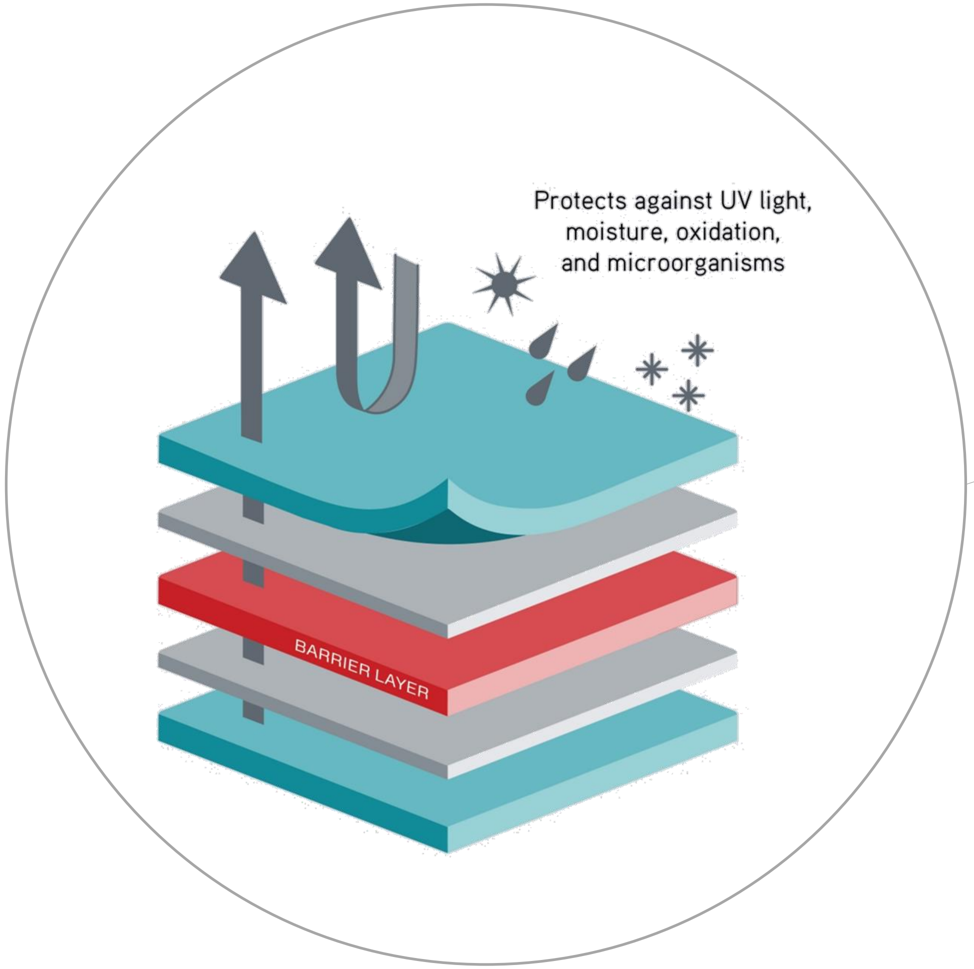
Packaging – FUNDAMENTALS

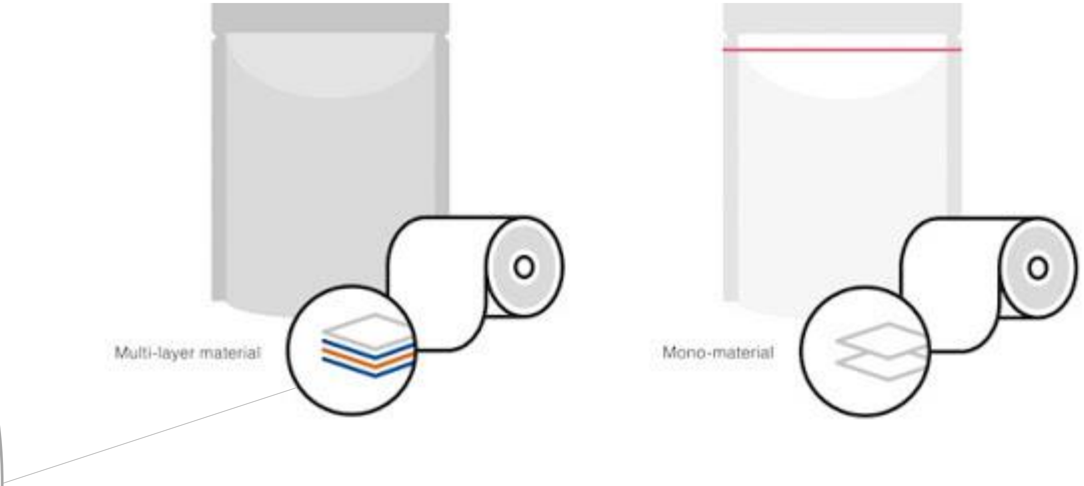
Primary Packaging

Secondary Packaging

Tertiary Packaging

Packaging Barrier Functions





Research and Development

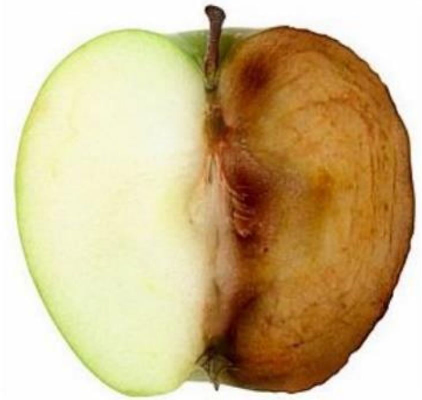
Packaging protects the food from external degradation factors

Most food products are sensitive to external degrading factors

- *Moisture uptake or loss*
- *Oxygen*
- *Light*
- *Temperature*
- *Mechanical stresses*
- *Microbial degradation*

Moisture loss

Caking



Oxidation

Mechanical damage

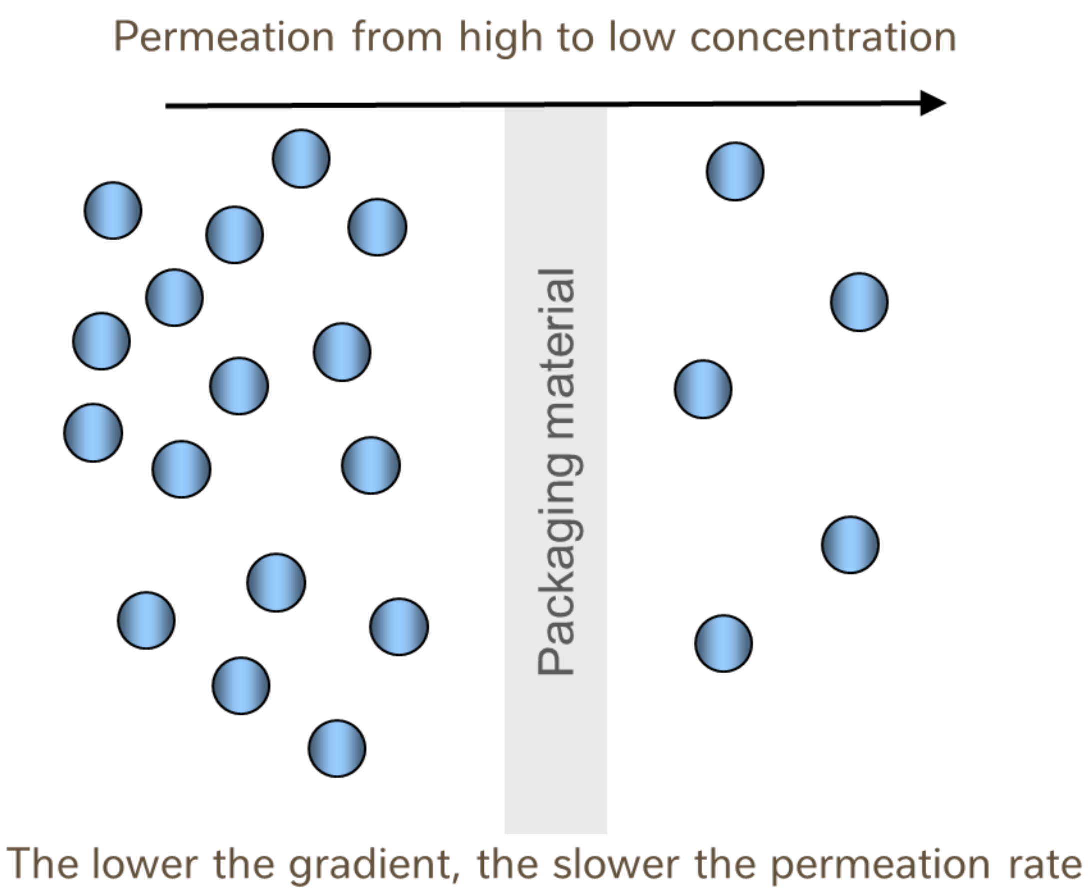
Protect the product: Permeability

- Permeability is defined as a quantity of permeant permeating through a given surface area of material of a given thickness in a given time in specific conditions.

- Oxygen Transmission Rate (OTR)
cc/m2/day/atm

- Water Vapor Transmission Rate (WVTR)
g/m2/day/atm

- Rigid packaging
cc/pack/day/atm and mg/pack/day



Research and Development

How to characterize Permeability

- **High concentration on one side**

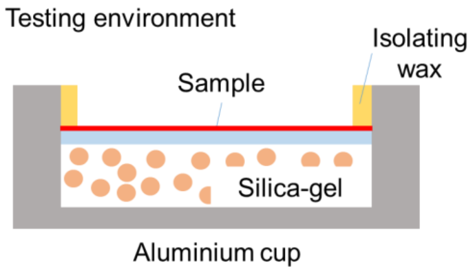
  Air, pure oxygen, moist air

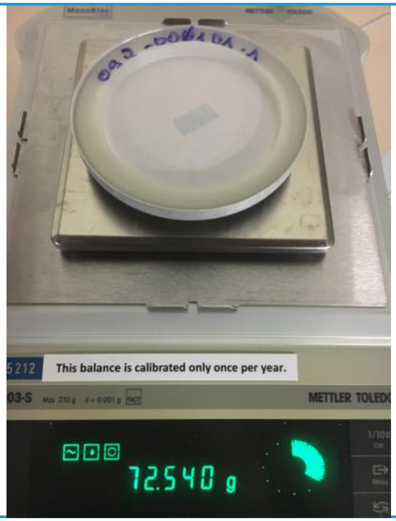
- **Low concentration on the other side**

  Nitrogen, dry air (silica gel)

- The increase of in concentration (or weight) on the low concentration side is monitored and the rate is linked to the permeation

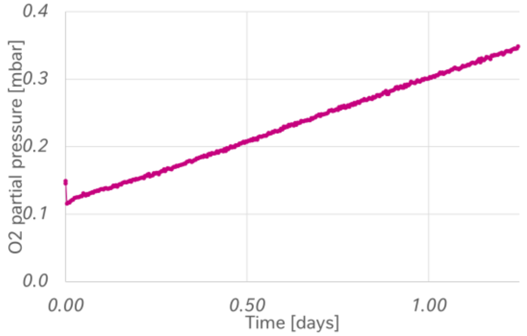
WVTR: gravimetric method

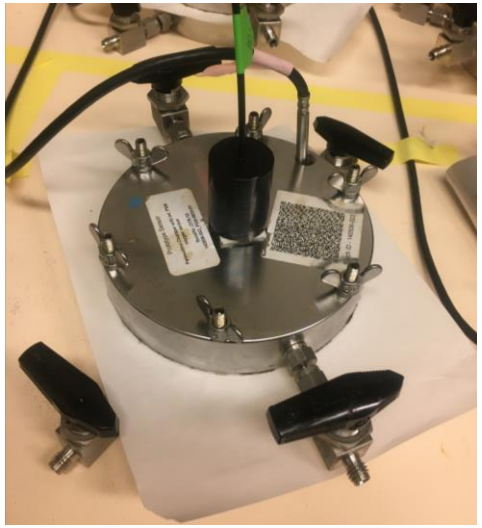




Regular weighing enables Determination of WVTR

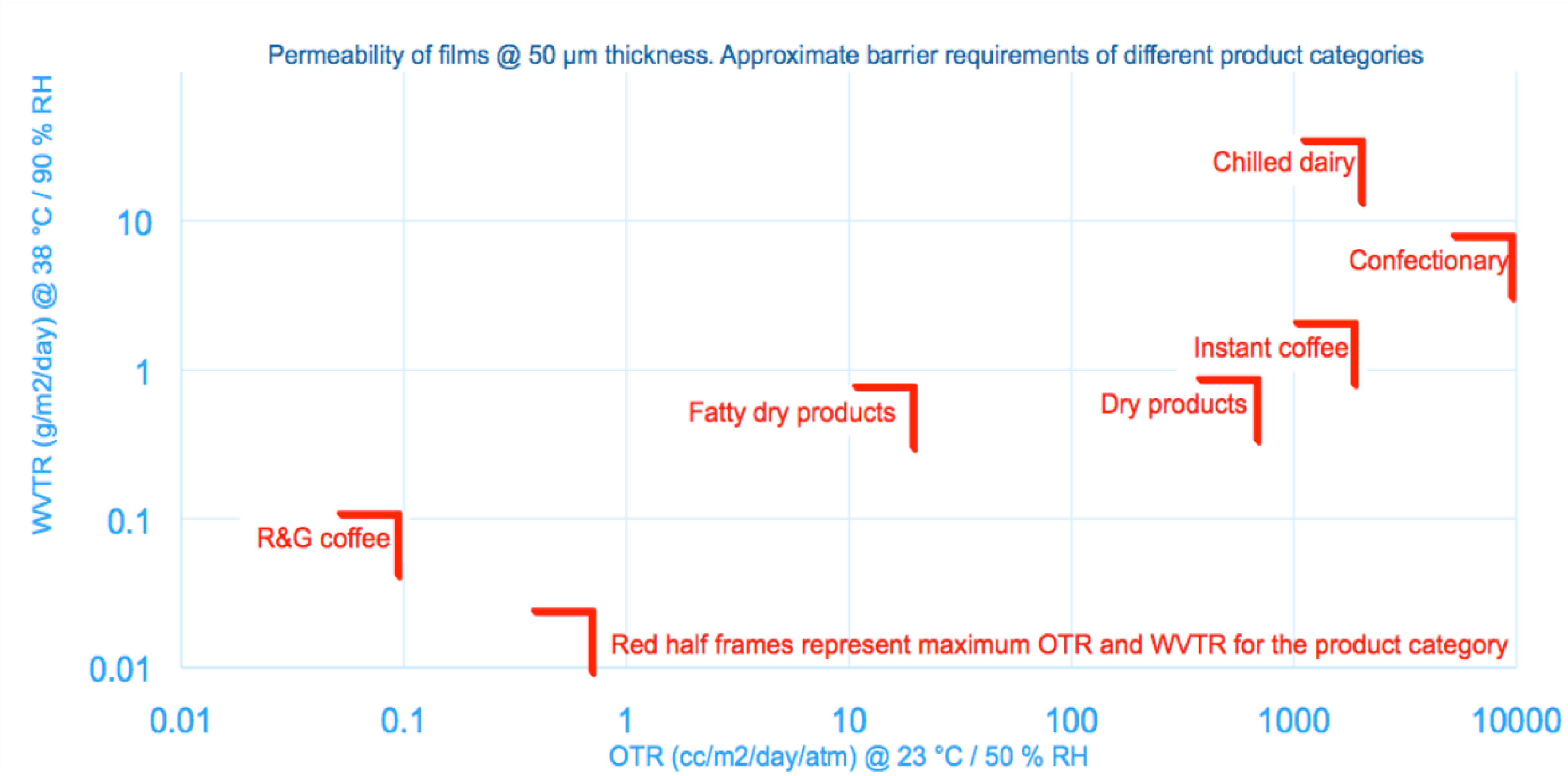
OTR: Fluorescent oxygen sensor





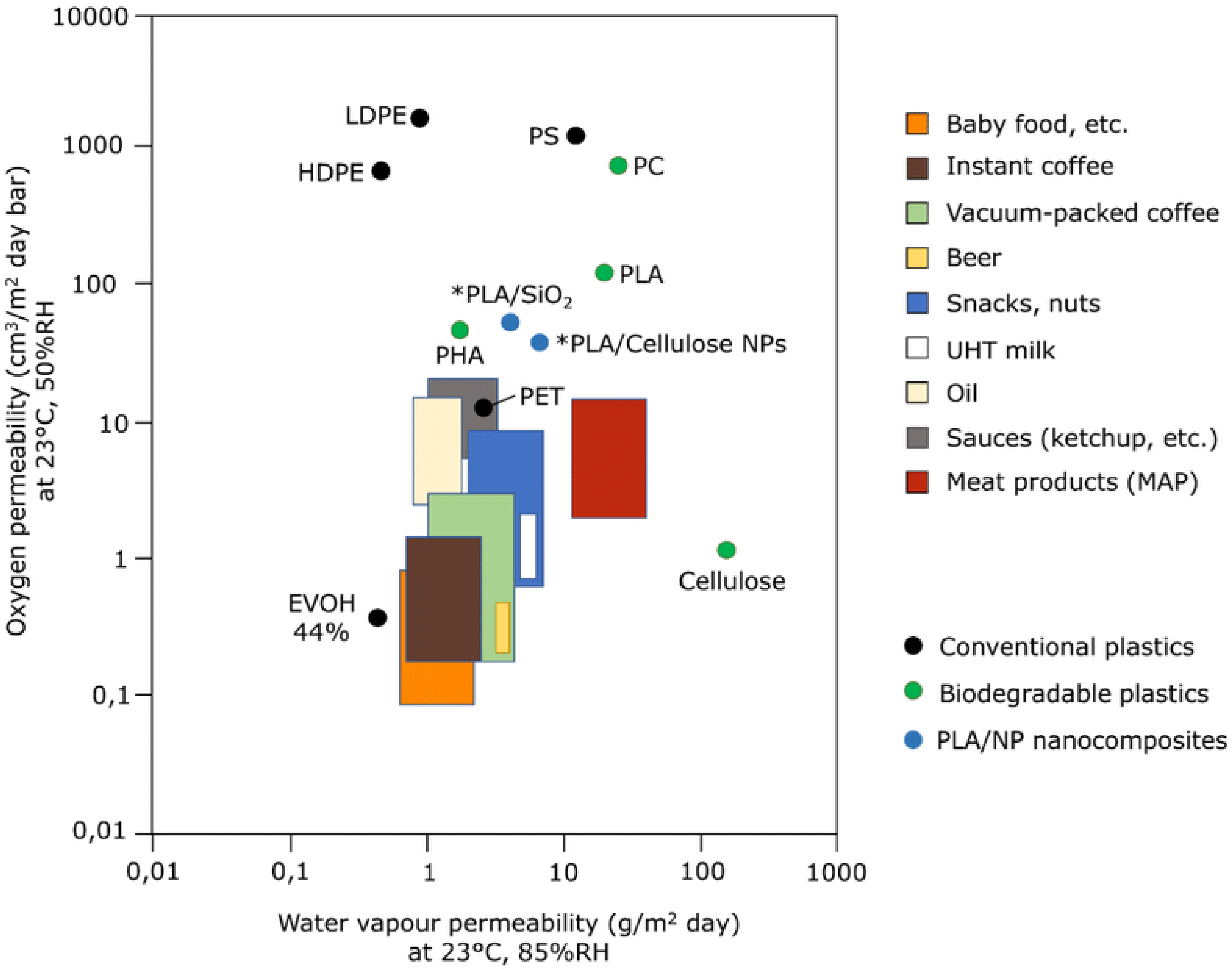
Monitoring oxygen concentration enables determination of OTR

Different products require different levels of protection



Wyser, Y.; Shires, D.: Packaging Technology and Science 2019, 32 (1), pp. 3.

Oxygen versus Water Vapor Permeation rates of Packaging Materials



Yanat, M.; Schröen, K.: Reactive and Functional Polymers, pre-proof.

Research and Development

Food Packaging Materials

Plastic

Paper

Bioplastic

Food Packaging Materials

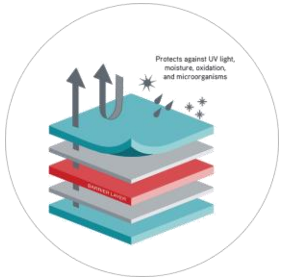
Plastic

Paper

Bioplastic

Research and Development

Food Packaging Materials – Plastic

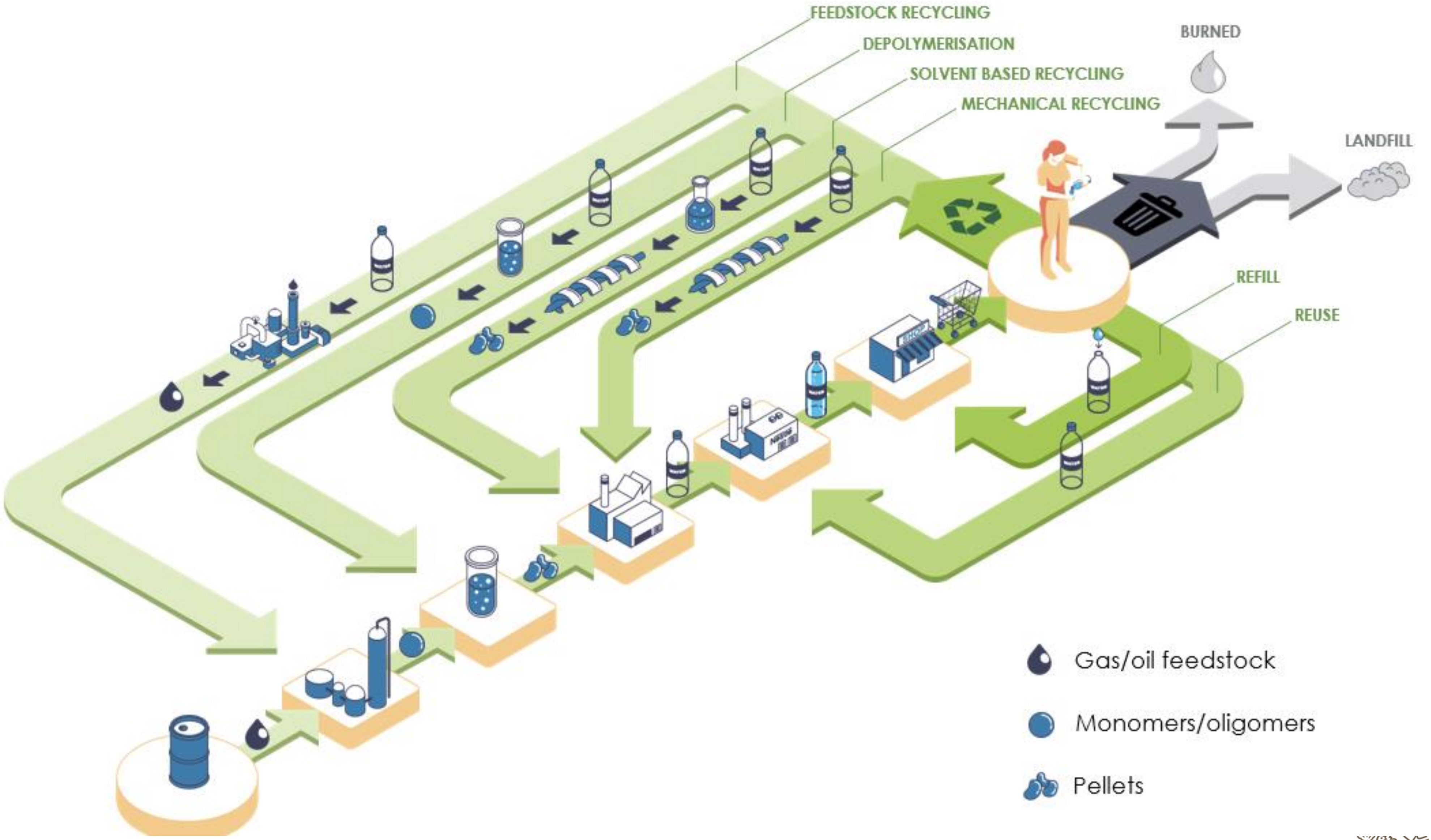


- Remarkably resource efficient
- Widest range of applications
- Widest range of complexity: from simple to high-tech

Mechanical strength
Moisture and O_2 barrier
Hermeticity
Sophisticated shapes
System fit
Pasteurized
Microwavable
Retortable

Increasing complexity

Food Packaging Materials – Plastic aiming for Circularity



Research and Development

Food Packaging Materials

Plastic

Paper

Bioplastic

Research and Development

Paper Based Packaging Materials

OPPORTUNITIES

Widely Recyclable

Paper is the most recycled material globally.

Renewable Source

Fiber for making paper can be sourced from managed forests.

Biodegradable

Paper on its own is biodegradable in home/industrial, marine.

Positive Consumer Perception

Consumers perceive paper-based packaging more sustainable.

CHALLENGES

Barrier Functionality

Paper is highly sensitive to moisture.

Sealability

Lower sealant to carrier ratio.

Machinability

Difficult to process on FFS packaging lines.

Hygro-expansion

Poor restraint to challenging climatic conditions.

Research and Development

Fibre-based packaging types

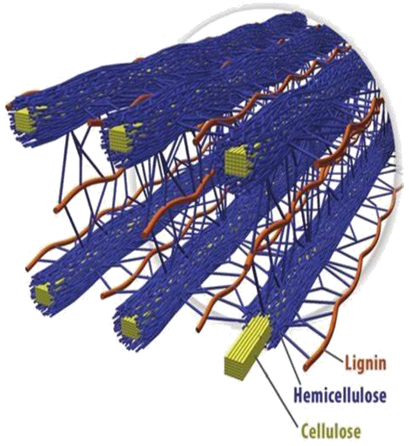
Paper

Paperboard

Molded Pulp

Corrugated Board

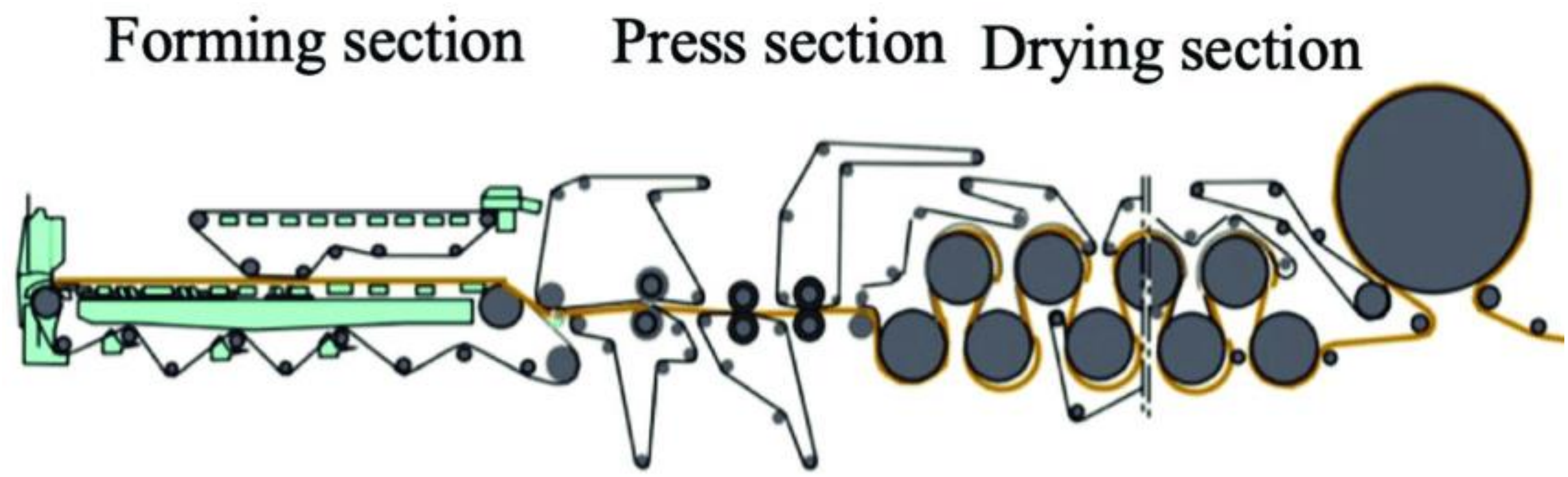
Raw materials for paper-Pulp



Pulp is a lignocellulosic fibrous material prepared by chemically or mechanically separation of fibres from wood, fibre crops or waste paper. Wood pulp is the most common raw material in papermaking

Principle of papermaking

- Papermaking process is largely associated with a removal of water from pulp slurry while ensure correct density, porosity and smoothness of paper
- Paperboard is made in a same way as paper but contains several layers of fibres joined together

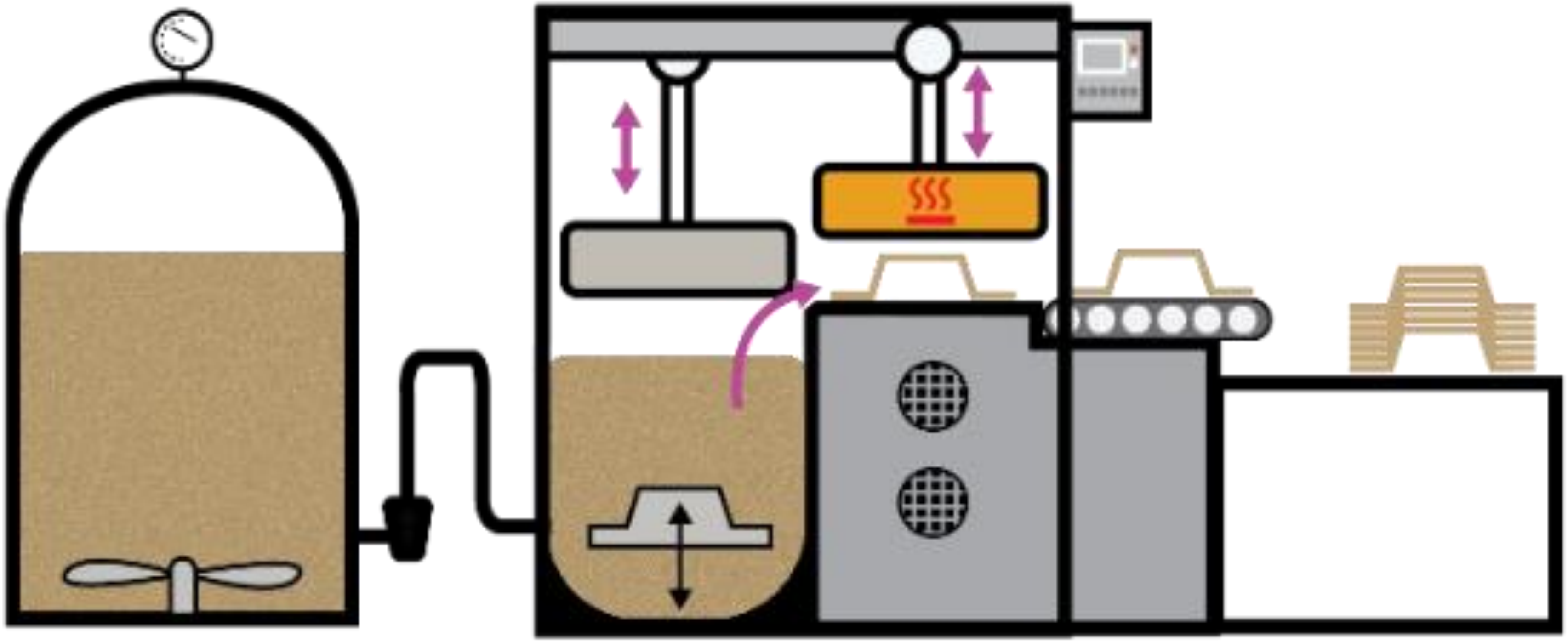


99% 70% 30% 8%

Water Content

Principle of molded pulp

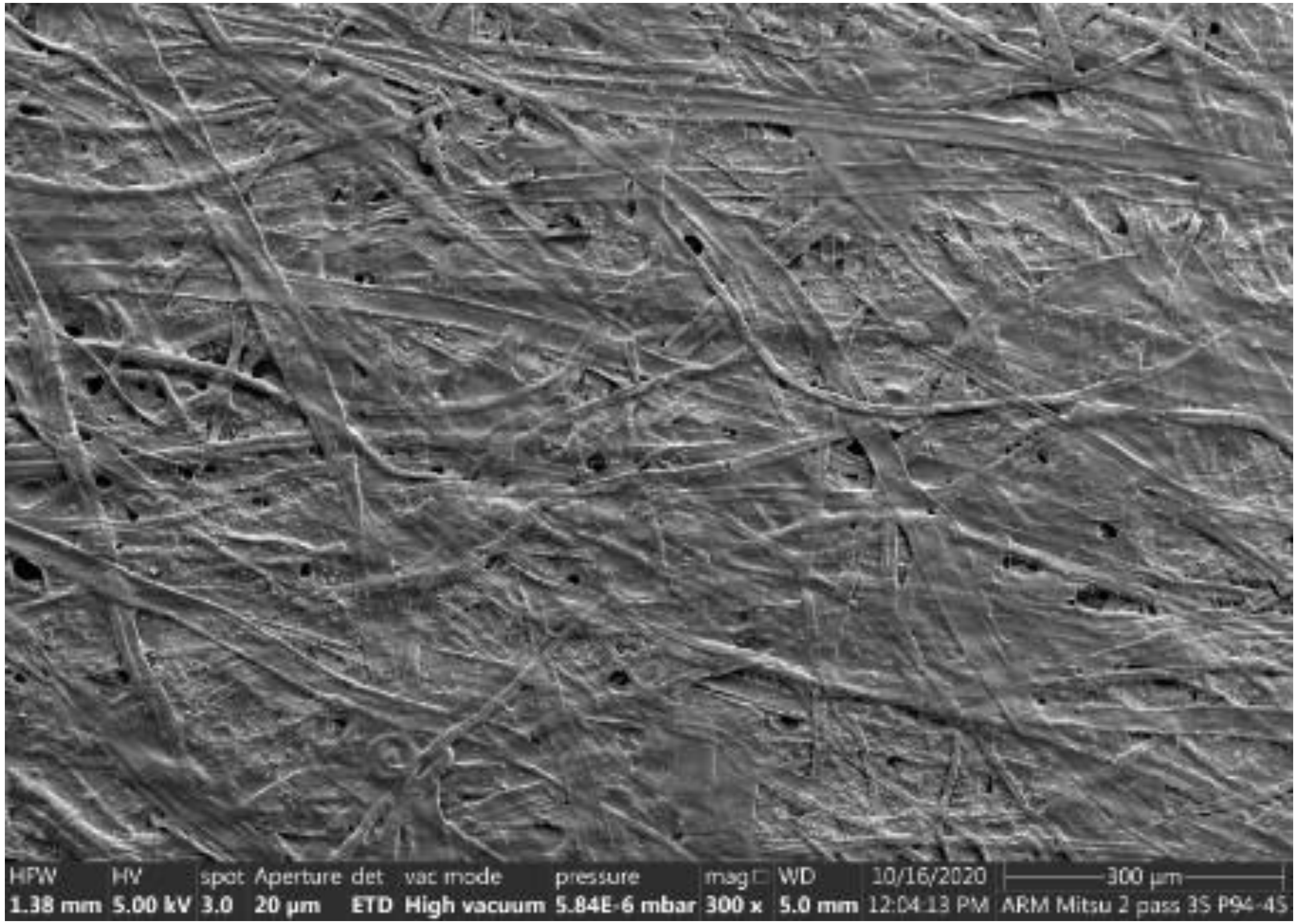
- Unlike paper, molded pulp is dewatered not on flat porous web but on 3D meshed mold which gives a corresponding shape to final product



Research and Development

Paper as packaging material

- Paper is a network of interconnected fibres and not a continuous film
- Paper has no barrier to water vapour, oxygen or grease
- Surface of paper is inhomogeneous and rough
- In order to make paper suitable for Food products we need to build barrier on quite challenging material



Coated paper packaging material

Research and Development

Different paper types

Test liner (Part of”cardboard)

Composition:
98% of recycled pulp

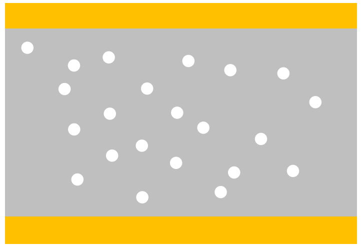
C2S paper (Ikea catalogue)

Composition:
60-70% of chemical and mechanical pulp
30-40% fillers, latex binders, starch

«Barrier Paper»

Composition:
80-90% chemical pulp
10-20% mineral and barrier polymer coating

Office paper



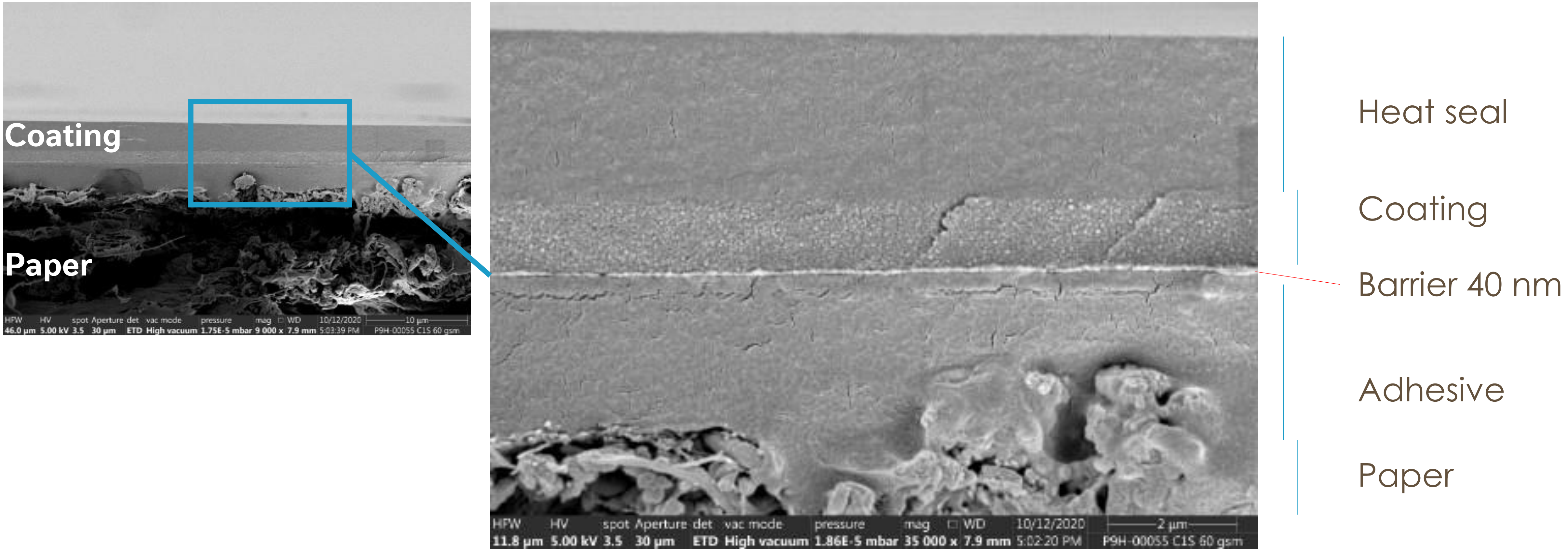
Composition:
70-80% of virgin pulp
30-20% fillers and starch

Baking paper

Composition:
100% virgin pulp cellulose (Chemically modified treated and not recyclable)

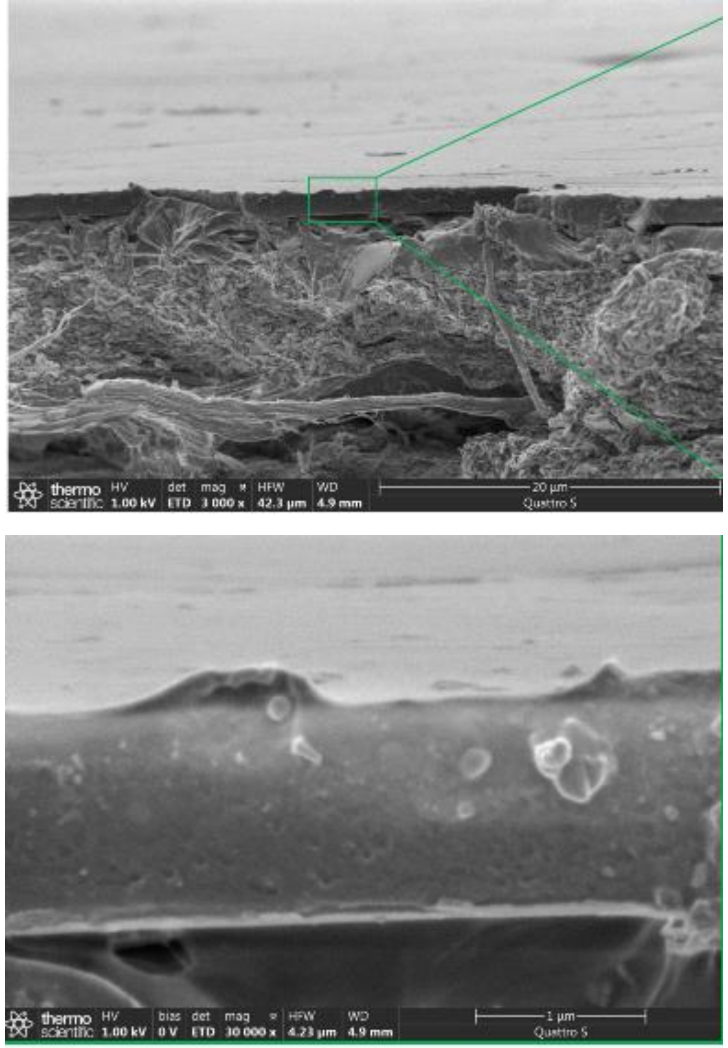
Research and Development

Thin polymeric coatings combined with vacuum deposited inorganic layer to create barrier without harm to fibre recycling



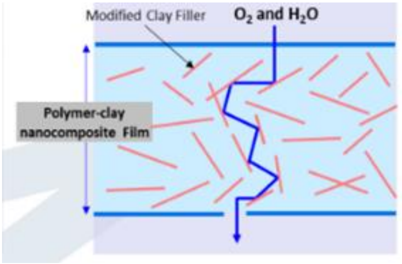
High Barrier Paper

Polymer coating formulation



Ultrathin layers of polymer coatings which can be recycled

Boost performance by increasing barrier functions including fillers



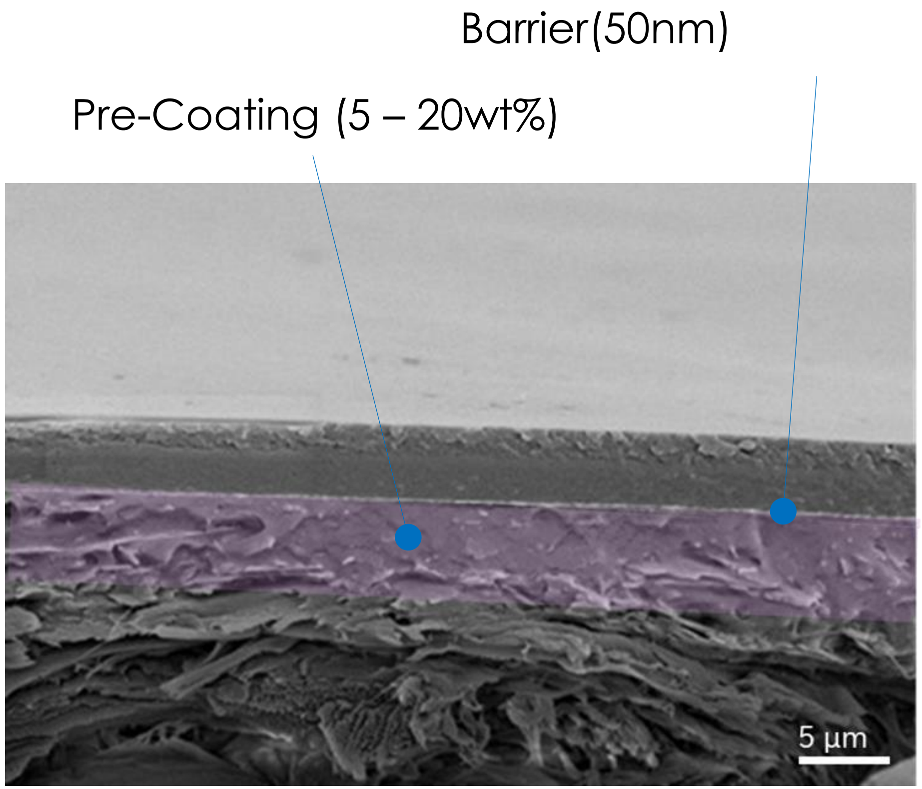
Select right polymer class to ensure resilience
(Impact on ost and performances)

Ensure Barrier Performance

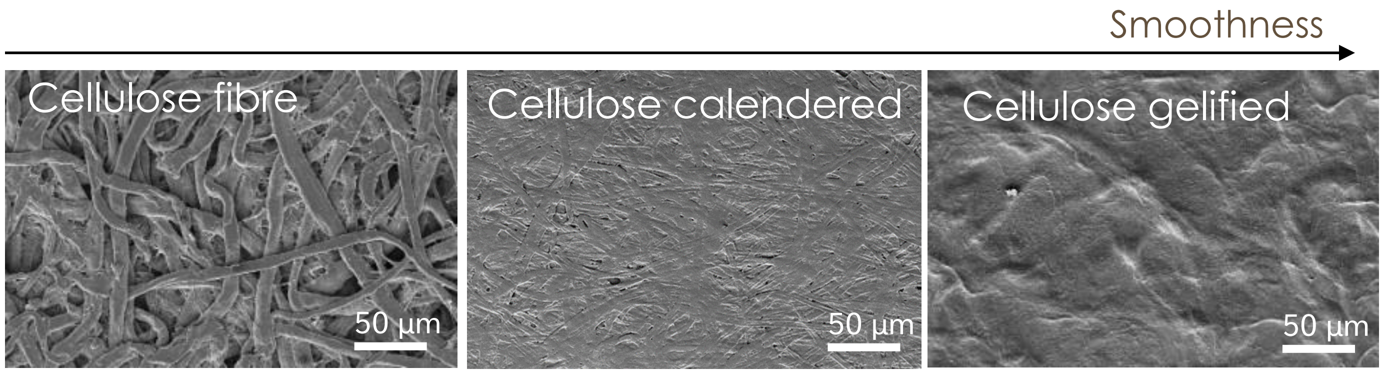
Environmental & Recyclability

Ensure Machinability

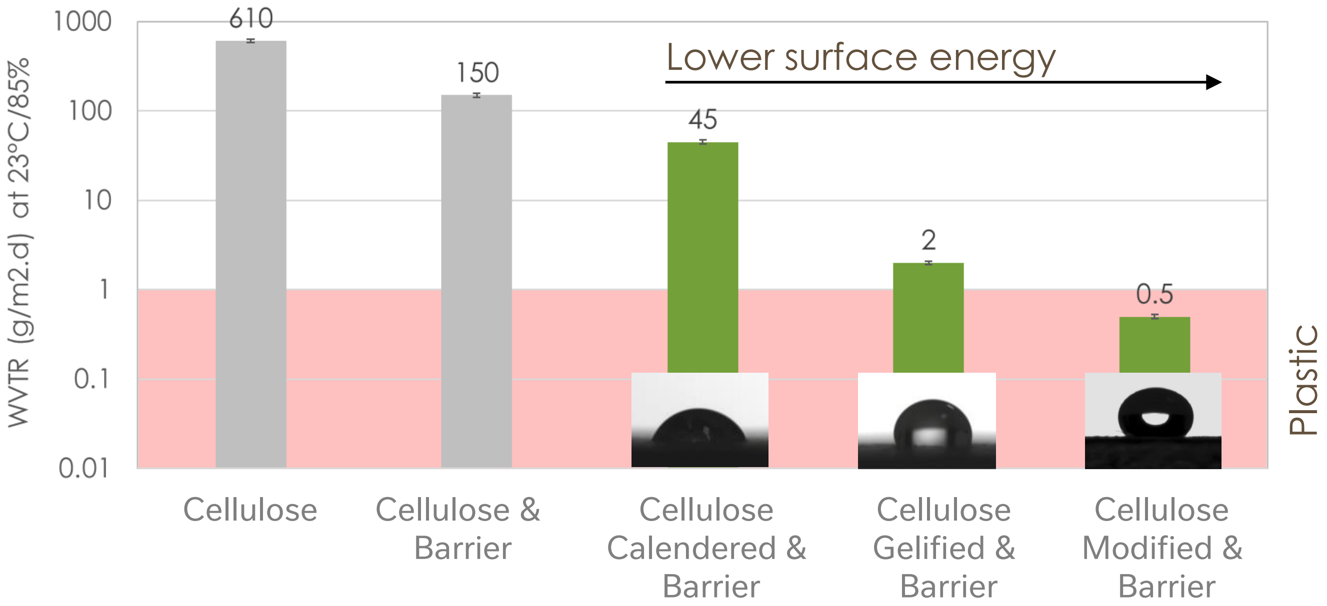
Mastering inorganic high barrier coatings by cellulose engineering



Inorganic coatings with thickness below 50nm create high oxygen and water barrier

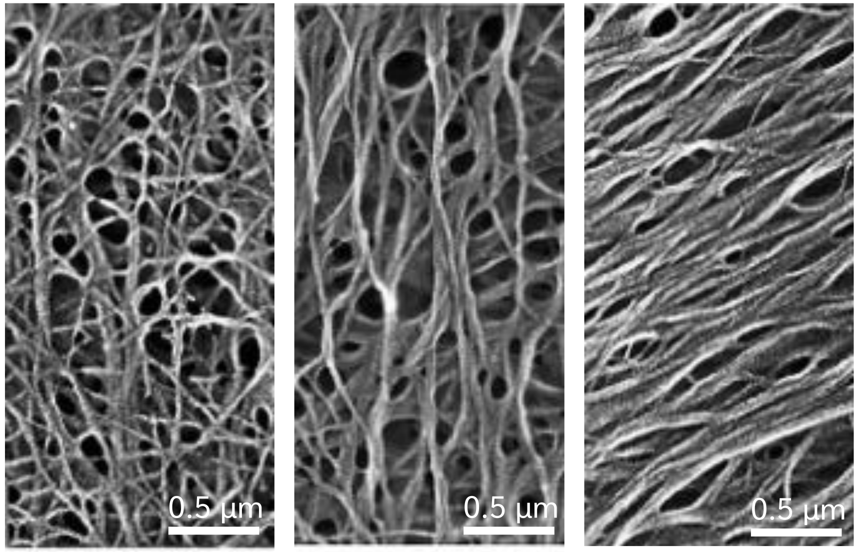


Cellulose surface **smoothness and surface energy** key for inorganic layer deposition and barriers

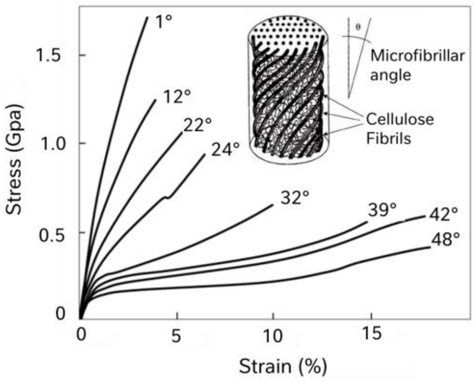


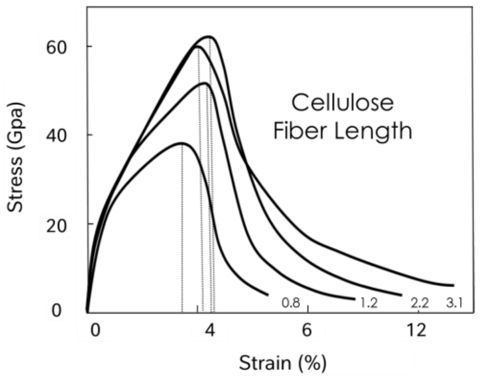
Cellulose fibers engineering to create paper elasticity

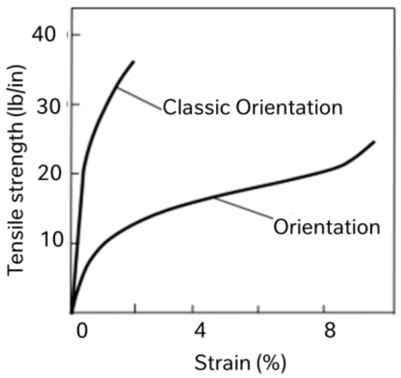
Orientated Cellulose Fibrils



Cellulose Fiber Structure, Length, Orientation and Physical State in combination with Process Parameters to create paper elasticity

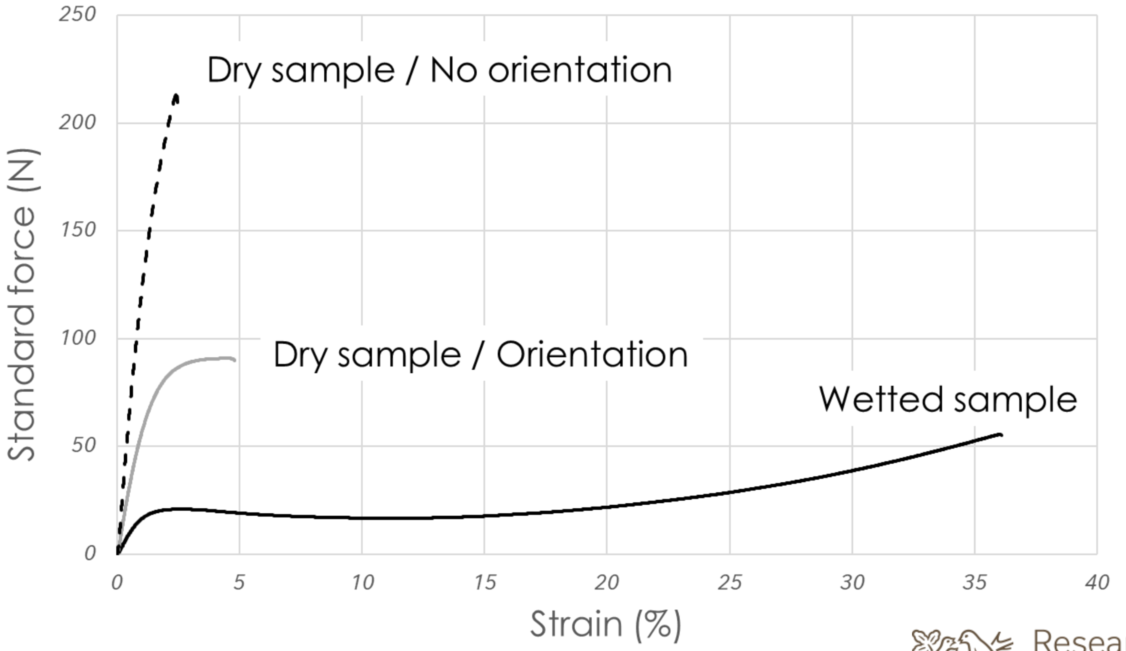






Page D. H., Journal of Pulp Paper Science, Vol. 9(4), 1983, pp. 99 - 100.

Vishtal A., BioRessources, Vol 9 (4), 2014, pp. 7793 – 7798.



Research and Development

Food Packaging Materials

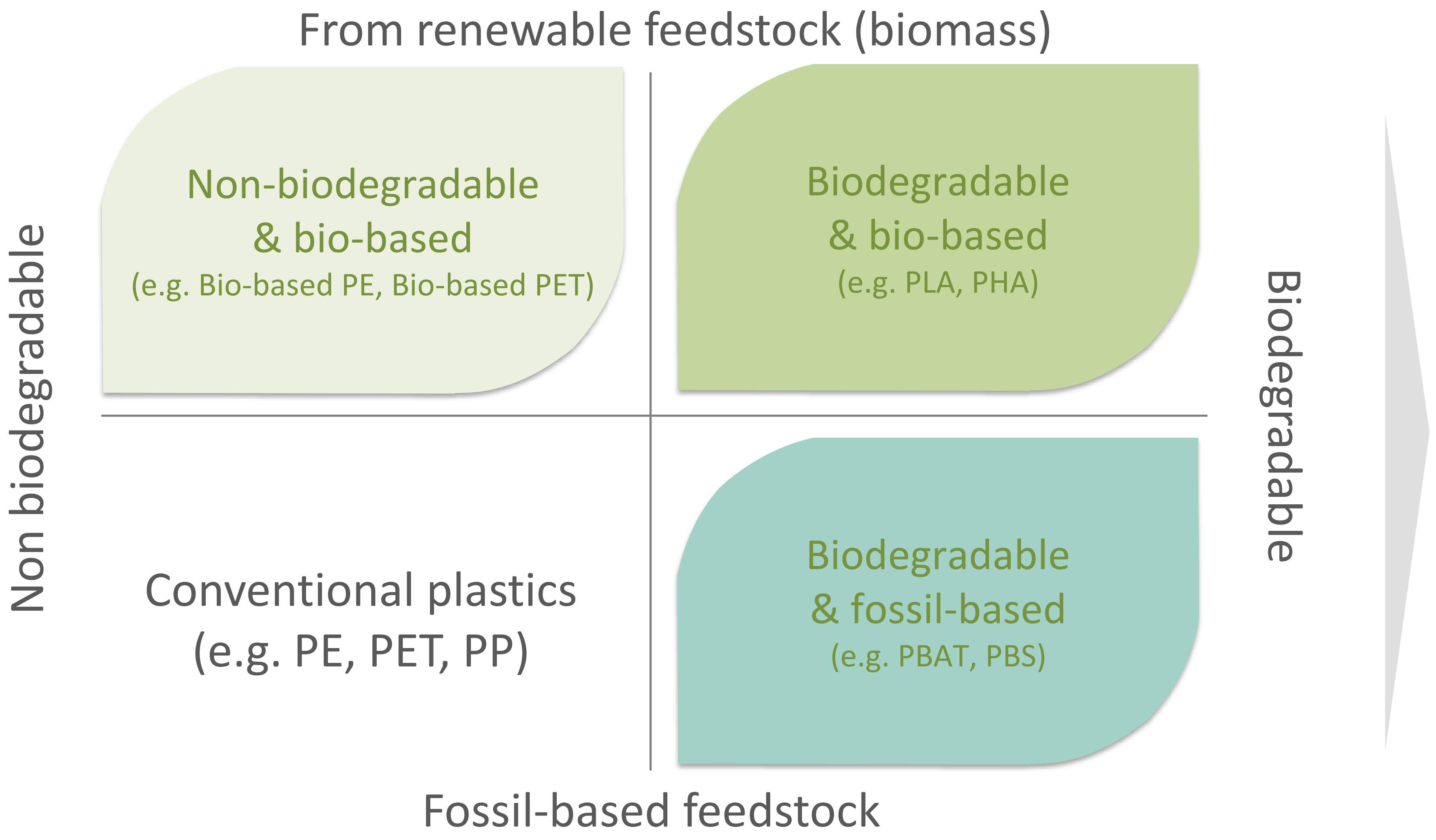
Plastic

Paper

Bioplastic

Research and Development

What are bioplastics?



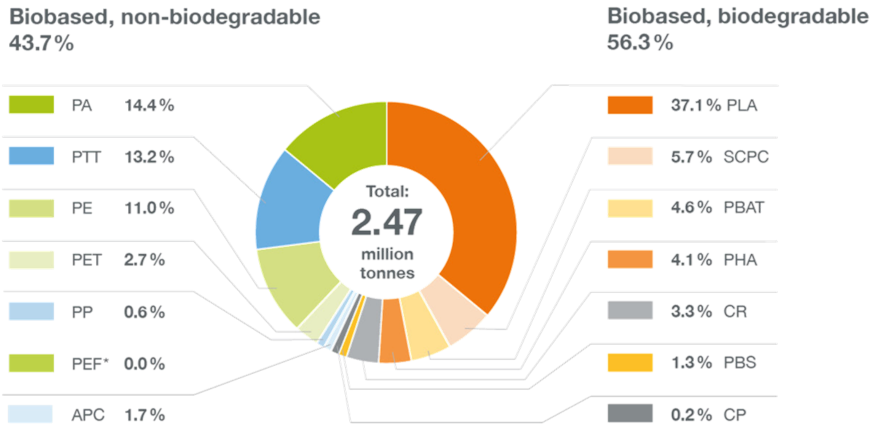
Bioplastics

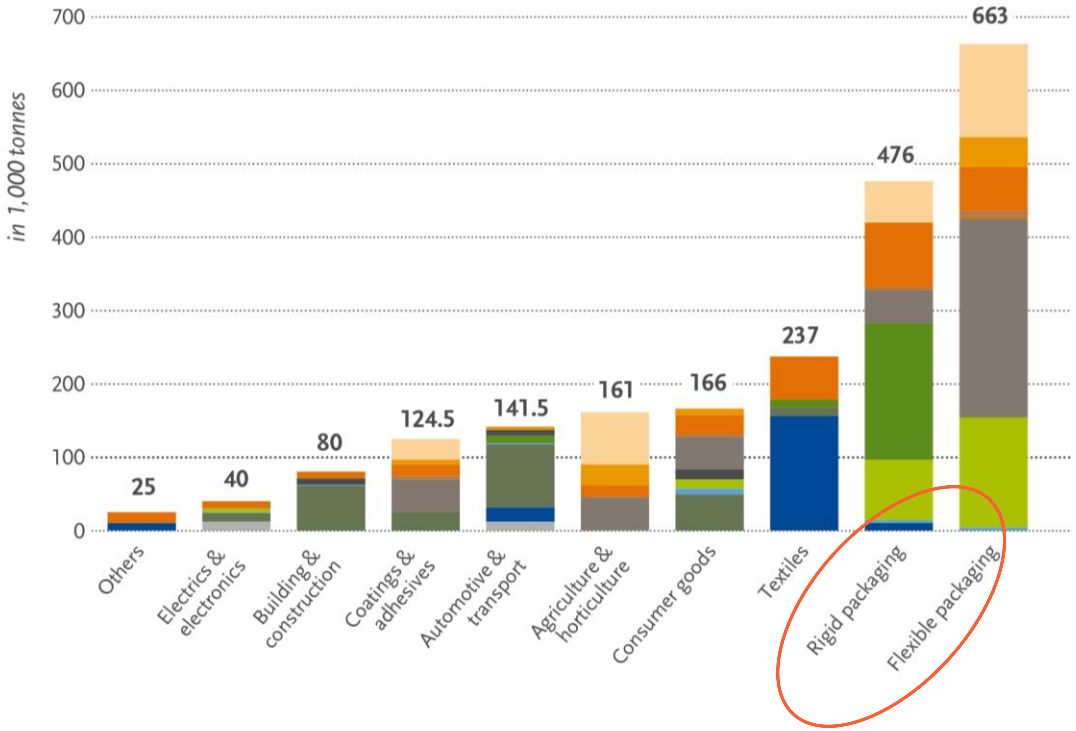
Biobased and/or biodegradable

PE	Polyethylene
PET	Polyethylene Terephthalate
PP	Polypropylene
PLA	Polylactic Acid
PHA	Polyhydroxyalkanoates
PBAT	Polybutylene Adipate Terephthalate

Bioplastic: production capacity & application

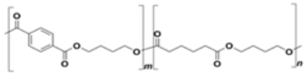
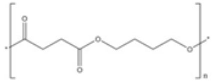
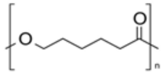
Global production capacities of bioplastics 2024*

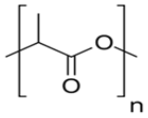
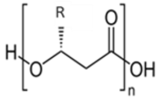




44.5%
bio-based
(non-biodegradable)

55.5%
biodegradable

	PBAT (polybutylene adipate-co-terephthalate)	~283k tons (1) BASF Novamont Eastman Chemical BIO-FED
	PBS (poly(butylene succinate))	~90k tons (1) BIO-FED PTT MCC Biochem
	PCL (poly(ε-caprolactone))	< 30k tons (1) BIO-FED

	PLA (polylactic acid, polylactide)	~290k tons (1,2) NatureWorks Total-Corbion Evonik WeforYou Carbiolice BIO-FED
	PHA family (polyhydroxyalkanoates) Industrially relevant today: PHB, PHBH, PHBV	25-50k tons (1)* Kaneka Danimer Scientific TianAn Bioplymer
	Starch blends	~450k tons (1) Novanomt BIO-FED

*Vs 141 M TONS of conventional

(1) Source: Nova Institute, https://www.european-bioplastics.org/bioplastics/materials/; 2019

Research and Development

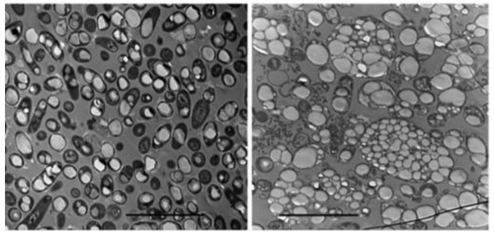
Biobased polymers through fermentation

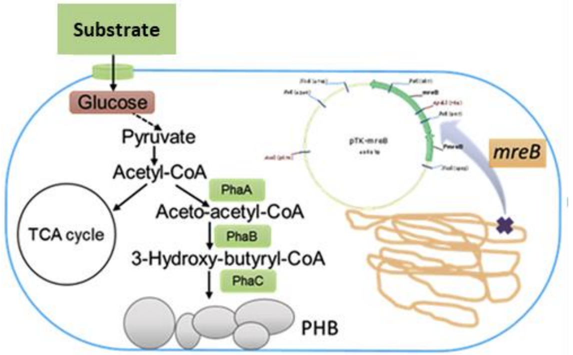
Renewable feedstock

Today: 1st gen

Tomorrow: 2nd & 3rd gen

Fermentation & downstream processing

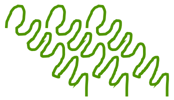




Synthetic & Systems Biotechnology, 2016, Vol. 1(4), pp. 236 -242.

PHA →

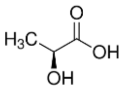
Polymer processing & formulation



Biobased polymer

+ fillers
+ additives
+ co-polymers
+ etc.

Building blocks synthesized into polymers



Lactic acid → PLA

1,4-butanediol
Succinate → Bio-PBS
Ethanol → Bio-PE

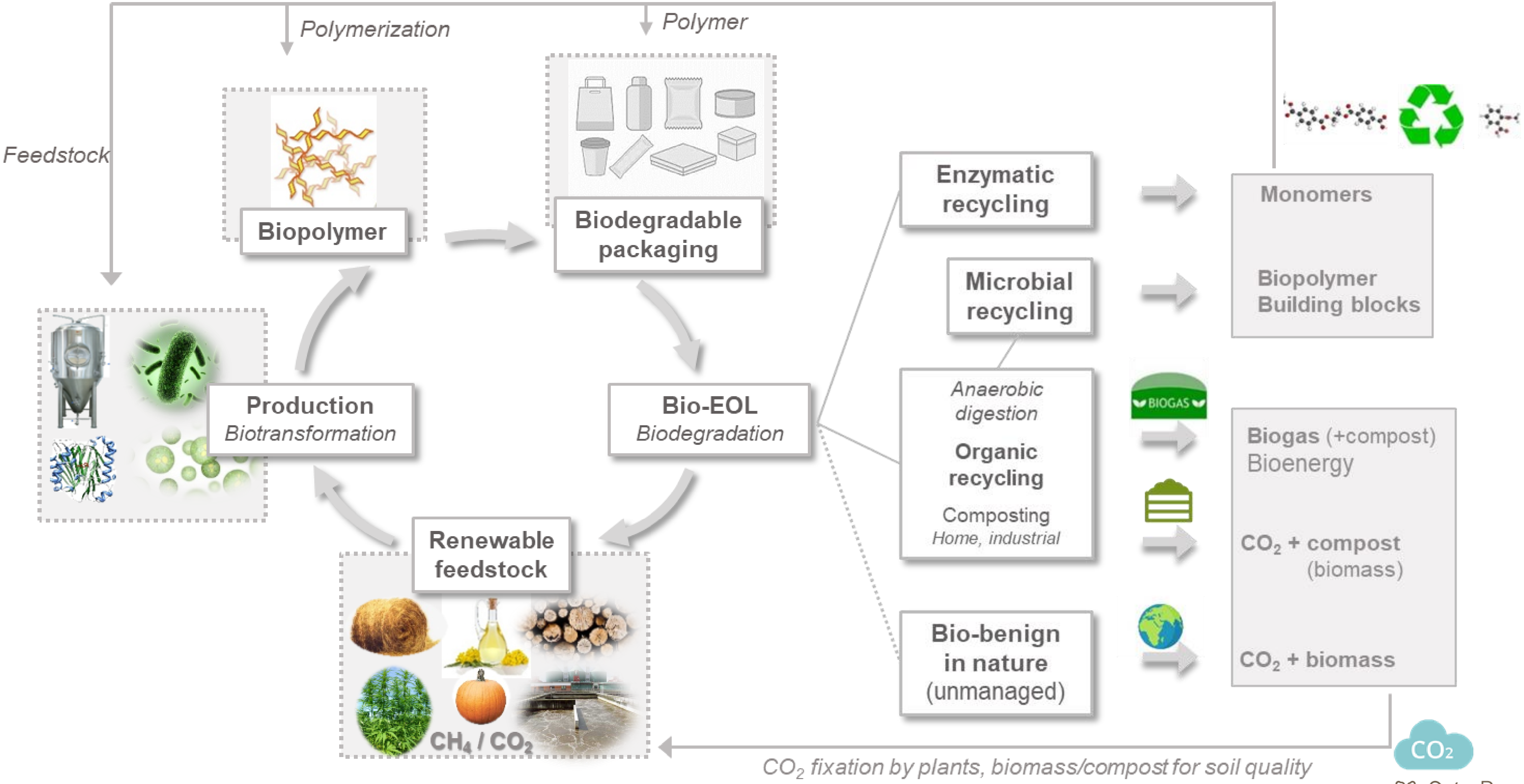
Bioplastic packaging

www.packaginginsights.com

Biobased packaging
(if also biodegradable depends on polymers)

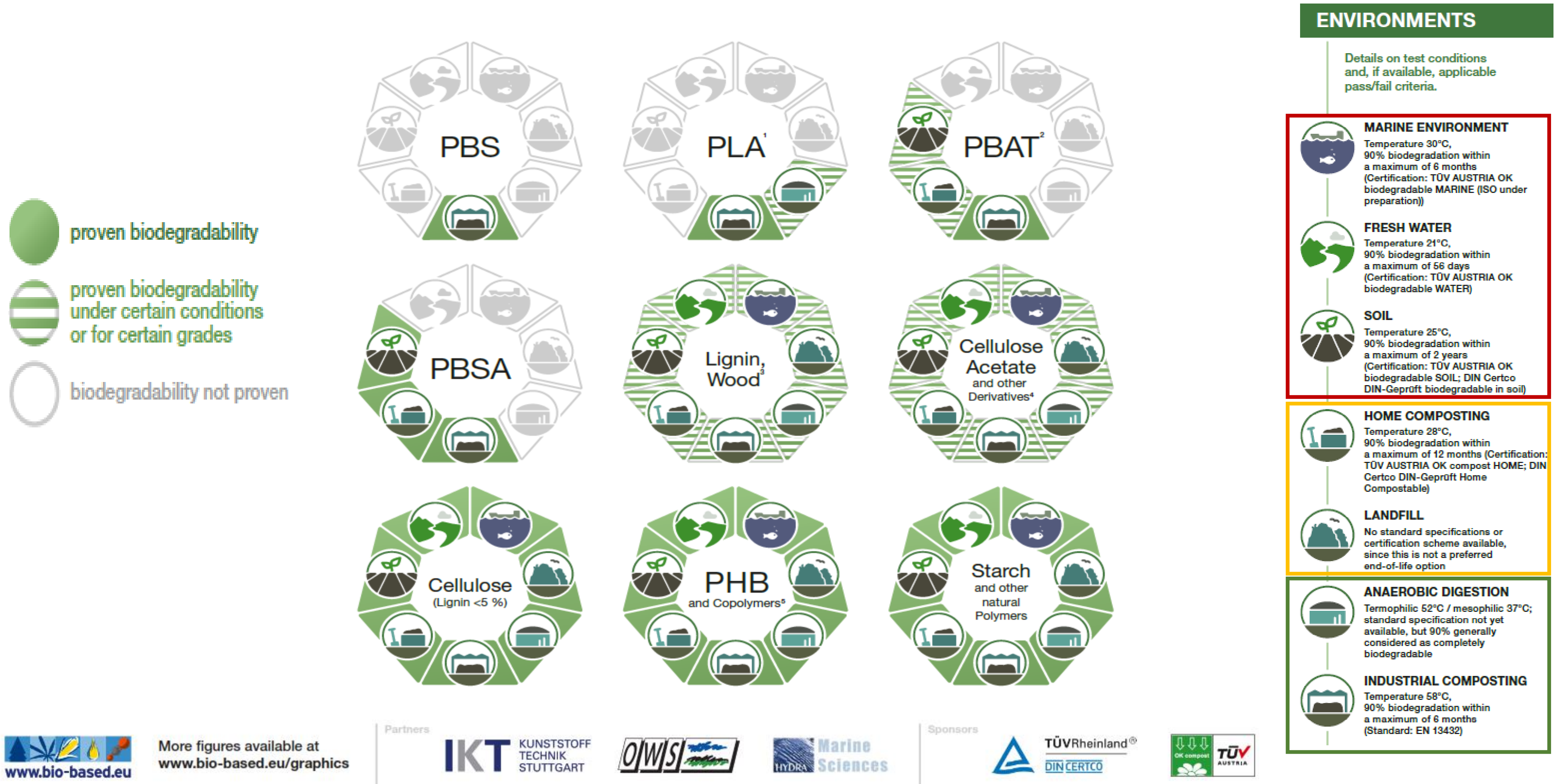
(1) Source: Nova Institute, https://www.european-bioplastics.org/bioplastics/materials/; 2019

Bioplastics and biodegradation: an opportunity for material circularity



Research and Development

Biodegradability of biodegradable materials for different environments: based on test standards



Unmanaged

Semi-managed

Managed

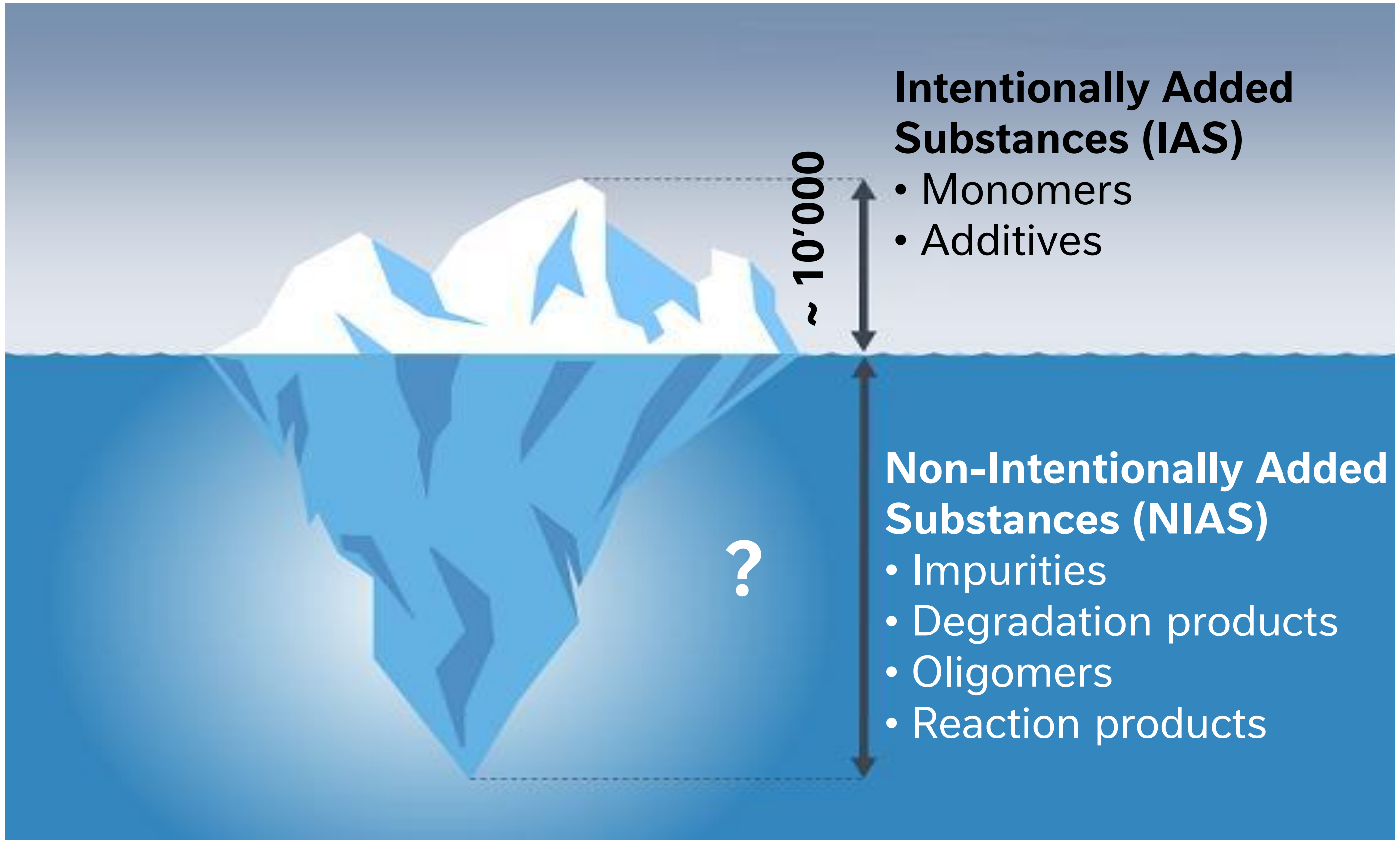
Research and Development

Food Packaging Safety

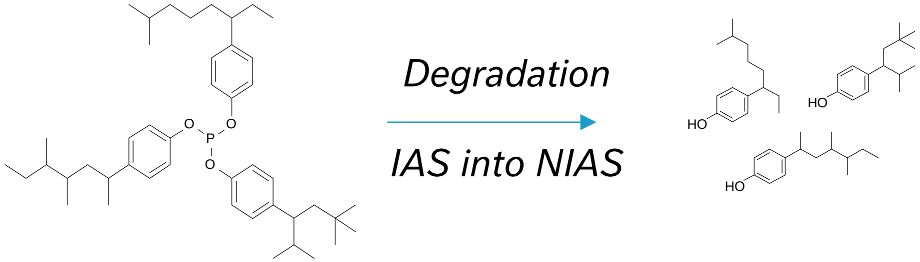
Guarantee food safety

Risks fairly well known, mainly a compliance concern.

Risks mainly unknown, compliance + safety concern?



Example:



Tris(nonylphenyl)phosphite (TNPP)

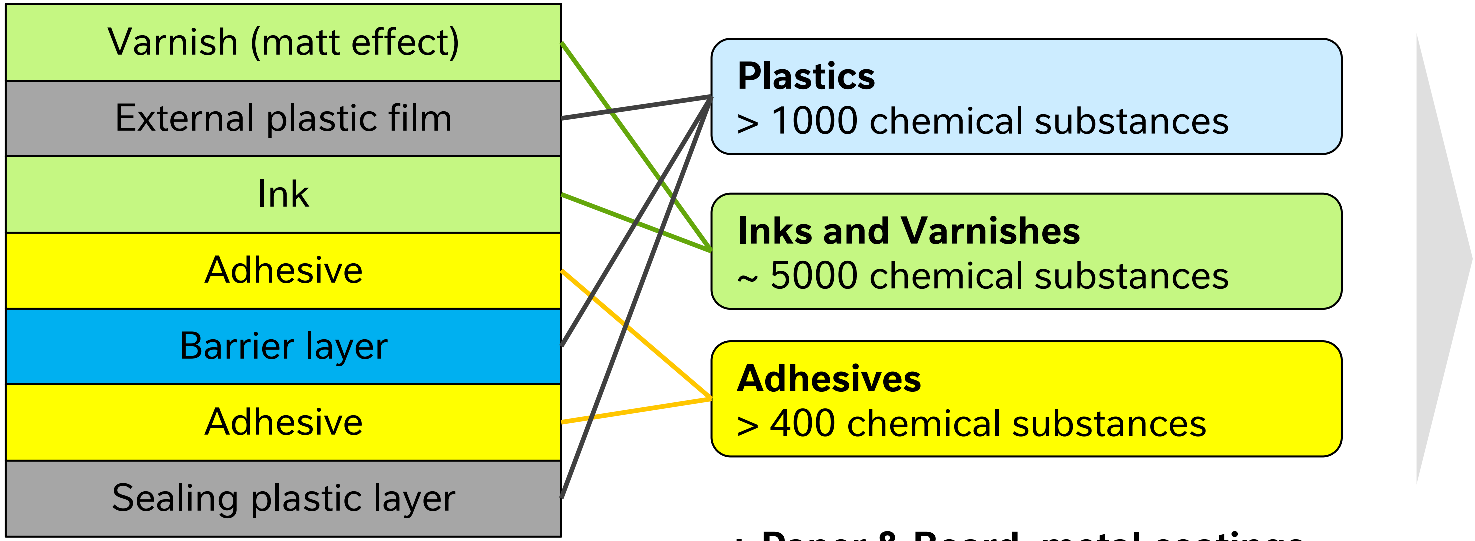
4-Nonylphenols (4-NP) (Mixture of isomers)

Endocrine disruptors

Research and Development

Packaging materials: often multilayer structures made with chemicals

Outer side

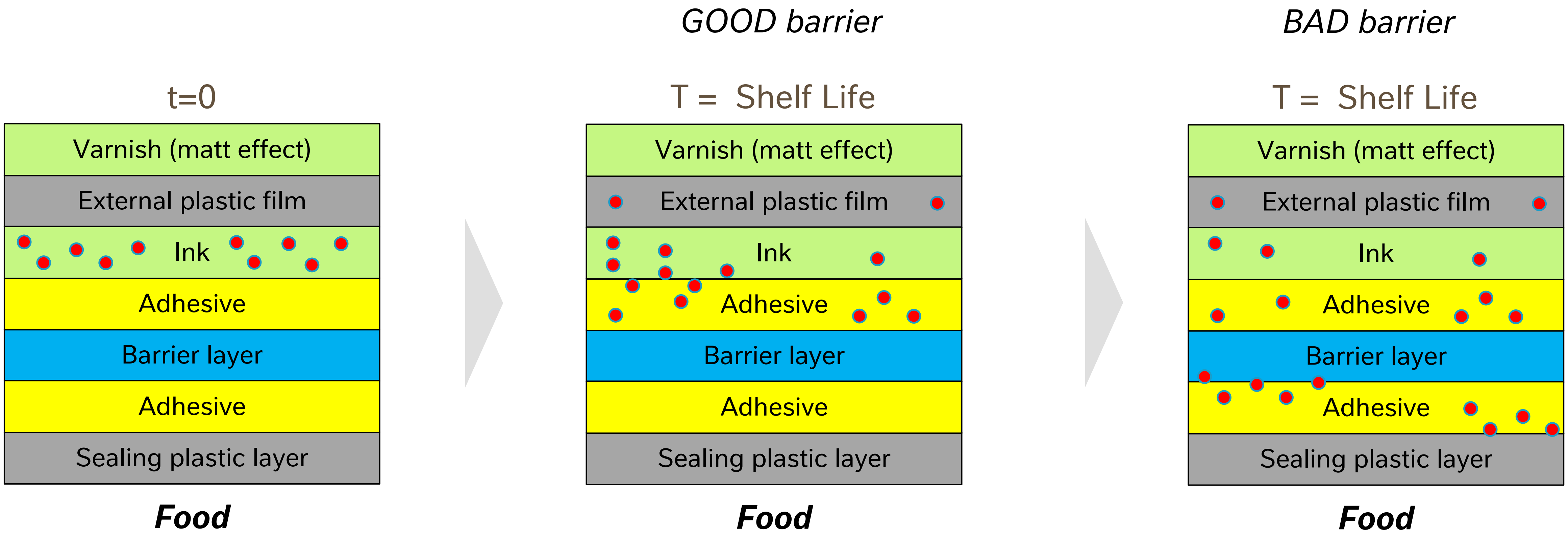


Food

+ Paper & Board, metal coatings…

Chemicals used *Intentionally (IAS)*

Migration: Chemicals can migrate in food



$$\frac{m_{F,t}}{A} = c_{P,0}\rho_P d_P \left(\frac{\alpha}{1+\alpha}\right) \times \left[1 - \sum_{n=1}^{\infty} \frac{2\alpha(1+\alpha)}{1+\alpha+\alpha^2 q_n^2} \exp\left(-D_P t \frac{q_n^2}{d_P^2}\right)\right]$$

$$D_P = D_0 \exp\left(A_P - 0.1351 M_i^{2/3} + 0.003 M_i - \frac{10454}{T}\right)$$

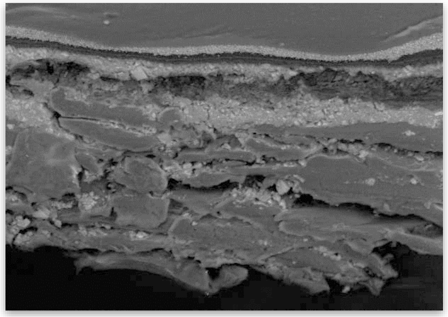
Many packaging substances allowed to migrate in low amount depending on toxicity.

However, many molecules not toxicologically assessed.

Brandsch J., et al.: Possibilities and limitations of migration modeling. Plastic packaging materials for food, 2000.

Pack Food Safety of new Paper-based Packaging Materials

Barrier papers

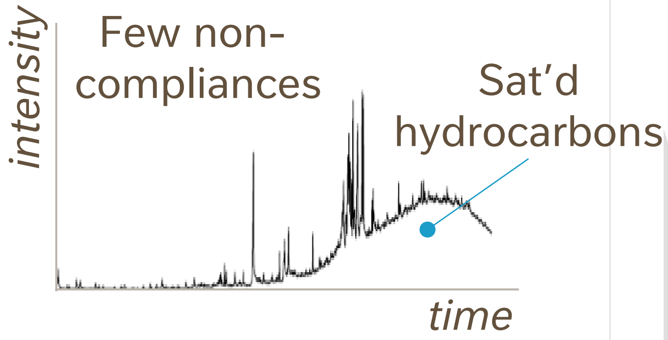


Components:

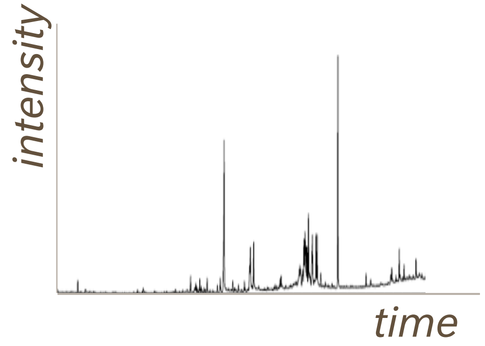
- Inks
- Adhesives
- Fibres
- Coatings

ANALYTICAL SCREENING

Initial material

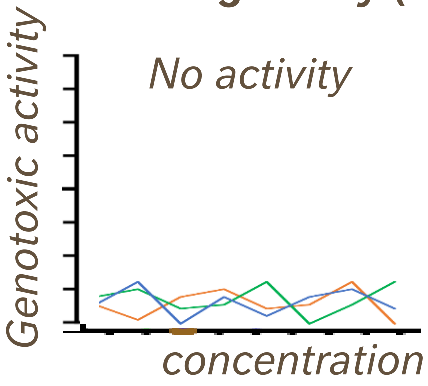


Re-designed materials

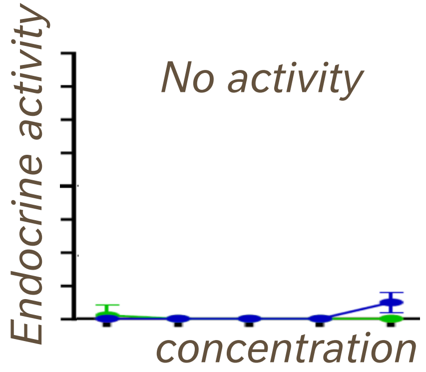


BIOASSAY SCREENING

Mutagenicity (Ames)



Endocrine activity



RISK ASSESSMENT

LCA quantifies different environmental impacts throughout a products life cycle

Entire life cycle

Greenhouse gas emissions ($kg\ Co_2eq$)

Water scarcity (m^3eq)

Non-renewable energy & minerals (kg Sb eq)

Impacts on ecosphere ($PDF \times m^2 \times year$)

Land use biodiversity impacts ($PDF \times m^2 \times year$)

Different aspects of the environment

PDF: Potentially Disappeared Fraction

Research and Development

The most simple Ecodesign (oversimplified...)

	Material Impact / kg	Conversion Impact / kg	End-of-life Impact / kg	Total Impact / kg
Paper & cardboard	1.5	- (included)	-0.2	1.3
PP, PE	2.2	0.6	0.7	3.5
PET	3.3	1.2	0.7	4.2
Glass	1.3	- (included)	-0.2	1.1
Tin-plated steel	1.7	0.2	-0.8	1.1
Alu	12	0.6	-4	8.6

Real ecodesign takes into account:

- amount of material required per packaging system
- exact material type, including transport distances, recycling content
- specific conversion process, and energy sources for conversion
- specific end-of-life process (e.g. incineration, landfill, recycling)
- environmental indicators other than greenhouse gas emissions
- and many other parameters

www.quantis-intl.com

Nestlé Good food, Good life

Innovation in paper-based packaging

Examples of Test & Learn with new High Barrier Paper Sachets

Paper Sachet

- Infant Cereals 50g
- 4 Side Seal pack
- Good Seal/Barriers
- Good Machinability

Results

- Qual test Ghana 2 months
- Good Appreciation
- Ease of opening
- Paper perception to be improved

Paper stick

- 3 in 1 stick 15 g SE
- 4 Side Seal pack
- Good Seal
- Good Machinability

Results

- Test In Hungary
- Good Appreciation
- Some technical issues do to hygroexpansion of paper

Research and Development

Examples of Test & Learn with new Barrier Paper Trays

Paper Tray – Single Serve

- Molded pulp trays with thin film laminate for MAP conditioning
- High Barrier Paper for top membrane to ensure gas barriers
- Transport: Frozen and then chill distribution
- EoL: Recyclable in the paper stream in DE Market (2021)

Results

- Tested @ REWE and PENNY in the DE Market (2 months)
- No defects or deformation where observed during supply chain
- Very well perceived by consumers leading to potential incremental sales
- Paper based packaging came out as the clear purchase driver but too expensive in real conditions

Research and Development

Reformulating Paper with Upcycled by-products

Paper Sleeves with Spent-Coffee Inclusions

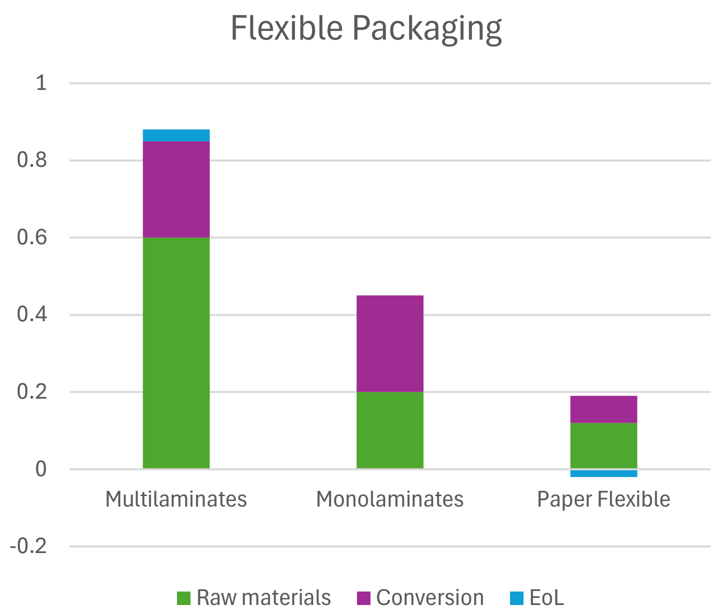
- Paper pulp was mixed with Spent Coffee Grounds from a capsule recycling site
- Up to 20 % coffee inclusions could be added to Pulp w/o loss of Mechemical performances nor recycling specs
- The addition of particles led to new texture features limited printing area and cost

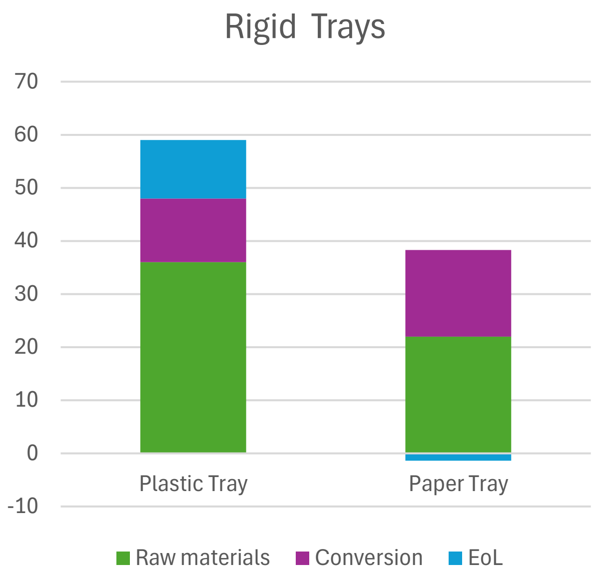
Results

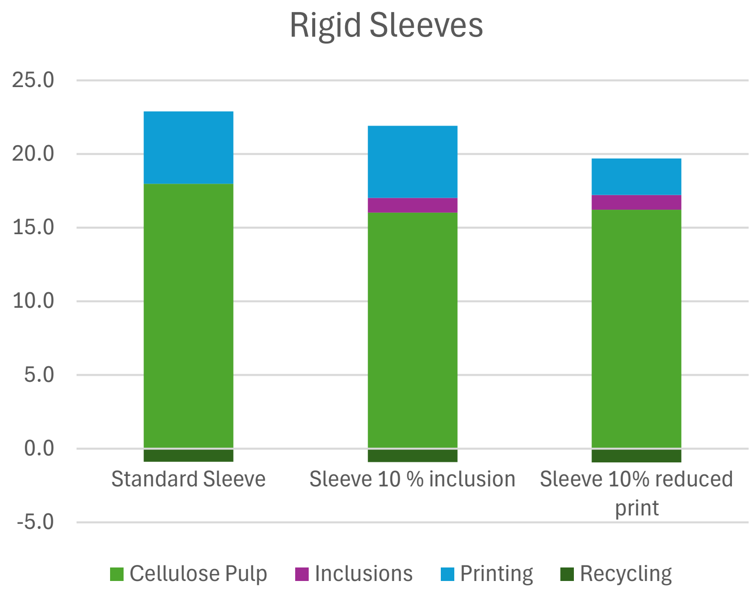
- Tests in filling line run smoothly as per standard carton material
- Migration tests did not detect and substance of concern
- **Quality of the spent coffee from used capsules could not be controlled and could generate the risk of the presence of mycotoxins.**

Research and Development

LCA - Packaging (Paper Vs Other Materials)*







Nestlé Paper-based Rigid & Flexible packaging material demonstrates **significantly lower GHG emission** compared to standard materials

*LCA studies were performed at the Nestlé Institute of Packaging Sciences

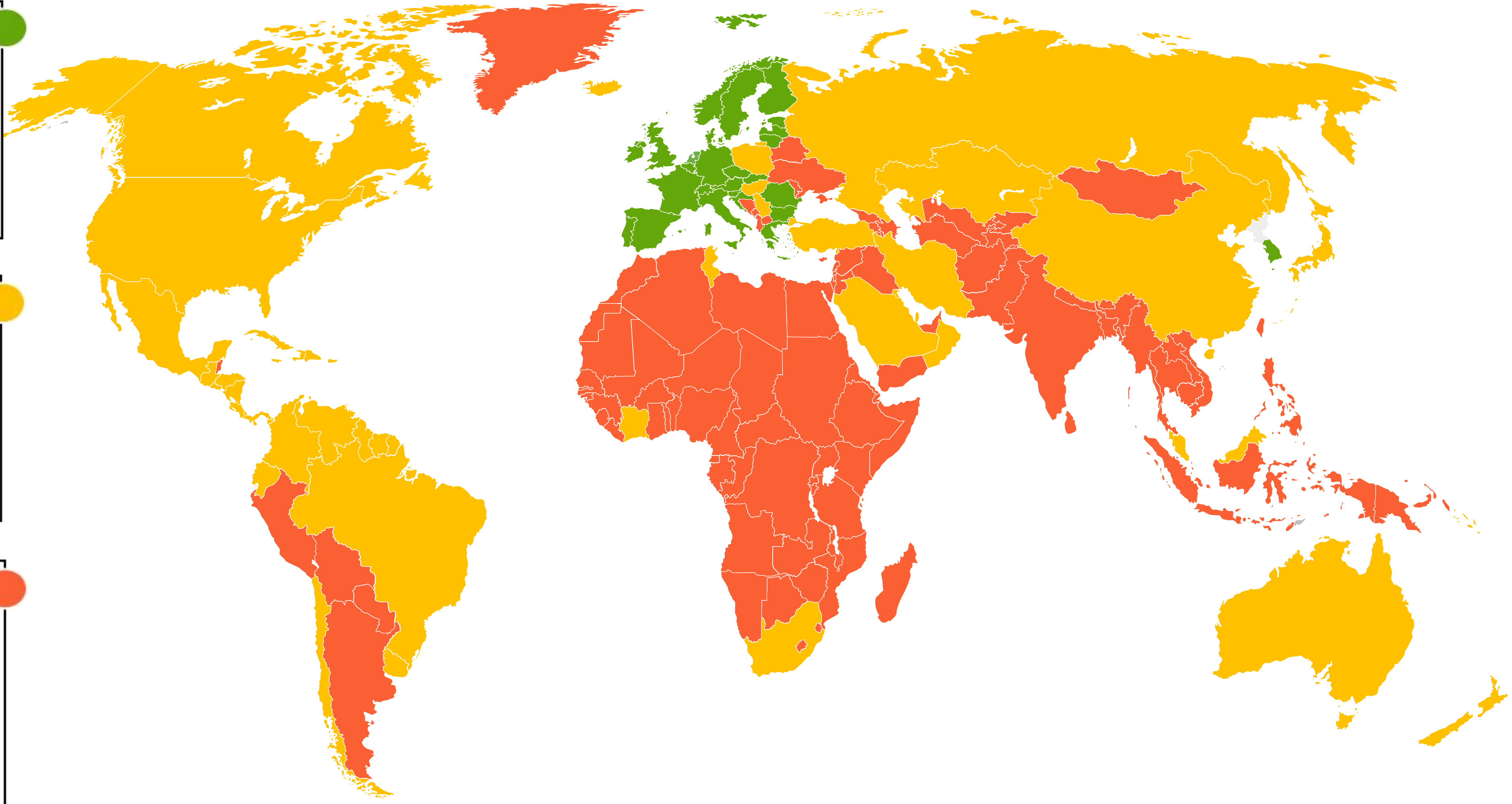
CONCLUSIONS

Most geographies where we operate have limited waste management

Archetype 1
Waste collected, recycled

Archetype 2
Waste collected, recovered/landfilled

Archetype 3
Mostly no waste collection, open-littering



Our need: Fit-for-purpose food-grade packaging Innovation

Delivering safe and nutritious food

SAFETY & QUALITY

FUNCTIONALITY

INFORMATION

EOL

Adapting to product and geography

PRODUCT SENSITIVITY

CLIMATE

ROUTE-TO-MARKET

LEGISLATION