

23^e
Voedings- en Gezondheidscongres
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Smart packaging: innovaties in actieve en intelligente voedselverpakkingen

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IMO-IMOMECC
UHASSELT imec

MPR&S
Materials and Packaging Research & Services

Market implementation of smart packaging

- Packaging 2021
 - ▶ Value perception of packaging functions
 - ▶ Current requirements
- Innovations?!
 - ▶ What are active and intelligent packaging?
 - ▶ How can AIP offer solutions to food safety and against food loss?
- How is the market implementation going?
 - ▶ Challenges, drivers, enabling technologies, resources



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Packaging

□ Scientific method of enclosing food in a container, box, pouch, ... to ensure its delivery to the ultimate consumer in the best condition intended for its use, maintaining

- ▶ Hygienical quality
 - Absence of noxious microbiological contaminants
 - Absence of potential toxic compounds migrating from the packaging
- ▶ Nutritional quality
- ▶ Organoleptic quality (taste, color, smell)

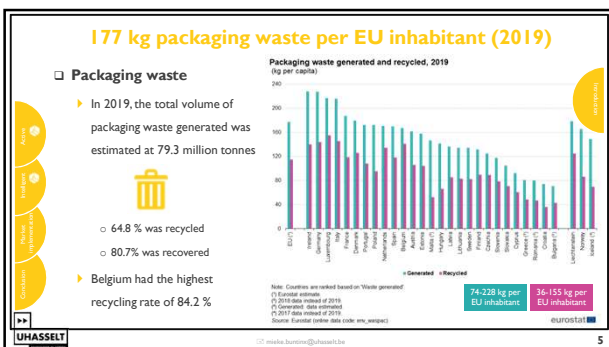


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Sustainable packaging

Sustainability in materials

- ▶ reusable
- ▶ recyclable
- ▶ biodegradable

Sustainability in functionality

- ▶ to guarantee product quality
- ▶ to guarantee product safety
- ▶ to minimize product waste

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Food waste

33% OF FOOD
PRODUCED WORLDWIDE IS
NEVER EATEN!

THIS EQUALS

- 88 MILLION TONNES OF CO₂ EVERY YEAR
- 173 KG PER PERSON
- ENOUGH TO FEED 48.9 MILLION PEOPLE FOR A DAY
- 576 MILLION TONNES OF CO₂ EMISSIONS

Source: Eurobarometer, EPRS, FAO

europarl.europa.eu

Food loss & food waste

FOOD IS WASTED EVERYWHERE:

PRIMARY PRODUCTION
11%

FOOD PROCESSING
19%

RETAIL & WHOLESALE
5%

FOOD SERVICE & CATERING
12%

HOUSEHOLDS
53%

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Food safety

- ✓ food safety
- ✓ country of origin
- ✓ cost
- ✓ taste

37%
OF EUROPEANS WORRY ABOUT FOOD SAFETY. THEY ARE MAINLY CONCERNED ABOUT:

QUALITY & FRESHNESS

FOOD POISONING

ADDITIVES & PRESERVATIVES

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Food safety

AND RIGHTLY SO, BECAUSE:

200

THERE ARE OVER 200 DIFFERENT DISEASES THAT ARE SPREAD THROUGH FOOD

33 MILLION EUROPEANS FALL ILL EVERY YEAR DUE TO FOODBORNE ILLNESSES

1 IN 8 COUNTERFEITED PRODUCTS ARE FOODSTUFFS

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Innovations in SMART packaging

□ **Active packaging interacts** with the packaged product in order to prevent quality loss and to prolong shelf life.

□ **Intelligent packaging senses** changes inside the packaging atmosphere and/or **communicates** about the quality of the product.

- To inform about product quality
- To establish any brand-consumer connection
- To control tracking or counterfeiting conducts in the supply chain

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Active packaging (I)

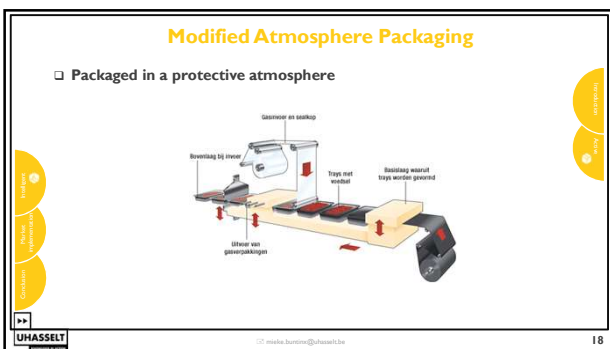
□ Modified Atmosphere Packaging

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Modified Atmosphere Packaging

FOOD PRODUCT	MAP GAS MIXTURE			TARGET MAP
	% CO ₂	% N ₂	% O ₂	
Fresh red meat	15-40	0-10	60-85	stability meat color + slow down bacterial development
Poultry	70	20	10	stability color + slow down bacterial development
Low fat fish	65	25-35	0-10	stability color + slow down bacterial development
High fat fish	40	60	-	slow down bacterial development and oxidation
Shrimps	65	35	-	slow down bacterial development
Hard cheeses	0-70	30-100	-	slow down mold growth and oxidation
Soft cheeses	0-30	70-100	-	slow down mold growth and oxidation
Bread and banquet	20-70	80-30	-	slow down mold growth
Vegetables and fruit	5	90	5	suppress respiration
Dry products (e.g. cookies, dry fruit)	-	100	-	slow down oxidation
Meat products (cooked ham, liver pâté, ...)	50-70	50-30	-	slow down bacterial development
Meat products (type of salted raw ham)	10-20	80-90	-	slow down development of bacteria, molds and yeasts

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Examples of active packaging concepts

New Active Recyclable Packaging with Natural Antioxidising for the extension of the fresh food shelf life

FRESHFILM
2009-2011



Fresher foods with FRESHFILM packaging

EU-funded researchers have developed a new recyclable packaging film that extends the shelf life of meat and fresh produce.



Bio-based smart packaging for enhanced preservation of food quality.

BIO SMART
2017-2021



Bio-based smart packaging for enhanced preservation of food quality (BIO SMART) This project has the ambition to develop active and smart bio-based and compostable packages, addressing the needs of fresh and pre-treated food applications, as for example, light weighting, reduced residues, shelf life monitoring and longer shelf life, easier waste handling, and all this at a competitive cost. BIO SMART project develops thus encompasses an approach for selectively integrating super-hydrophobic surfaces, microencapsulated phase change materials, barrier coatings, sensing devices, and new bio-active antimicrobial and antioxidants, into all-bio-based multilayer flexible plastic packages.

Ex. of active packaging concepts

HIGH PERFORMING ADVANCED MATERIAL PLATFORM FOR ACTIVE AND INTELLIGENT FOOD PACKAGING: CRONOGARD™

CHRONOGARD
2017-2020



New product dramatically improves the capabilities of food packaging

Keeping food longer on shelves will become an absolute priority for feeding the planet as the rise in temperature reduces crop yields. An EU initiative introduced an innovative product to significantly extend the life of packaged food.



Granting society with Low environmental impact innovative PACKaging

GLOPACK
2018-2021



The multi-objectives of GLOPACK

GLOPACK focuses on finding the possibility of new materials and technologies in the food packaging.

- Biodegradable materials made with agro-food residues
- Low energy consumption in the production process
- High performance barrier properties (O2, water vapor, etc.)
- High performance barrier properties (O2, water vapor, etc.)


Intelligent packaging


Intelligent solutions

- ▶ To inform about product quality
- ▶ To establish any brand-consumer connection
- ▶ To control tracking or counterfeiting conducts in the supply chain

Different types of intelligent

- ▶ **Indicators** provide visual qualitative or semiquantitative information about the packaged food by means of a color change
- ▶ **Sensors** detect, record, and transmit quantitative information of changes in the environment, the condition of the packaged food.
- ▶ **Data carrier devices** such as barcodes, radio frequency identification (RFID) and near field communication (NFC) tags enable more efficient information flow within the supply chain.





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Intelligent label on packaging

Indicator and detection of bacteria

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Ex. of active & intelligent packaging concepts

Innovative Packaging for the Detection of Fresh Meat Quality and Prediction of Shelf-Life

TOXDTECT
2013-2016

Intelligent packaging detects meat quality

An EU-funded consortium comprising European associations, research centres and SMEs developed an accurate, non-destructive and cost-effective method for determining the quality and shelf life of packaged meat.

A revolutionary quality indicator platform for the food industry

MultiSens
2017-2019

Intuitive freshness indicator helps consumers reduce food waste

The EU-funded MultiSens project's innovative freshness indicator can be integrated directly into food packaging.

PAPERONICS

- ❑ Printed electronics on fiber-based substrates
- ❑ RFID smart packaging flow

	Chip manufacturing	Antenna manufacturing	Tag assembly (chip + antenna)	Label conversion	Package integration
Today	Company 1	Company 2	Company 3	Company 4	Packaging company
Paperonics	Company 1	Packaging company			
Future	Packaging company				

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PAPERONICS

6 Research Partners

34 Industrial Partners
from Belgium, Germany & The Netherlands

Logos include: ABBE, ESMA, FETRA, AFS, pacocon, AGFA, OROKEL, i4, adpho, THIMM, CHYODA, QUAD, BARRIOPAC, WEBER, PreSens, DS Smith, REYNDEERS, des, sozalon, Felix Schoeller Group, elep, R-PAK, Tocon, Koechler, SEMPA, ethiclo, Smurfit Kappa, vijq, cornet, AGENTOMAS INNOVATION & ONDERZOEK, imo-imomec, imec, KULLEUVEN, ivlv, Fraunhofer, PTS, AF.

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PAPERONICS objective

□ To design and develop smart packaging demonstrators by integrating (printed) electronic components as smart labels in cardboard packaging

Demo 1: Customer relationship product

Demo 2: anti-tampering packaging

Demo 3: temperature indicator

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Ideas for use of RFID's in paper/cardboard applications

Track & trace	Product authentication	Consumer interaction
<ul style="list-style-type: none"> Logistic labels to track goods E-commerce RFID in medicine packaging on the secondary packaging (box) Sustainable packaging Remote reading of mouse and rat traps in larger complexes such as industrial or hospital sites 	<ul style="list-style-type: none"> Smart (medical) packaging with leaflet information in multiple languages that can be read via mobile devices or speech Product information for niche products (e.g. perfumes of high-end brands) Counterfeiting Prevention of alcoholic beverages for underage people 	<ul style="list-style-type: none"> Smart (medical) packaging with leaflet information in multiple languages that can be read via mobile devices or speech RFID on (Tyvek) wristbands and back numbers Applications to make lectures and events interactive

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Reusable cardboard box with RFID label for 3rd party logistics

□ **IDEA: circular packaging in logistics**

▶ Sustainable, reusable and foldable secondary packaging

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Reusable cardboard box with RFID label for 3rd party logistics

□ **IDEA: circular packaging in logistics**

▶ Sustainable, reusable and foldable secondary packaging

▶ Functionality and reliability testing

▶ Software tool to support the logistic cycle

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materials MDPI

Article

Screen Printed Antennas on Fiber-based Substrates for Sustainable HF RFID Assisted e-Fulfillment Smart Packaging

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AIP can reduce food waste and contribute to food safety

Category	Strategy	Checkmark	Checkmark
Active Ingredients	REDUCE GROWTH OF MICRO-ORGANISMS THAT CAUSE FOOD SPOilage & FOODBORNE ILLNESSES	✓	✓
	SLOW DOWN RIPENING PROCESSES TO MAKE PRODUCTS LAST LONGER	✓	
	PREVENT PRODUCTS FROM GETTING SOGGY OR RANCID TO MAINTAIN TASTE & APPEARANCE	✓	
Active Packaging	REDUCE THE NEED FOR ADDITIVES & PRESERVATIVES IN FOODSTUFFS	✓	✓
	MAINTAIN QUALITY & FRESHNESS AFTER THE PACKAGING HAS BEEN OPENED (SECOND SHELF-LIFE)	✓	✓
	DETERMINE REMAINING SHELF-LIFE MORE ACCURATELY AND REAL-TIME	✓	✓
Active Labels	COMMUNICATE MORE CLEARLY ABOUT PRODUCT QUALITY & SHELF-LIFE	✓	
	COMMUNICATE MORE CLEARLY ABOUT FOOD SAFETY & SHELF-LIFE	✓	✓
	GUARANTEE THAT PRODUCTS ARE AUTHENTIC AND HAVE NOT BEEN TAMPERED WITH	✓	✓
		✓	

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Smart Packaging Market - Growth Rate by Region (2019 - 2024)

Regional Growth Rates

- High (Green)
- Mid (Yellow)
- Low (Red)

Source: Mordor Intelligence

<https://www.mordorintelligence.com/industry-reports/smart-packaging-market>

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Research approach

COST Action FP1405 ActInPak (2015–2019)

- gathered over 400 participants from research organizations, industry, branch organizations and policymakers from 34 European countries in the areas of papermaking, printing, packaging, bio-based materials, and chemicals to openly discuss the market implementation of AIP.
- resulted in technological, socio-economic & sustainability roadmaps directing future activities in the field.

Consumer survey among 1249 European millennials (Gen Y)

- the current value perception of packaging functions
- intentions to purchase AIP
- the willingness to buy AIP

<http://www.actinpak.eu/roadmaps/>

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foods MDPI

Article
Holistic Approach to a Successful Market Implementation of Active and Intelligent Food Packaging
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Main factors

□ **Most influential factors in successful market implementation on socio-economic level:**


1. Market drivers that affect developments
2. Gap between science and industry
3. Gap between legislation and practice
4. Cooperation between the producing stakeholders within the value chain
5. Gap between industry and consumer




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1. Market drivers that affect developments


A&I COMPONENT PRODUCER




PACKAGING PRODUCER




PACKER/ BRAND OWNER



RETAILER




CONSUMER/ END USER



Sustainability goes mainstream

- ▶ circular economy, bioeconomy
- ▶ reduction, recyclable, reusable, biobased, biodegradable
- ▶ plastics vs fiber-based materials?
- ▶ shelf life
- ▶ infrastructure and production processes



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1. Market drivers that affect developments

The internet-of-things

- ▶ e-commerce
- ▶ tracking & tracing
- ▶ interactive packaging
- ▶ consumer engagement & data collection

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2. Gap between science and industry

❑ Science works for >30 years on smart packaging concepts

- ▶ There is a **lack of awareness on AIP**, its benefits, added value and impact.
- ▶ Scientific publications will not help, but **communication** targeted towards industry is needed.
- ▶ Opportunities for AIP technologies should be discussed with engineers, marketers, designers, purchasers, etc... preferably using a "proven" demonstrator to show the potential of the solution.

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3. Gap between legislation and practice

❑ EU legislation

- ▶ Framework Regulation (EC) no. 1935/2004 (food contact materials)
- ▶ Regulation (EU) no. 10/2011 (plastic FCM)
- ▶ Regulation (EC) no. 2023/2006 (GMP)
- ▶ Regulation (EC) no. 450/2009 (active & intelligent materials)
 - Individual substances must be safe and comply with the framework Regulation
 - EFSA evaluation → positive community list
 - New guidance document of 27 March 2021

Administrative guidance for the preparation of applications on substances to be used in active and intelligent materials and articles intended to come into contact with food

EFSA Journal
<https://doi.org/10.2903/jsp.efsa.2021.EN-4513>

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4. Cooperation between stakeholders of the value chain

A&I COMPONENT PRODUCER
 Dependency
 Costs vs revenues
 Availability
 Legislation

PACKAGING PRODUCER
 Awareness
 Costs vs revenues
 Availability
 Legislation

PACKER/ BRANDOWNER
 Awareness
 Costs vs revenues
 Availability
 Trust in technology
 Legislation

RETAILER
 Awareness
 Costs vs revenues
 Transparency
 Trust in technology
 Reliability
 Legislation

CONSUMER/ END USER
 Awareness
 Costs vs revenues
 Trust in technology
 Perception
 Way of communication

► Mutual challenges can be overcome by increased communication and cooperation
 ► Conflicting interests can create boundaries

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5. Gap between industry and consumer

❑ **Again, there is a lack of awareness, so informing and educating consumers might prove to be beneficial.**

- Unknown or invisible extra features in a packaging might be perceived as suspicious and benefits might be unknown and unclear.
- AIP features should not be too complicated for a consumer:
 - no misunderstanding
 - the way information is presented, will also affect consumer trust.

❑ **More research is needed in this area to explore the perception of different consumer groups, e.g. elderly, gen Y, gen Z, ...**

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Willingness to pay extra for smart packaging

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(A) Active Packaging 75%
 Gen X: 100% (100%)
 Gen Y: 100% (100%)
 Gen Z: 100% (100%)

(B) Intelligent Packaging 85%
 Gen X: 100% (100%)
 Gen Y: 100% (100%)
 Gen Z: 100% (100%)

GENERATION Y

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Holistic view on the implementation of smart packaging

- **Packaging 2021**
 - ▶ Value perception of packaging functions
 - ▶ Current requirements
- **Innovations**
 - ▶ Active and intelligent packaging
 - ▶ AIP can offer solutions
- **Market implementation is coming**
 - ▶ Challenges, drivers, enabling technologies, resources

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UHASSELT KNOWLEDGE IN ACTION

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