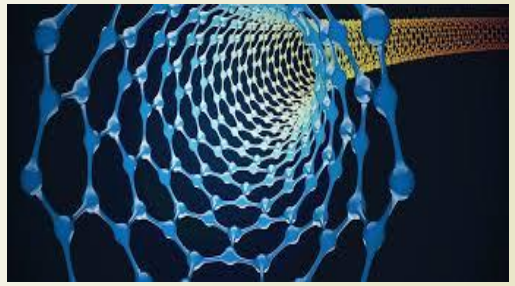
Global Harmonization Initiative

1st WORLD CONGRESS
Food Safety and Security
24-28 March 2019 • Leiden • The Netherlands

Nanostructures in food packaging



Prof. Mona Elena Popa
University of Agronomic Sciences and Veterinary Medicine of Bucharest
Member GHI – various working groups

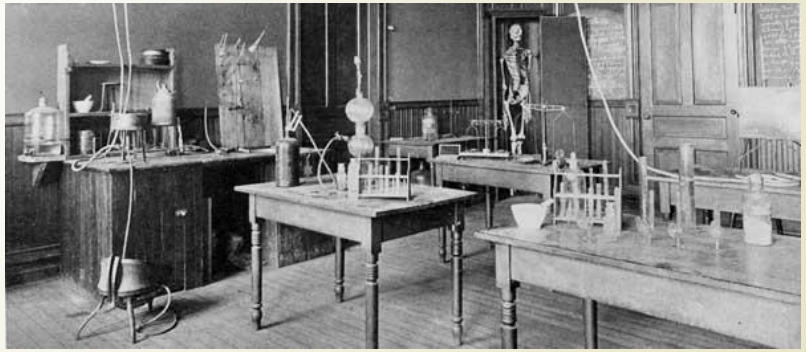
What nanotechnologies means?

- Nanotechnology is science, engineering, and technology conducted at the nanoscale.
- A general description of nanotechnology was established by the USA Nanotechnology Initiative, which defines nanotechnology as the manipulation of matter with at least one dimension sized from 1 to 100 nanometers.
- Although modern nanoscience and nanotechnology are quite new, nanoscale materials were used for centuries.
- Today's scientists and engineers find ways to deliberately make materials at the nanoscale to take advantage of their enhanced properties such as higher strength, lighter weight, increased control of light spectrum, and greater chemical reactivity than their larger-scale counterparts.

Old science but new applications

- Casein mycelia which are responsible for high stability of milk fat (at nano scale)
- Nanotechnologies market in food industry will grow from 7 billions $ (2015) to 20.4 billions $ (2020) (**Research and Markets** Jun 12, 2015)
- 40% more publications
- 90% more patents

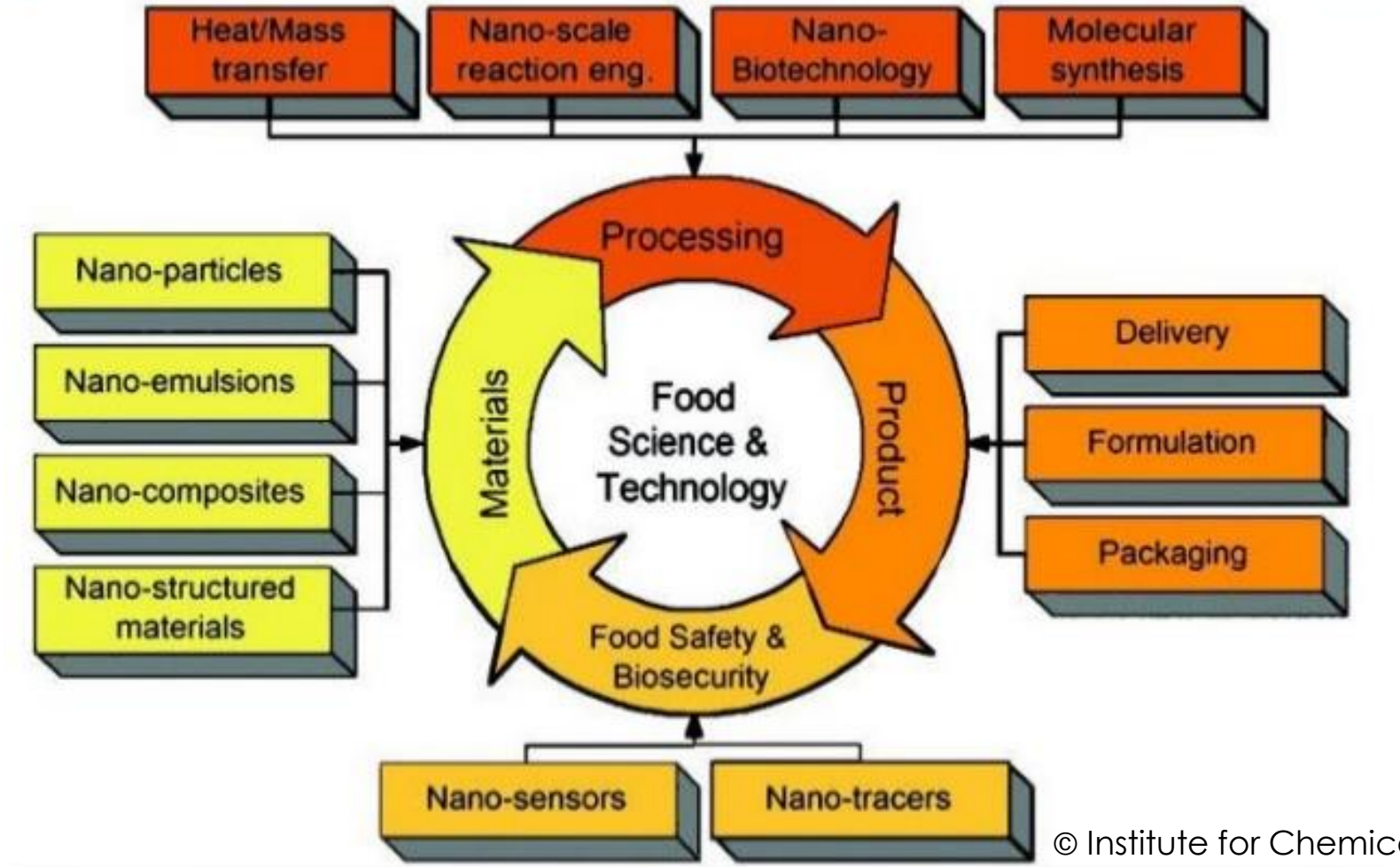
in the last 20 years



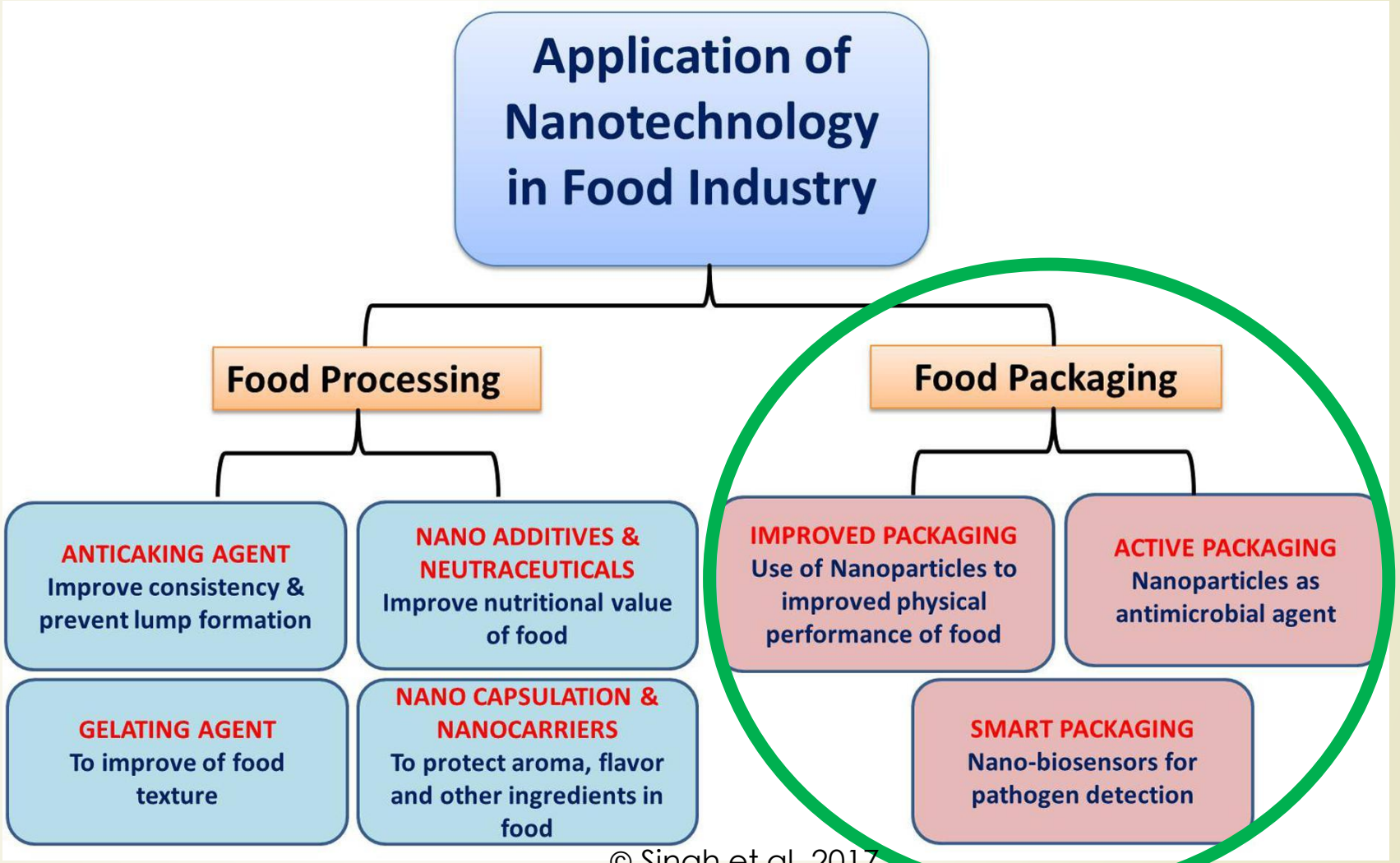
Global challenges

- Enough food (sustainability) - Feeding the increasing world population in a sustainable way
- Safe food (that prevent food-borne illness)- Improving the quality and safety of foods
- Healthy food (nutritious)- Delivering those nutrients to individual consumers that are required for good health
- Good food (satiety)- Helping in the prevention of welfare diseases like obesity through satiety and satisfaction control.

Where is Nanotechnology in Agriculture and Food Science



Most visible applications in food industry



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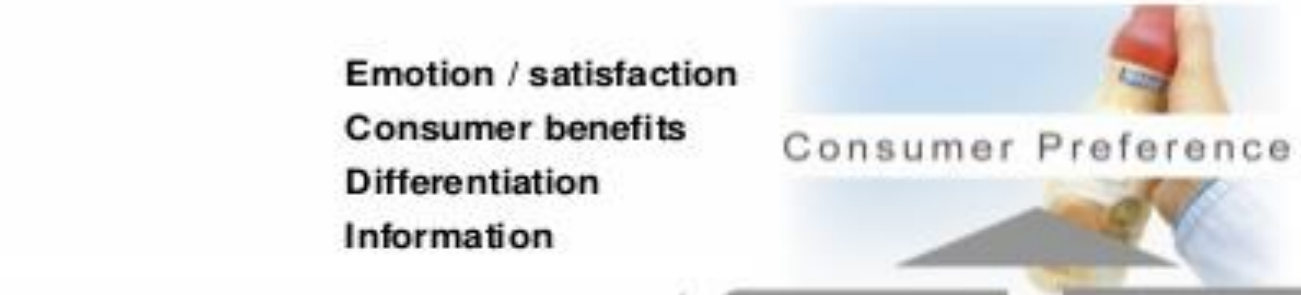
PACKAGING

Any package is a Combination of three Core Requirements influenced by four main Factors

Nestlé



Emotion / satisfaction
Consumer benefits
Differentiation
Information

Consumer Preference

Ergonomic
Convenience
Easiness and comfort

Visual Identity

Visual Requirement

Functional Requirement

Physical Purpose

Technical Requirement

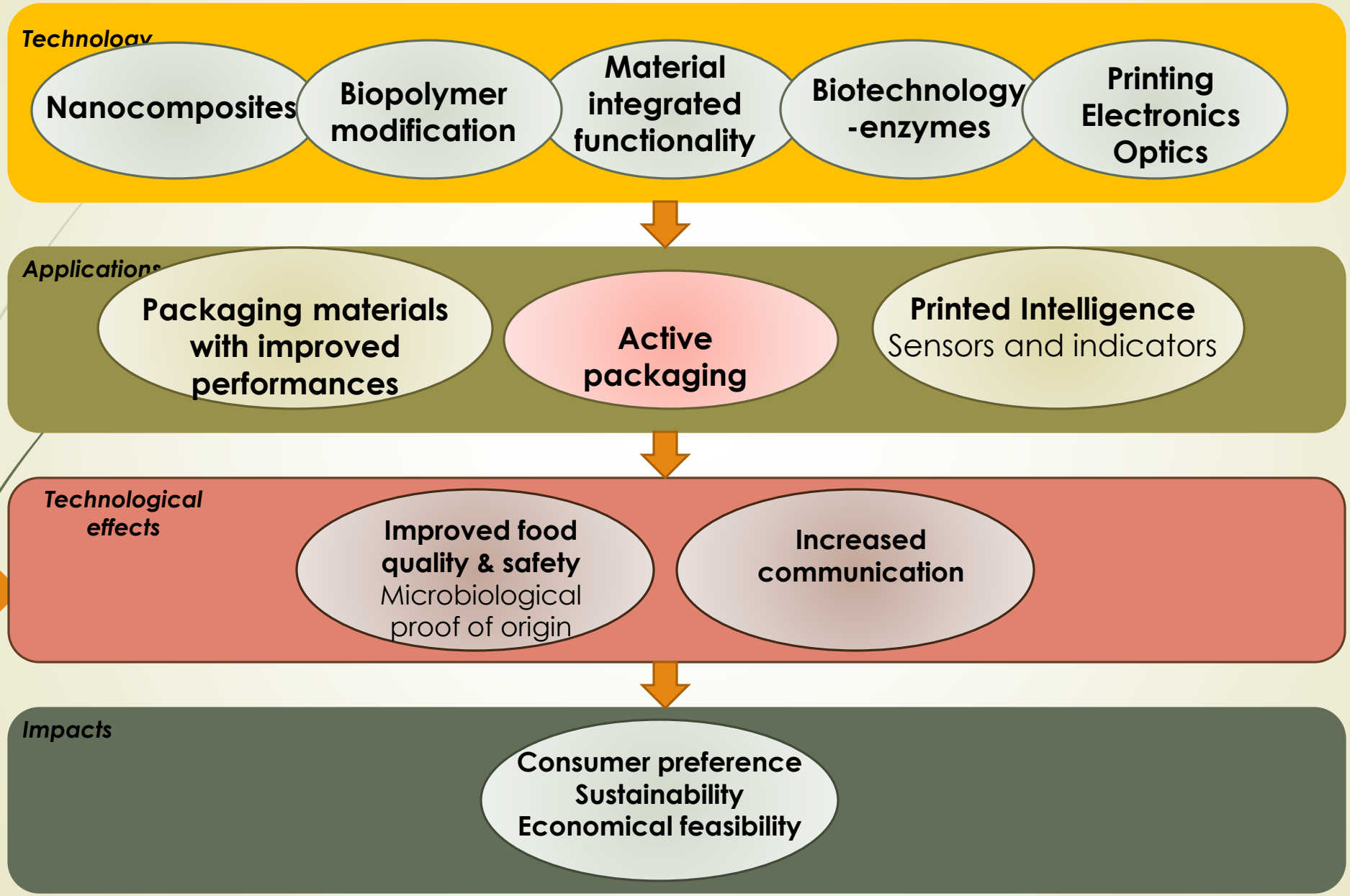
Image and appearance
Aesthetic and appeal
Brand awareness
Visual Communication
Display needs

Protection and integrity
Quality and safety
Shelf-life
Environmental respect
Supply Chain handling and identification
On-Shelf/ Off-Shelf needs

Competitive Performance

Cost competitiveness
Manufacturing and supply chain performance
Machinability
Specifications
Modularity and flexibility

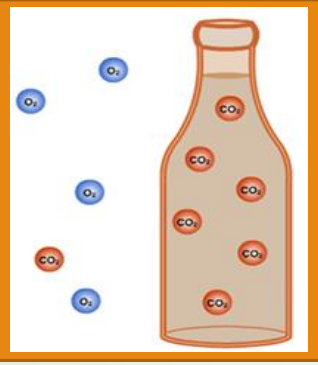
Potential of nanotechnology in food packaging

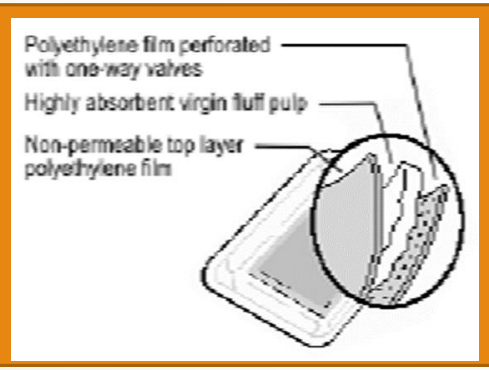


Active packaging - spoilage under control

Microbial growth inhibition

Ethylene control

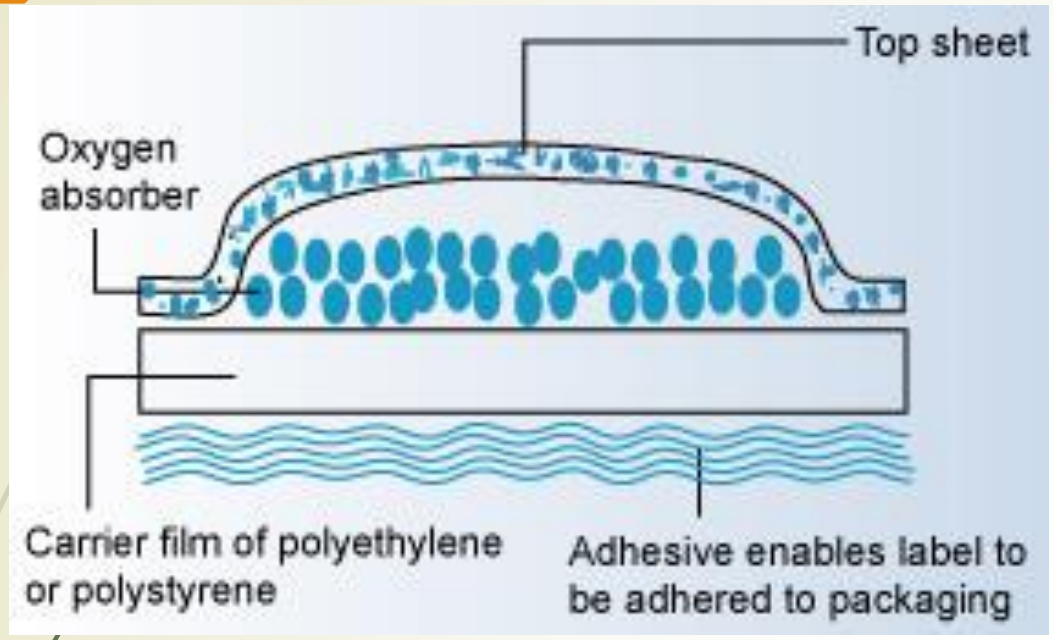


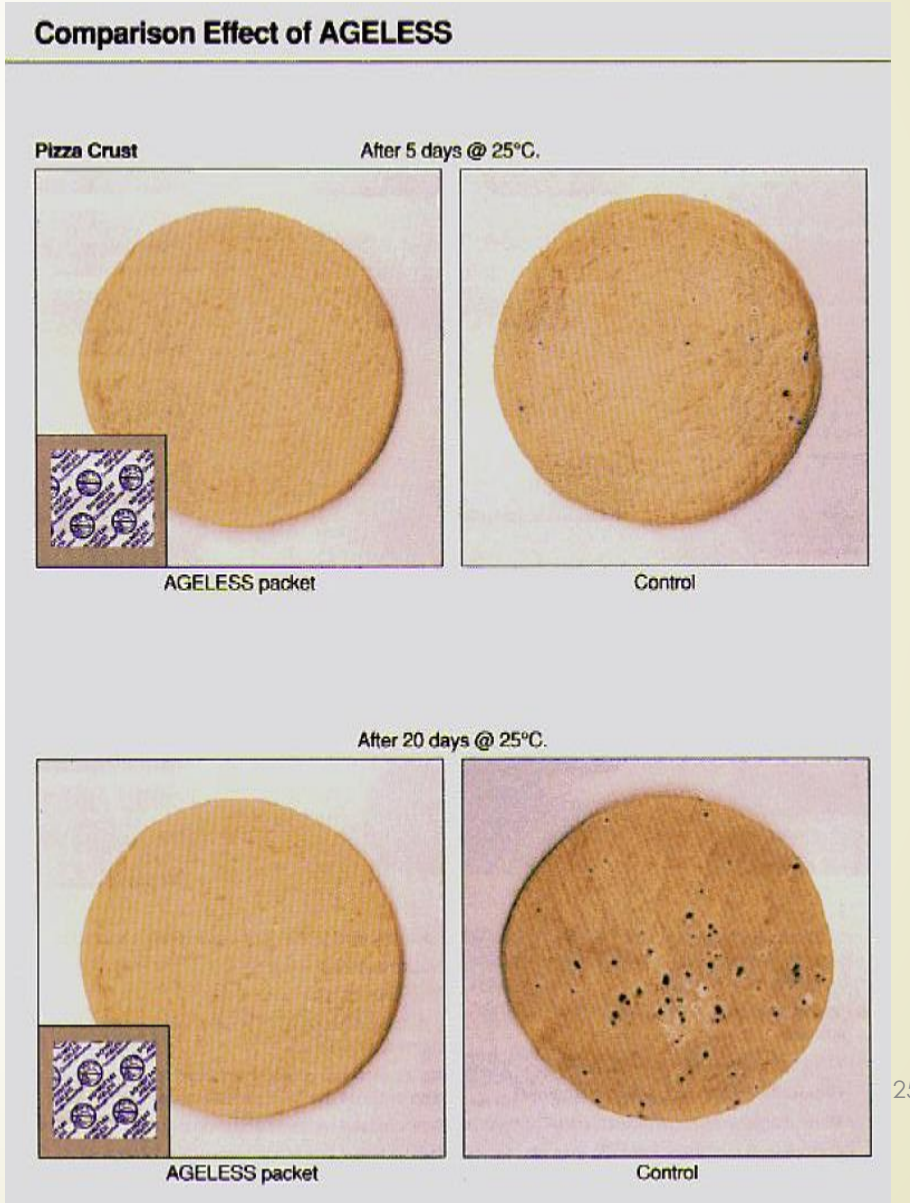


CO2, Silver NP, Nanoparticle containing antimicrobial and antifungal surface coatings

- Ripening process for some vegetals
- Inhibition of senescence in others

Mitsubishi Ageless® Oxygen Absorber





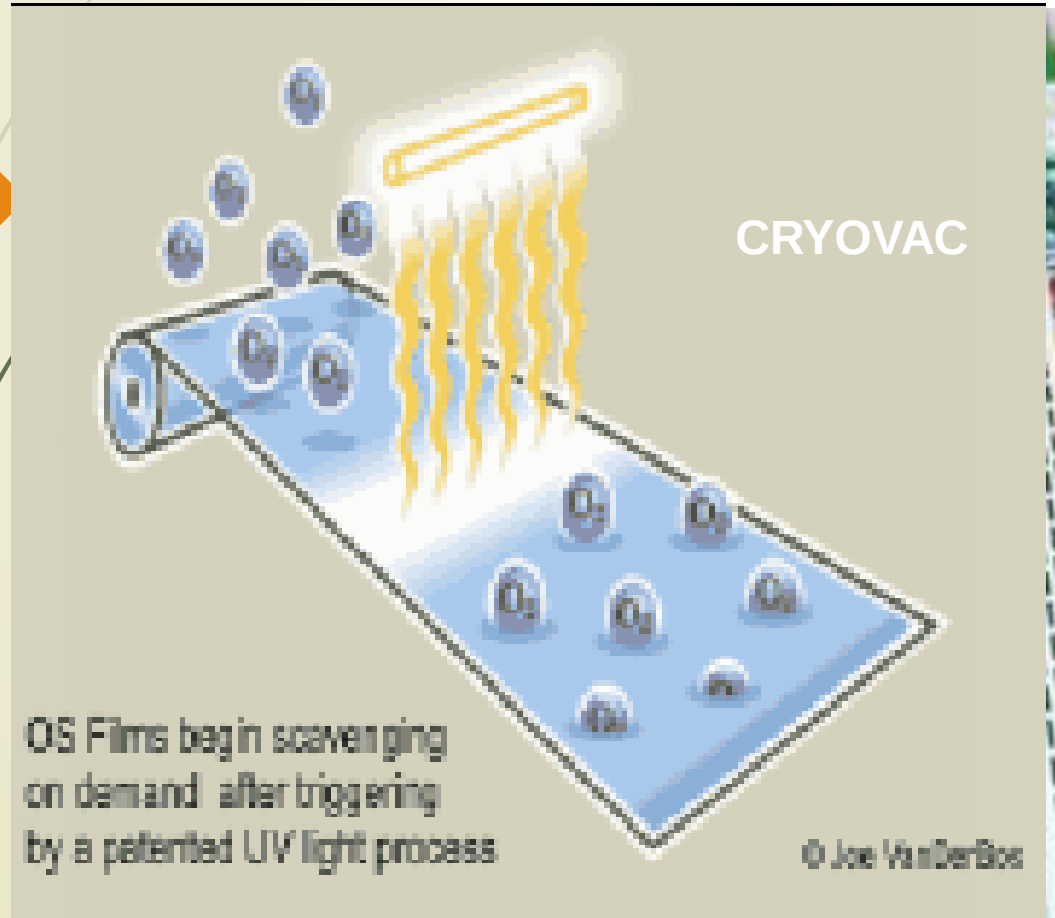
OXYGEN SCAVENGERS

Benzoacrylates

✓No resulting odor from oxidation reaction

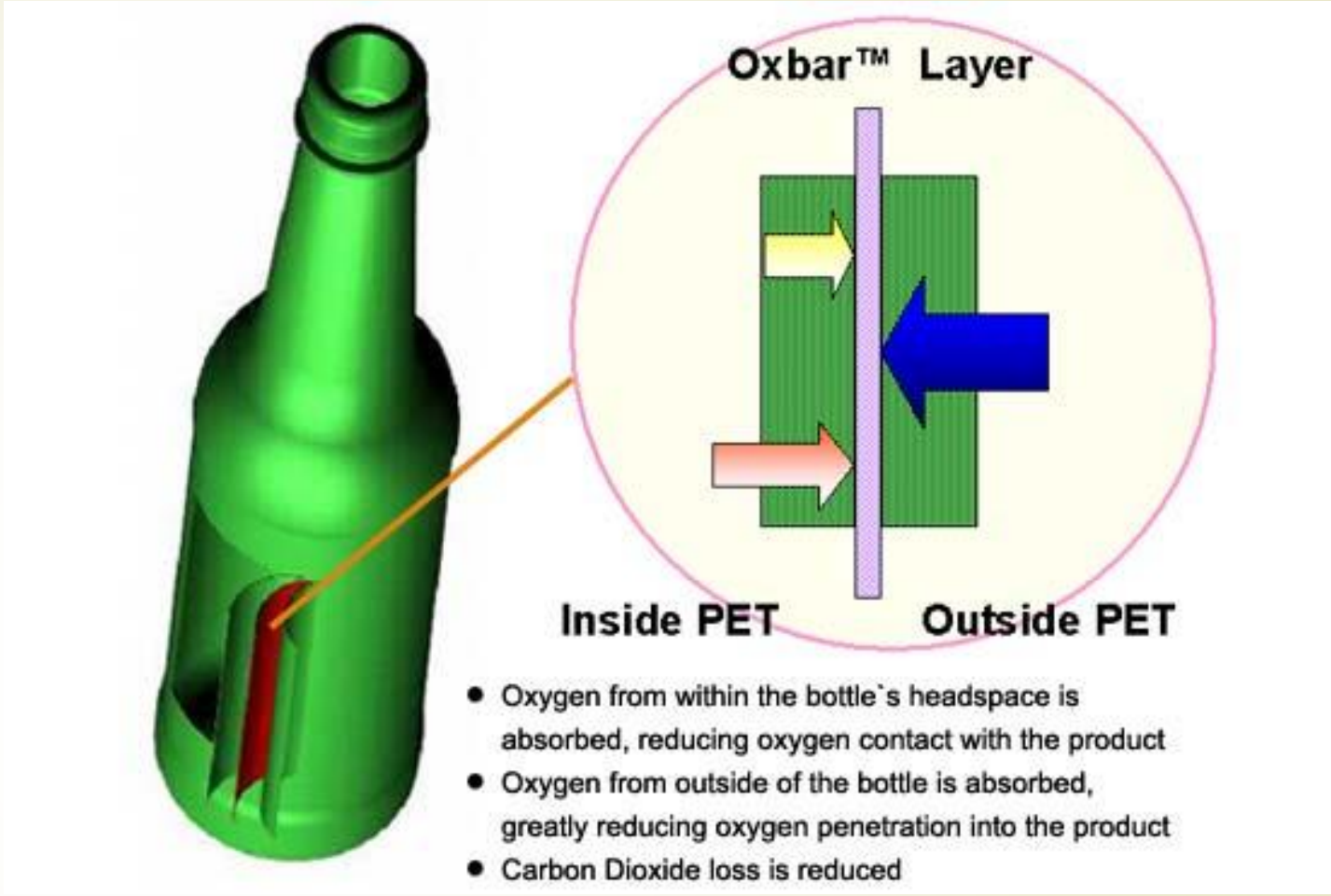
✓Basis for current CryovacOS2000

Chevron Phillips OSP (oxygen scavenging polymer).



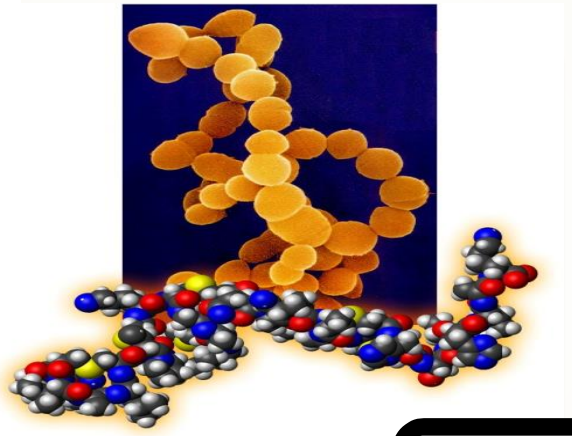
Oxygen Scavengers

PET bottles
- Multilayer preforms
- PET/5 % Oxbar/PET
- Oxbar=MXD6 nylon + Cobalt catalyst
- For beer and juice



Active packaging - to improve food quality

Microwave susceptors



Odor absorbers

Odor emmiters

ADDING OXYGEN

- To retard respiratory anaerobiosis
- To retard respiratory anaerobic pathogenic microbiological growth
- To retard respiration in lettuce:

> 70 % oxygen From Atco, France

- To “control” oxymyoglobin red color in fresh meat

OTHER ACTIVE PACKAGING CONCEPTS

Odor scavengers:

- Remove trivial amounts of odor such as from initial lipid or plastic oxidation from package headspace
  - Activated carbon - Most effective and best when it is on interior surface
  - Cyclodextrins
  - Molecular sieves
  - Alpha tocopherol (vitamin E)
  - Polyethylene imidealdehyde scavengers

ODOR CONTROL

Aroma additions - Enhance the product sensory attributes.

❖May be incorporated into plastic

- Continuous emission

❖May be on plastic surface

❖May be independent device such as an impregnated straw or closure - activate on opening

ETHYLENE ABSORBERS

Ethylene is respiratory gas from fresh produce – also from engine exhaust fumes

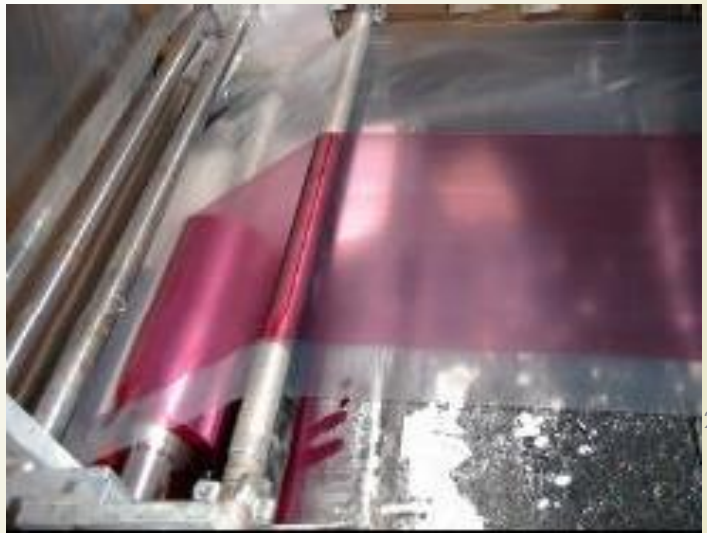
- Excess ethylene accelerates respiration
- Remove ethylene extend shelf life.

Physical absorption on active surfaces:

- Activated carbon
- Zeolite

Chemical removal with permanganate.

- Effective and commercial – in bulk distribution



Nanotechnology Applications for "Smart" Packaging

Nanotechnology derived intelligent packaging

- Nanoparticle based intelligent inks
- Reactive nanolayers
- Analyte recognition at nanoscale

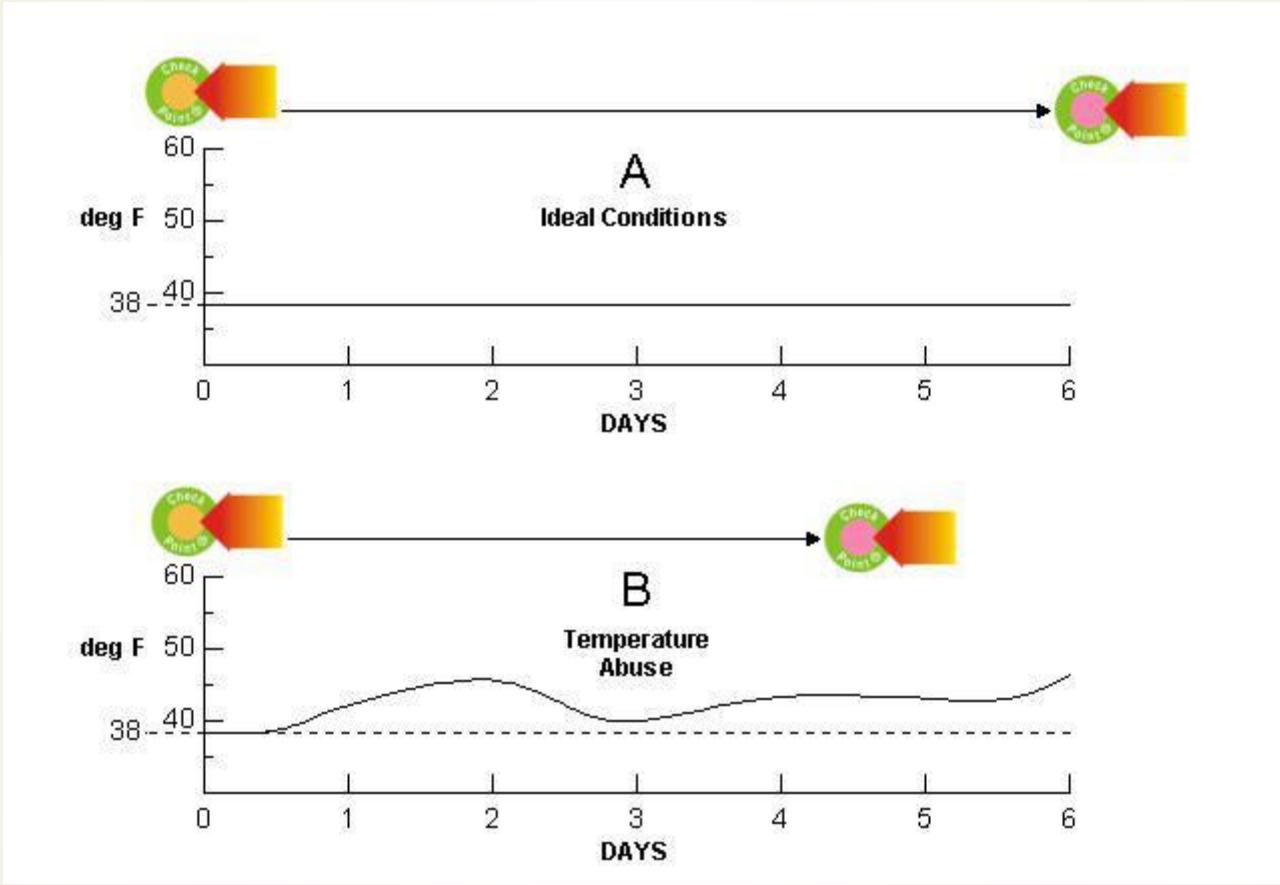
Safety requirments

- Non toxic & compatible
- Reliability of products
- Waste issues

- Temperature
- Pathogens
- Freshness
- Integrity
- Humidity

3M MONITORMARK TTI

CheckPoint®(VitsabInternational, Sweden)


A
Ideal Conditions
deg F
60
50
40
38
0
1
2
3
4
5
6
DAYS
B
Temperature
Abuse
deg F
60
50
40
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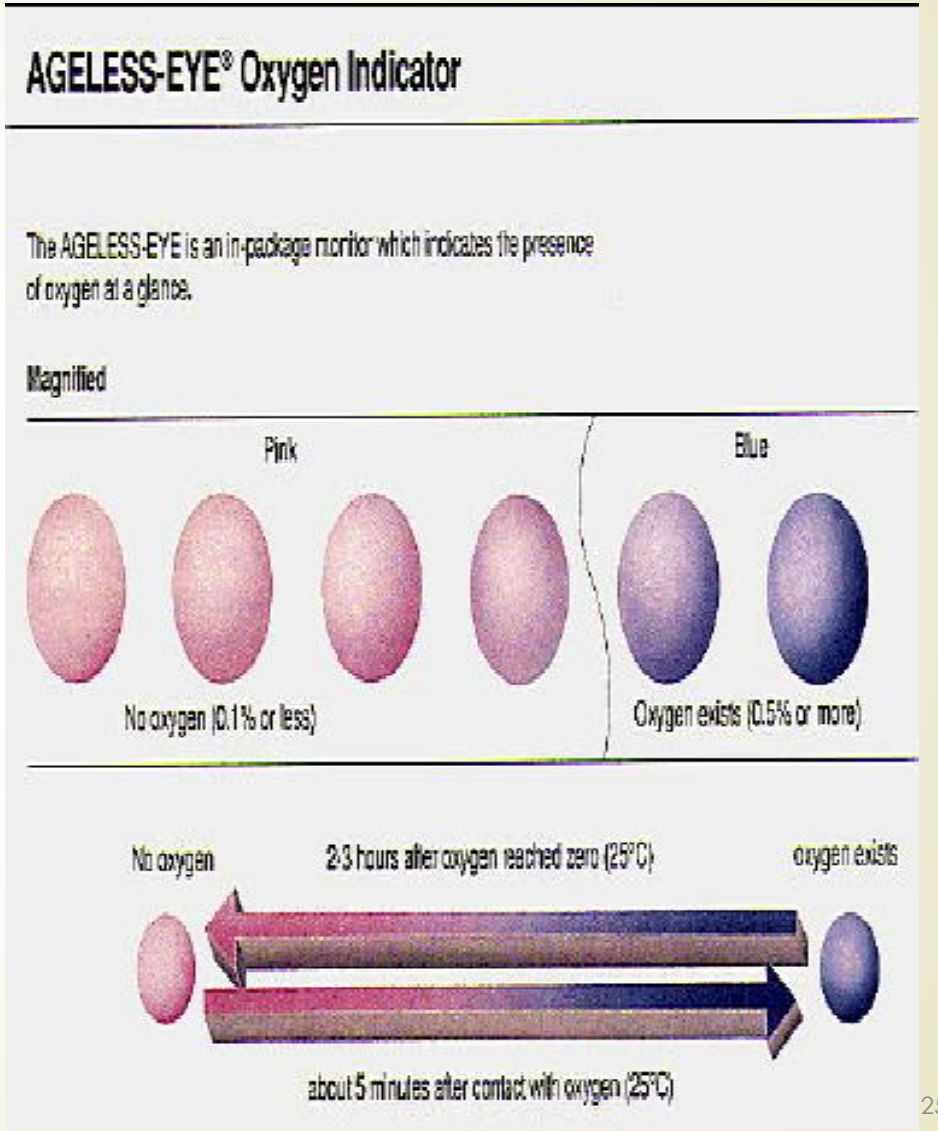
6
DAYS

Oxi check from Mitsubishi Gas Chemicals

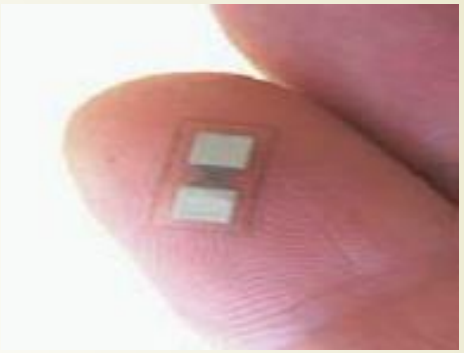
- Packs integrity

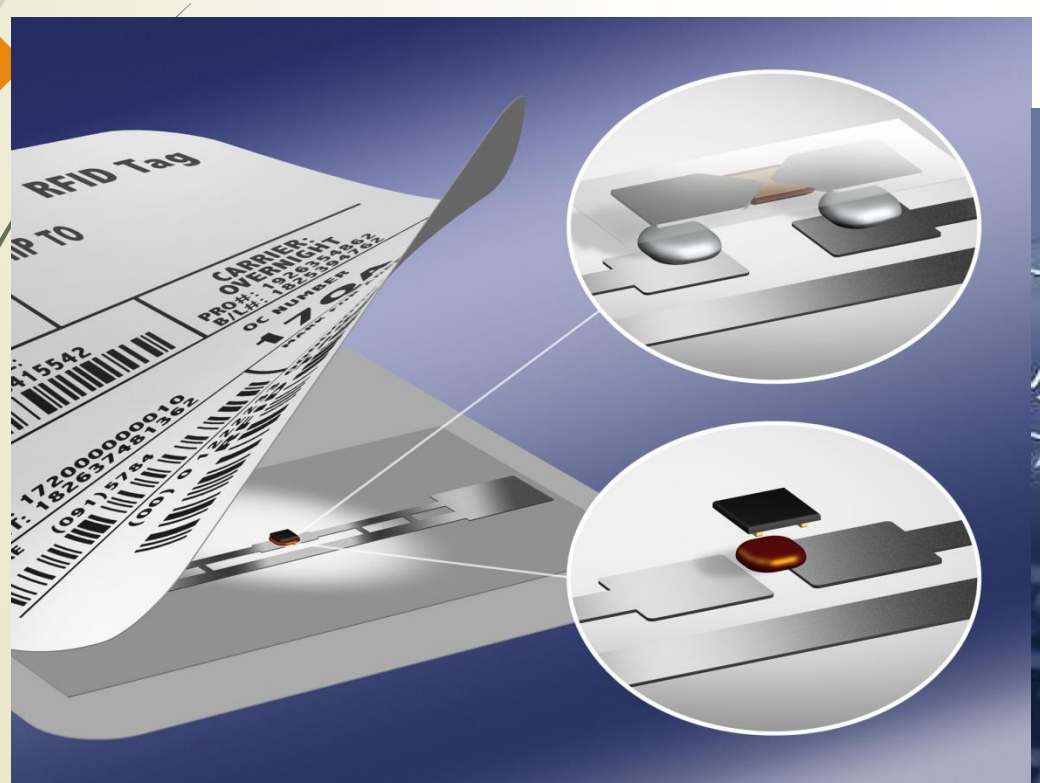
(leak) indicators

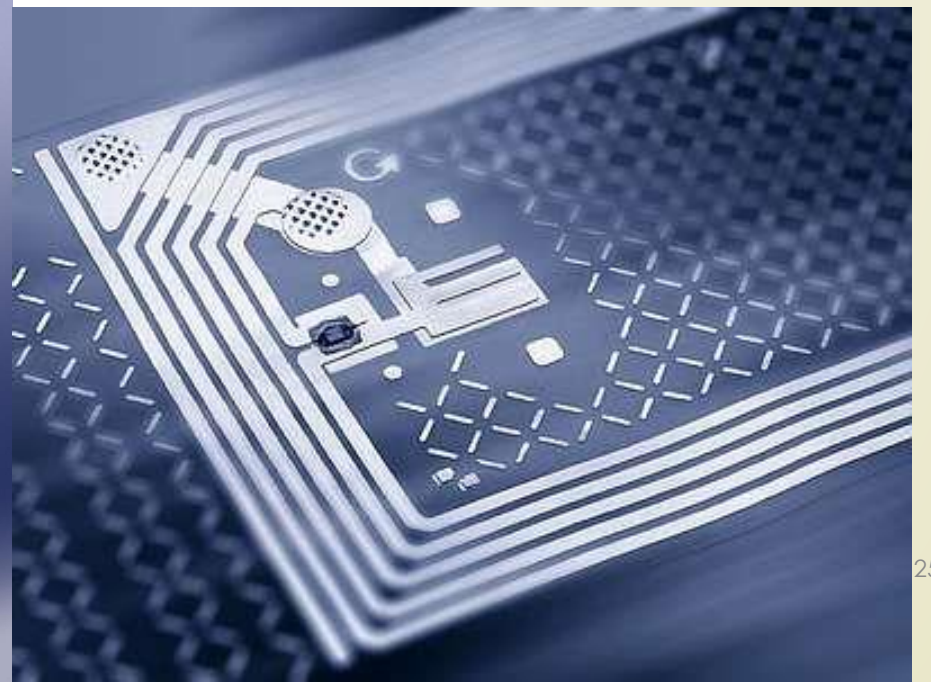


RFID – new challenge for packaging

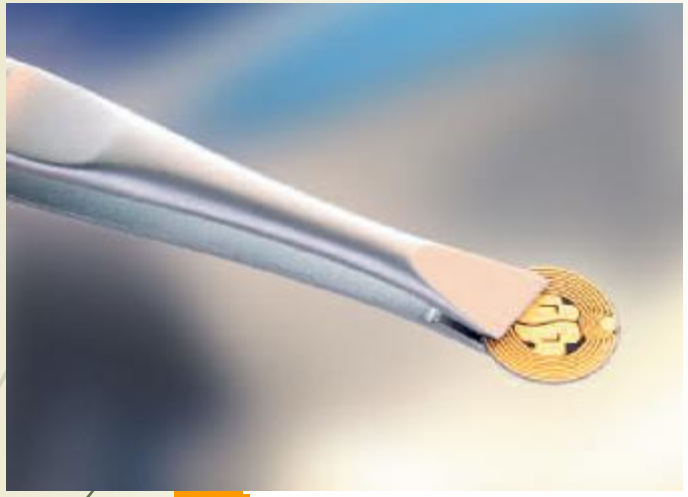
A portable data file which can embedded a lot of information in a very small electronic tag.

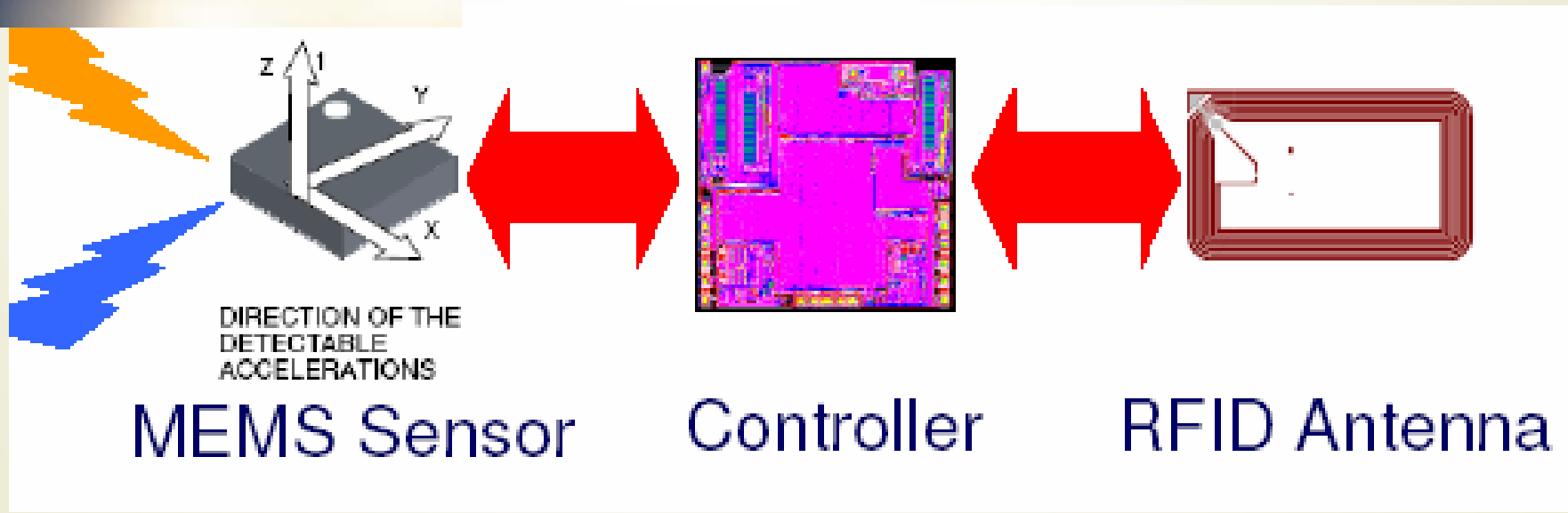






Acceleration, shock, vibration sensing





Source Montalbano

BIOSENSORS

✓Biomolecular recognition as principle.

- Antigen-antibody
- Phage capture
  - Spores
  - Bacteria
  - Higher capture rate than antibodies
- Both highly specific

✓**Transducer** to convert biological signals to an electrical response (electrochemical, optical etc.)

SIRA Technologies Inc.
Food Sentinel SystemTM

The SIRA Food Sentinel System™, The Transinformative Thermal Barcode Time & Temperature Integrator (TTI)

Origin labels

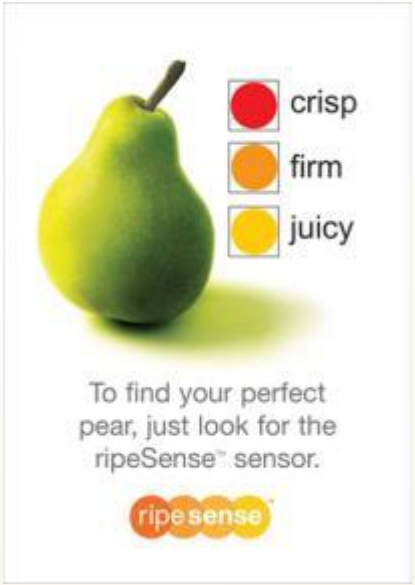
Actual DNA Label

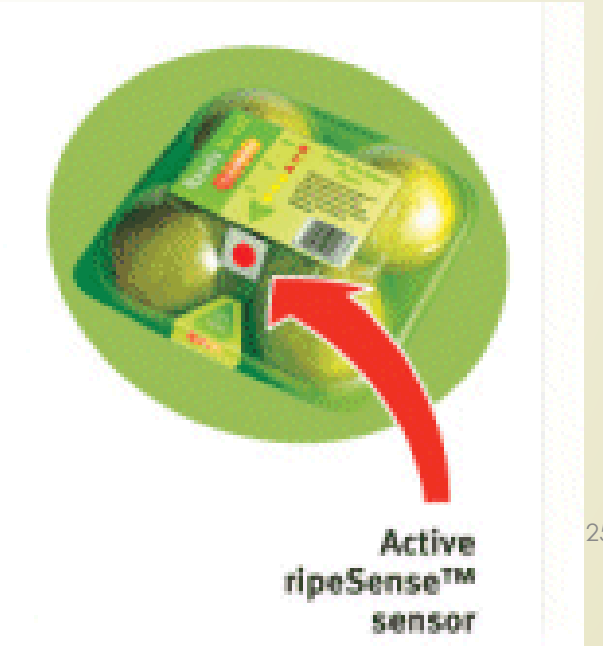
Applied DNA Sciences Inc.

Based on DNA added ink detected by electronic scanners against anti adulteration.

Ripeness Sensors

- SenseLabel - senses aromatics emitted from ripening fruit
- Signals ripeness by label visual cue/col or change –for fruit that does not change color during ripening
  - Pears
  - Melons
  - Avocados





Fp 7 Project Forest Resource Sustainability through Bio-based-Composite Development

SEVENTH FRAMEWORK PROGRAMME

INCERPLAST





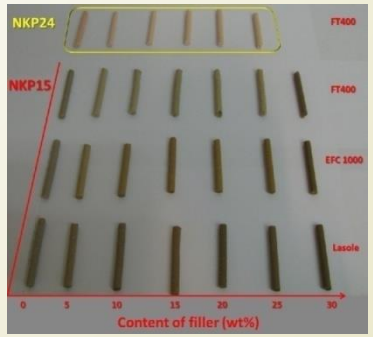


PEMU



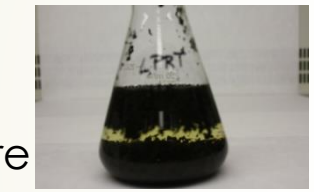


Laboratory of Plastics and Rubber Technology Budapest



Prototypes Validation

University of Agronomical Sciences and Veterinary Medicine of Bucharest
Agriculture and food packaging application



University of Almeria
Ecotoxicity, Agriculture

NORCONSERV-NOFIMA
Migration tests

Improving food safety through the development and implementation of active and biodegradable food packaging systems

ACTIBIOSAFE

Project Promotor: "Petru Poni" Institute of Macromolecular Chemistry - Iasi (PPIMC)

Partner 1: NOFIMA AS - Norway

Partner 2: SC Research Institute of Organic and Auxiliaries Products SA (ICPAO)
Partner 3: SC RODAX IMPEX SRL
Partner 4: University of Agronomic Sciences and Veterinary Medicine Bucharest (USAMVB)

Improving food safety through the development and implementation of active and biodegradable food packaging systems

ICELAND LIECHTENSTEIN NORWAY eea grants

norway grants

ACTIBIOSAFE

- **The chicken sample packaged in the Actibiosafe system (PLA / MB + PEG8 / CS-M1 / VIT E and PLA / MB + PEG12 / VIT E based trays) and stored at 4±0.5 °C demonstrated a good behavior for 7 days, whereas the control sample began the degradation process only 5 days after packing.**

Concluding Remarks

Packaging will be an integrator among the food chain players and nanotechnologies and nano sensors could be valuable tools for future development

Functionalities of the packs will grow exponentially in the future

Main engine in future developments in packaging will be innovation in biodegradable and composite materials obtaining (biotechnologies and nanotechnologies).

However, despite this impressive potential for nanotechnology applications in packaging, they have not become mainstream yet.

PUBLIC CONCERNS

- Nanomaterials which measure less than 70 nm can even be taken up by a cell`s nuclei, where they can cause major damage
- It remains unknown what levels of exposure could harm human health or the environment, if there is any safe level of nano-exposure, and whether or not nanomaterials will bioaccumulate along the food chain
- In Europe, the regulation states that the use of nanoparticles is prohibited in general unless they are specifically authorized in their nano form, and the European Food Safety Authority (EFSA) recommends that nanomaterial risk assessment has to be performed on a case-by-case basis, with just few exemptions.

Future needs

- Consumer Safety requirements and Regulation in Different Countries need to be harmonized
- Defined test methodologies that would enable the risk assessment of nanotechnology products are still not available which is making the assessment both difficult and uncertain. The present state of knowledge still has many gaps which prevents from setting what the level of safety should be. On top of that, there is the need for further migration, toxicological and other studies (like biodegradability) in order to set the right standards.
- Finally, careful evaluation of both advantages and disadvantages of using nanomaterials in packaging is needed in order to balance potential benefits and drawbacks on human health and the environment, as well as the cost-effectiveness of the solution.


Any questions
Thank you for your attention!