PROGRAM STUDI TEKNOLOGI PANGAN
FAKULTAS TEKNIK & INFORMATIKA
UNIVERSITAS PGRI SEMARANG

Teknologi Nano (Nanotechnology)

TP
UPGRIS

Apa itu teknologi nano?

Teknologi nano adalah suatu kemampuan yang digunakan untuk menghasilkan atau memanipulasi ukuran molekul dari suatu bahan menjadi sangat kecil.

1 **nanometer (nm)** adalah satu per 1 milyar meter, lebih kecil dari panjang gelombang cahaya tampak, dan 1/100 dari rambut manusia.

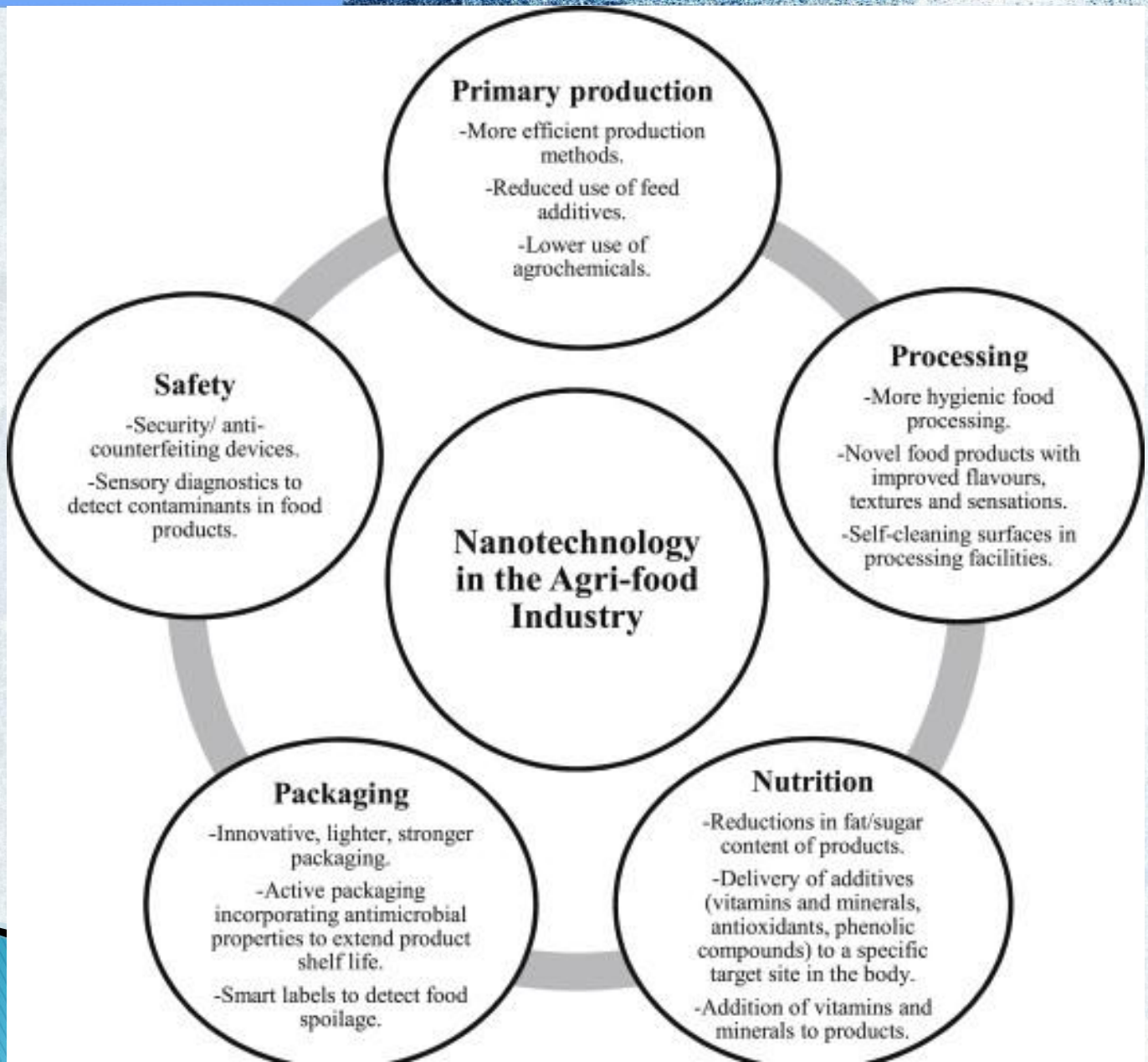
Teknologi Nano umumnya diaplikasikan untuk mencapai ukuran 1 hingga 100 nm.

Mengapa?

- Teknologi nano menjadi salah satu alternatif proses dalam perkembangan ilmu pengolahan bagi industri pangan dan pertanian

Bagaimana?

- Teknologi nano memberikan berbagai peningkatan dalam berbagai hal di industri makanan, contohnya dalam segi bahan baku (hewani dan nabati), pengolahan, pengemasan, penyimpanan, dan berbagai sektor lainnya.


Primary production
-More efficient production methods.
-Reduced use of feed additives.
-Lower use of agrochemicals.
Processing
-More hygienic food processing.
-Novel food products with improved flavours, textures and sensations.
-Self-cleaning surfaces in processing facilities.
Nutrition
-Reductions in fat/sugar content of products.
-Delivery of additives (vitamins and minerals, antioxidants, phenolic compounds) to a specific target site in the body.
-Addition of vitamins and minerals to products.
Packaging
-Innovative, lighter, stronger packaging.
-Active packaging incorporating antimicrobial properties to extend product shelf life.
-Smart labels to detect food spoilage.
Safety
-Security/ anti-counterfeiting devices.
-Sensory diagnostics to detect contaminants in food products.
Nanotechnology in the Agri-food Industry

Aplikasi

- **Teknologi nano untuk pertanian dan pangan** – Salah satu riset terapan yang menggunakan partikel nano atau teknologi untuk mencapai tujuan tertentu seperti meghasilkan panen yang lebih banyak, hewan ternak yang sehat, dan karakteristik bahan pangan yang lebih baik.

- Teknologi ini menawarkan perangkat yang dapat mengubah biosistem dan membantu proses pengolahan pangan dengan cara mempermudah proses pengawasan, analisis, persiapan, pengemasan dan penyimpanan.

Aplikasi

- Agri-food nanotechnology enables new nanoscale materials and processes, green manufacturing, development platforms as well as promise of sustainable development in long term.

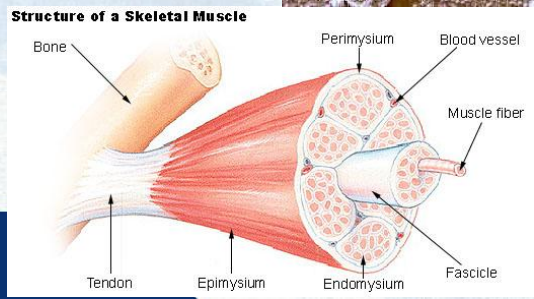
Struktur Nano Alami

- Beberapa protein pangan berada dalam bentuk globular dengan ukuran antara 1 hinga 10 nm (nanopartikel)

- Struktur miofibril dalam daging →

- Sebagian besar polisakarida dan lipi merupakan polimer yang memiliki ketebalan kurang dari 1 nm
  (1 dimensional nanostructures)

- Struktur planar dari dinding sel selulosa tanaman
  (2 dimensional nanostructure)



Struktur nano dari proses pengolahan

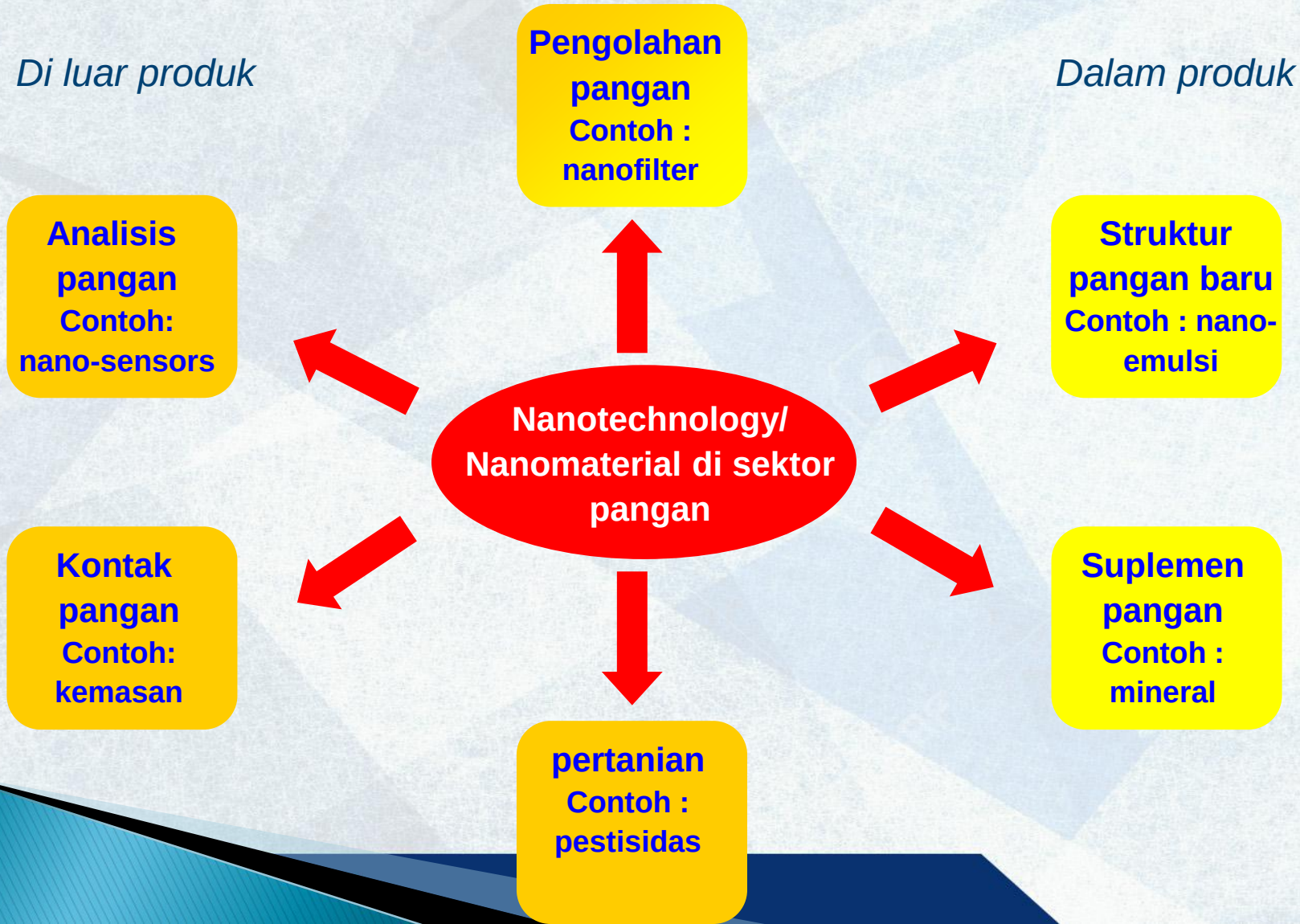
- Beberapa pengolahan pangan seperti koagulasi, emulsifikasi atau homogenisasi dapat menghasilkan struktur partikel nano yang baru

- Susu
  - Globula lemak (sekitar 100 nm) dihasilkan melalui melalui proses homogenisasi

- Busa (*foam*)
  - Proses pembentukan dan stabilisasi membutuhkan struktur nano 2 dimensi (contoh es krim, whipped cream, saos, butter, margarine)

- custard / yogurt
  - Menghasilkan struktur jaringan 3 dimensi

Aplikasi Teknologi Nano Pada Industri Pangan



Teknologi nano pada industri pertanian (agrobisnis)

- Beberapa aplikasi teknologi nano yang diterapkan pada produksi tanaman dan hewan ternak :
  - Nanosensor untuk memonitor kondisi tanah, pestisida, herbisida, pupuk, insektisida, pertumbuhan tanaman, dan lain sebagainya,
  - Nanosensor untuk mendeteksi kontaminan yang dapat menyebabkan keracunan atau mengetahui kondisi lingkungan lahan,

Teknologi nano pada industri pertanian (agrobisnis)

- Beberapa aplikasi teknologi nano pada industri pertanian :
  - Nanochip untuk mengidentifikasi proses penyimpanan dan disribusi,
  - Nanokapsul untuk for delivery of pesticides, herbicides, fertilizers and vaccines that allow the dosage reducement and ensure controlled slow delivery to plants,
  - Bio-nanosensors to detect metabolites like lactate, glucose and ATP within animals

Nanotechnology in plant and livestock (agriculture)

- Some of the current applications of nanotechnologies in in plant and livestock production:
  - Aptasensors for determination of antibiotics, drugs and their residues (e.g. cocaine, oxytetracycline, tetracycline, kanamycin),
  - Aptasensors for determination of heavy metals (e.g. Hg^{2+}, As^{3+}, Cu^{2+}).

Nanomaterials in the Food Sector

- nanotechnology applications are expected to bring changes to the food sector:
  - improved production and processing techniques
  - improved food contact materials
  - modification of taste, texture and sensation
  - monitoring food quality and freshness
  - reduced fat and salt content
  - enhanced nutrient absorption
  - improved traceability and security of food

Nanotechnology in food production

- Nanotechnology plays a key role in achieving safe and quality food products, through detecting pathogens and contaminants by using nanosensors and indicators, encapsulating nutrients and developing new functional products.

Nanotechnology in food production

- Applications of nanotechnology in food production:
  - Nanotechnology-based tracing for detection of the presence of pathogens, spoilage microorganisms, allergens, chemicals and other contaminants in food as well as nutritional information,
  - Nanoencapsulated flavor enhancers,
  - Aptasensors for determination of microbial toxins (e.g. OTA, Fumonisin B1)

Food Processing

raw material

naturally occurring nanostructures

Food Processing

proteins, starches, fats undergo structural changes at the nm and µm scales

huge variety of food products

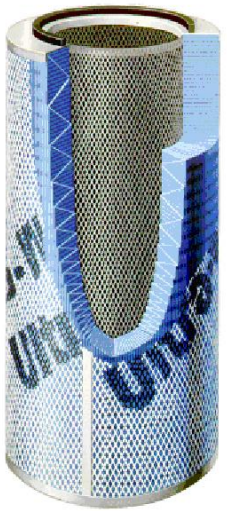
naturally occurring nanostructures
+
nanostructures introduced through processing

Food Processing

Nano-filtration

- nano-ceramics for restaurant deep-frying machines
- treatment of effluents from the food industry
- food industry
  - global market for nanofiltration membranes should reach USD 310.5 million by 2012
  - the water treatment sector was projected to account for 72.7% of total revenues in 2007
  - the main applications of nanofiltration in food production are in the dairy and sugar industry
  - around 300,000 m^2 of nanofiltration membranes are assumed to be currently applied in the food

nano-ceramic for deep-frying machines



commercial air filter cartridge using nanofibre filter media

Nanospectroscopy in food processing

- Applications:
  - monitoring of food processes and fermentation,
  - heating and oxidation of edible oils,
  - processing and preservation of meat,
  - determination of food contaminants.

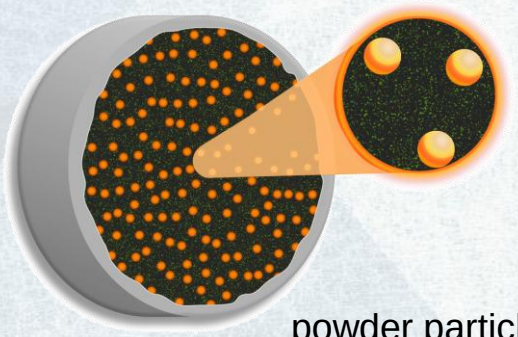
Nanospectroscopy in food processing

- Surface enhanced Raman spectroscopy (SERS) techniques have been applied in food analysis as a rapid and sensitive tool for the detection of food contaminants and as a diagnostic tool for foodborne microorganisms.

Food Supplement

Nano-lycopene (Lycovit®, since 2009 approved as a novel food)

- BASF produces a synthetic form of the tomato carotenoid lycopene
- mean particle diameter in the range of 300 nm
- nanoparticles in powders or in oil
- additive for beverages and other foods
- addition not only for health purposes, but also for colouring



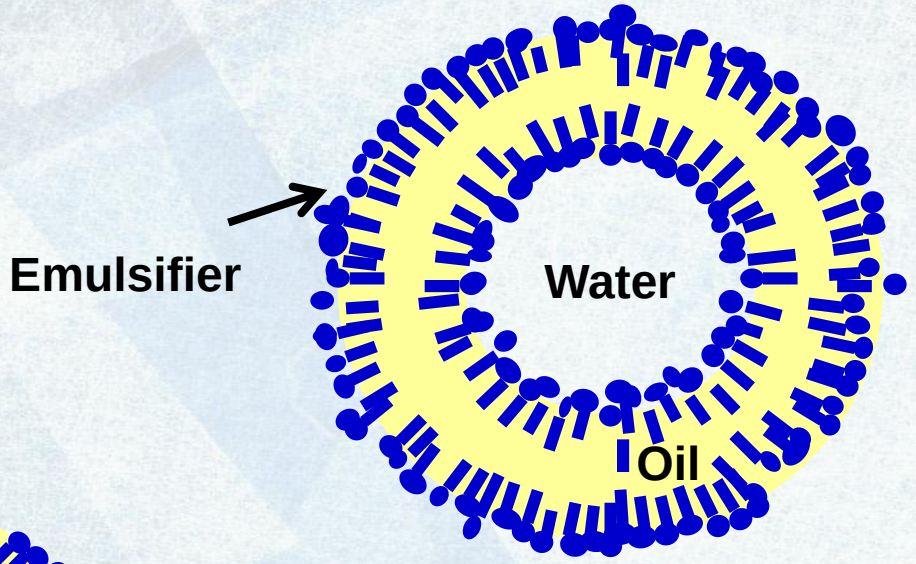
powder particle 0.3 mm

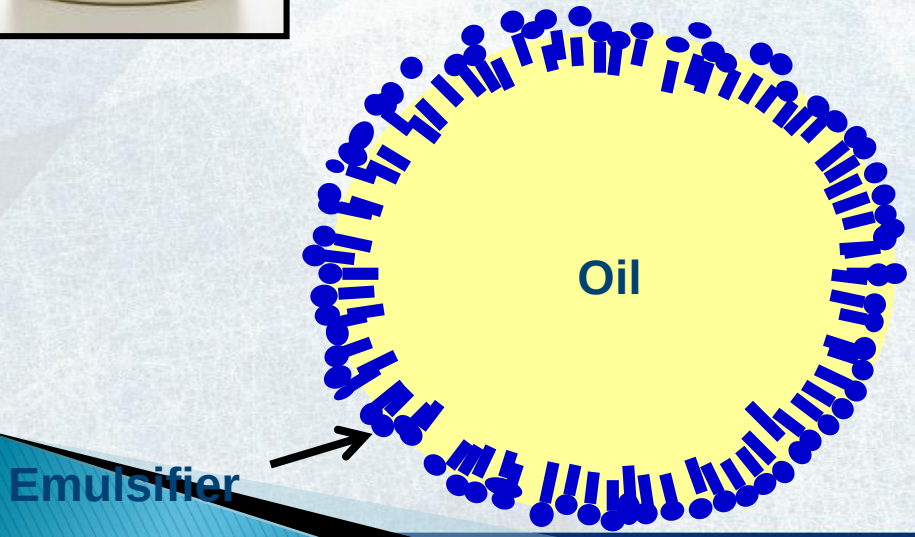
nanoparticles
300 nm

BASF, 2006

Novel Food Structures

Structuring of Foods
Fat-reduced Mayonnaise

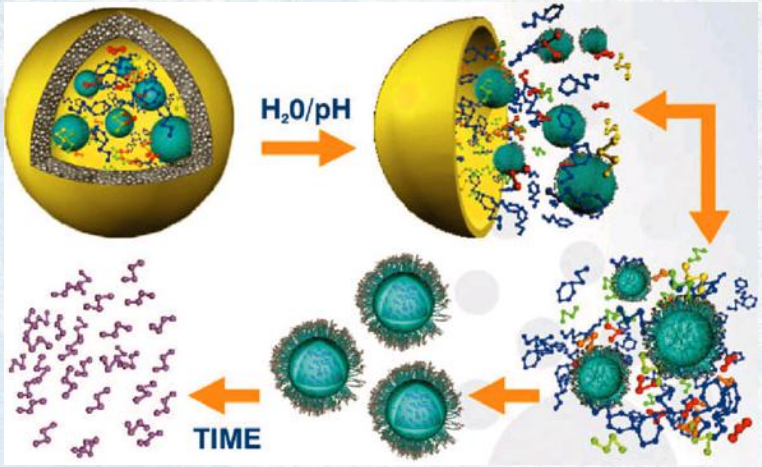




Novel Food Structures

Nano-encapsulation

- bioavailability (e.g. fat-soluble vitamins)
- protection / stabilisation
  (e.g. acid-labile compounds)
- masking (e.g. omega-3 fatty acids)
- controlled release



Food Contact Materials

Packaging

- anti-microbial coatings (e.g. nano-Ag, nano-MgO, nano-ZnO, release-systems)
- improved mechanical and technical properties (e.g. nano-clay, nano-titanium nitride)
- improved barrier properties for gas and moisture (e.g. nano-clay)
- UV-protection in transparent wraps, films or containers (e.g. nano-titanium dioxide)
- non-stick coating
- active and intelligent materials (e.g. nano-clay with metal oxides)

ketchup bottle with a non-stick coating to improve emptying

Food Packaging

Active Packaging

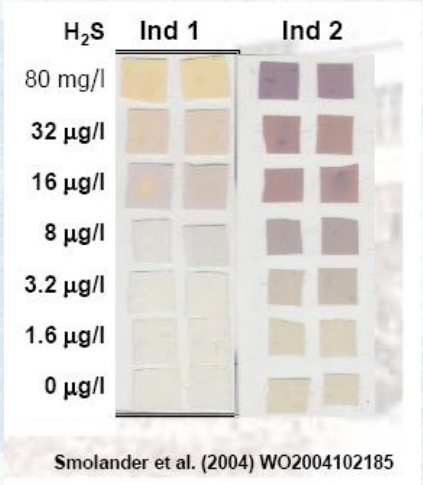
- actively changes the condition of the packaged food to extend shelf-life or to improve safety or sensory properties, while maintaining the quality of the food

ethylene scavenging foils for packaging of fruit products to prevent early ripening

Intelligent Packaging

- monitor the conditions of packed foods to give information about the quality of the packed food during transport and storage

hydrogen sulphide indictor



Food Packaging

Packaging / Surfaces

- anti-microbial coatings (e.g. nano-Ag)

FresherLonger Miracle Food Storage, The Sharper Image (USA)

Nano Silver Spray, Nanogist Co. Ltd. (South Korea)

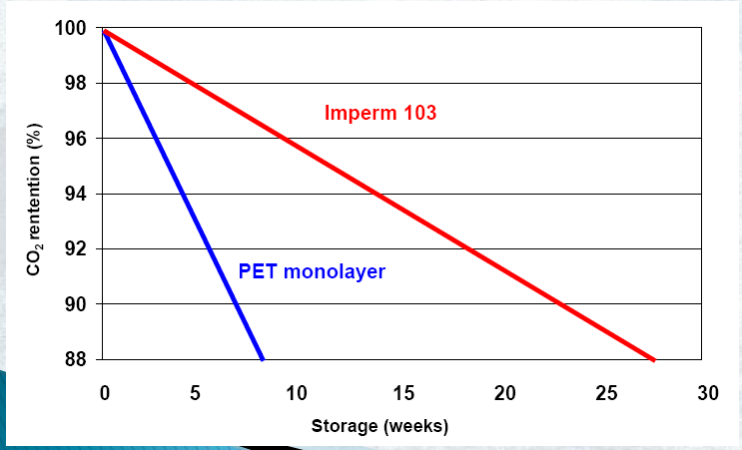
Anti-bacterial Kitchen Utensils, Nano Care Technology Ltd. (Hong Kong)

Baby Milk Bottles with Nano-Silver-Soother, Baby Dream Co. Ltd. (South Korea)

Food Packaging

Food Packaging - Imperm®

Nanoclay particle-based nanocomposite of Nanocor



- reduced entrance of oxygen (80%) and minimized loss of carbon dioxide
- lighter and stronger
- used in plastic beer bottles, films and multilayer bottles, could replace EVOH layer in ketchup bottles

Food Packaging

Nanotechnology in food packaging and transportation

- In nano-food system, packaging plays significant role in prolonging shelf life, freshness and quality of fresh and stored food products.

- Numerous nanosensors are developed for various applications in food sector, mostly for improving the shelf life, food quality, safety, fortification as well as utilizations of biosensors for contaminated or spoiled food or food packaging.

Food Packaging

Nanotechnology in food packaging and transportation

- Nanosensors in food packaging → Smart packaging and food tracking
  - Nanosensors and antimicrobial activators are being engineered to be capable of detecting food spoilage and releasing nanoantimicrobes. Such systems will extend shelf-life of food.
  - Mars Inc. is a company that has patented invisible edible nano wrapper which will act as an envelope for foods to prevent gas and moisture exchange.

Nanotechnology in food packaging and transportation

- Nanosensors in food packaging
  - **Interactive 'smart' food**
    - Kraft and Nestle food companies are working on designing „smart" foods that are intended to interact with the consumers so they can personalize their food, by changing color, flavor, and nutrients on demand.
    - Kraft is developing a clear tasteless drink that contains hundreds of flavors in latent nanocapsules, by using a microwave you would be able to trigger the release of the color, flavor, concentration and texture of the individual's choice.

Nanotechnology in food packaging and transportation

- Nanosensors in food packaging
  - **Aptasensors**
    - Aptamers are single stranded nucleic acid or peptide molecules of size less than 25 kDa with natural or synthetic origin. They are highly specific and selective towards their target compound.
    - There is a wide variety of nanomaterials which can be used in aptasensors, metal nanoparticles and nanoclusters, semiconductor nanoparticles, carbon nanoparticles, magnetic nanoparticles etc.

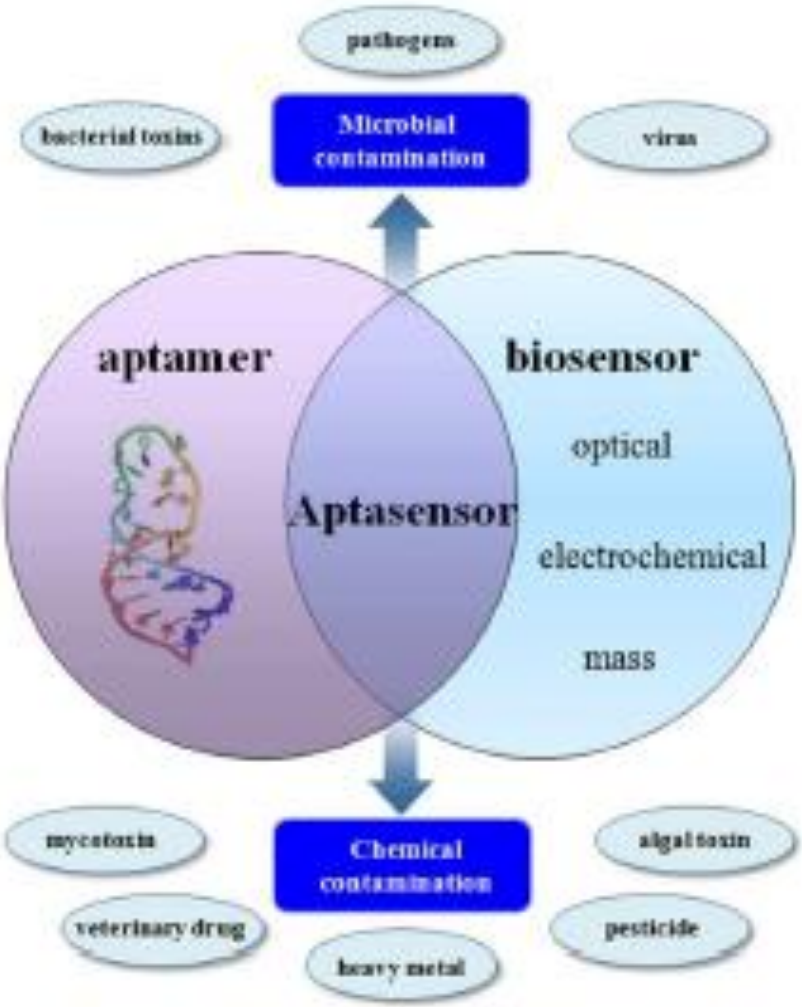
Food Packaging

Nanotechnology in food packaging and transportation

- Nanosensors in food packaging
  - **Aptasensors**
    - Nanospectroscopic techniques Raman scattering and SERS and surface enhanced resonance Raman scattering (SERRS) have important application in construction of aptasensors applied in food packaging.

Food Packaging

- Nanosensors in food packaging
  - **Aptasensors**



Food Analysis

Food forensic

- Investigation of :
  - Food origin
  - Authentication (fraud)
  - Provenance of a foodstuff
  - Microbial spoilage and contamination

Food Analysis

Food forsenic

- Food forensic involves the possibility of using powerful scientific methods for the authentication and traceability of foodstuffs.
- Nanospectroscopic methods are very important in this field
- Raman spectroscopy is ideally suited for food forensic, due to the specificity and the diversity of the analytes which can be probed; ranging from the macro-food, lipids, proteins and carbohydrates, to the minor components, dyes, pigments, preservatives.
- .

Food Analysis

Food forensic

- Raman and IR spectroscopy have been applied in the identification of olive oils adulterated with hazelnut oil.
- Raman spectroscopy have been employed in the authentication of apple, pomegranate and blueberry juices.

Food Analysis

Food forensic

- Raman spectroscopy has been used to confirm the botanical and geographical origins of European honey.
- Methods based on IR spectroscopy are used more in the determination of microbial spoilage and contamination than Raman spectroscopy.

Conclusions

- Nanotechnology and nanospectroscopy play an important role in agriculture and food production as well as in livestock production.
- Their potential use and benefits are enormous.
- Existing applications of nanotechnology in food and agriculture are more oriented to reduce the negative impact of agrochemical products in the environment and human health, rather than the utilization of nanotechnology applications to improve their properties for food and livestock production.

THANK YOU!!