EUROPEAN COMMISSION

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MARIE CURIE ACTIONS

UNIVERSIDAD NACIONAL DE LUJAN

EULA-NETCERMATProject

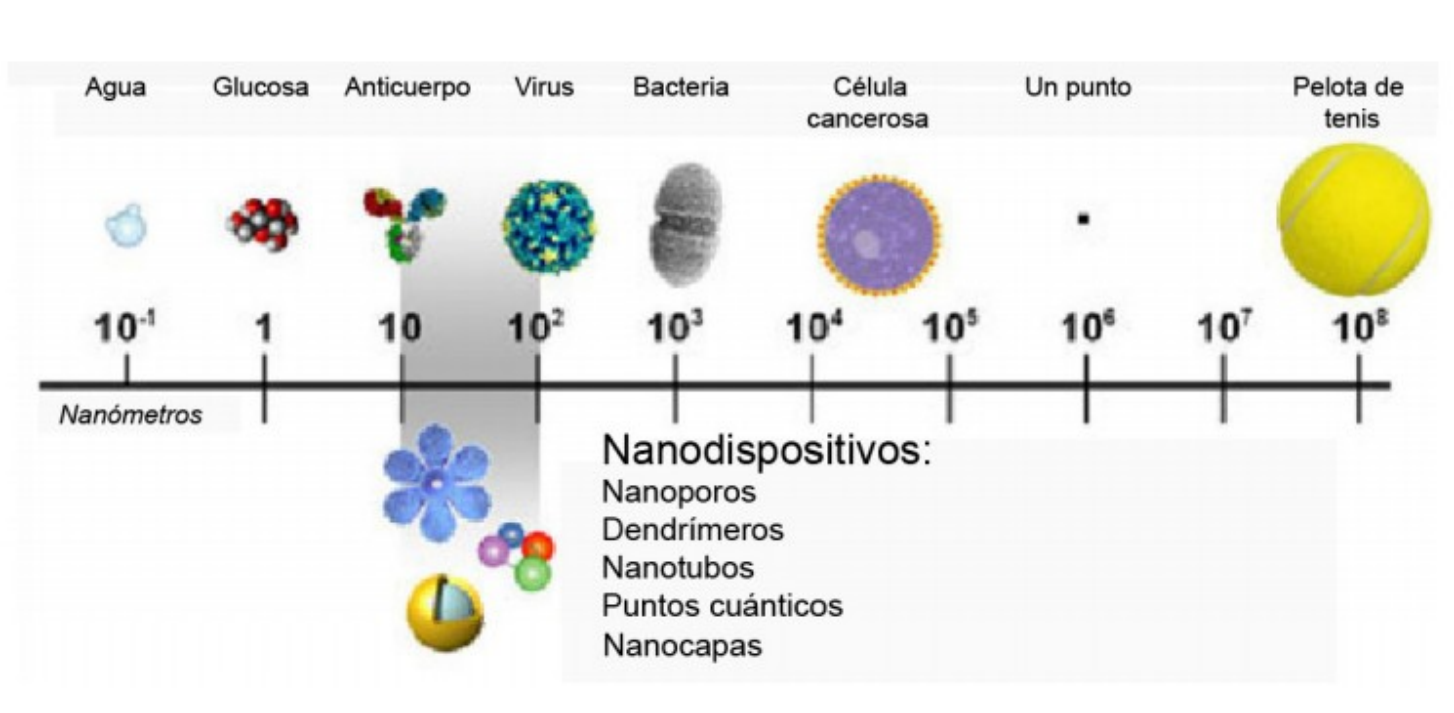
with environmental and industrial applications

Nanotechnology applications in Food Science

Dra. Ing. Alicia Gallo

Seminario internacional
La nanotecnología: Eje importante para el futuro de la cooperación CELAC-UE
Organizado por IRELAC y los socios del proyecto EULANetCermat

A new scale ???



1 micrón 10-6 metro

1 nanómetro 10-3 micron

1 nanómetro 10-9 metro

Nanotechnology has spread its wings in various spheres of life.

It has progressed from the first generation passive nanomaterials to
nanotechnology active (drug delivery) and

nanosystems (for example, robotics).

And, what about the nanofood??
Still in its childhood?

Where is “the nano” in food??

Nature

Digestive Process

Molecules

Fresh food

Processed foods

Molecules

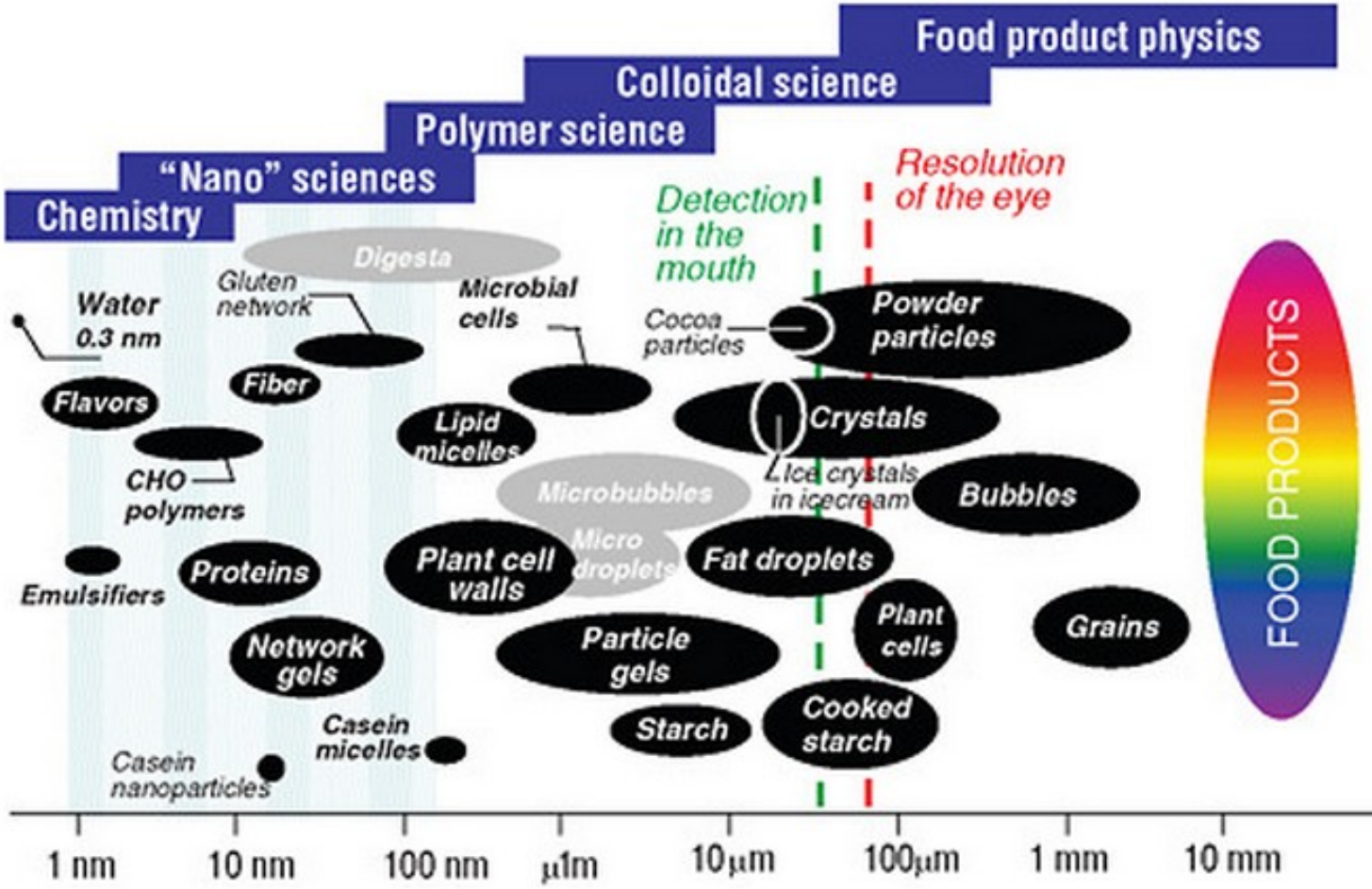
Ingredients

Processing

Ingredients: molecules, macromolecules, biopolymers, water

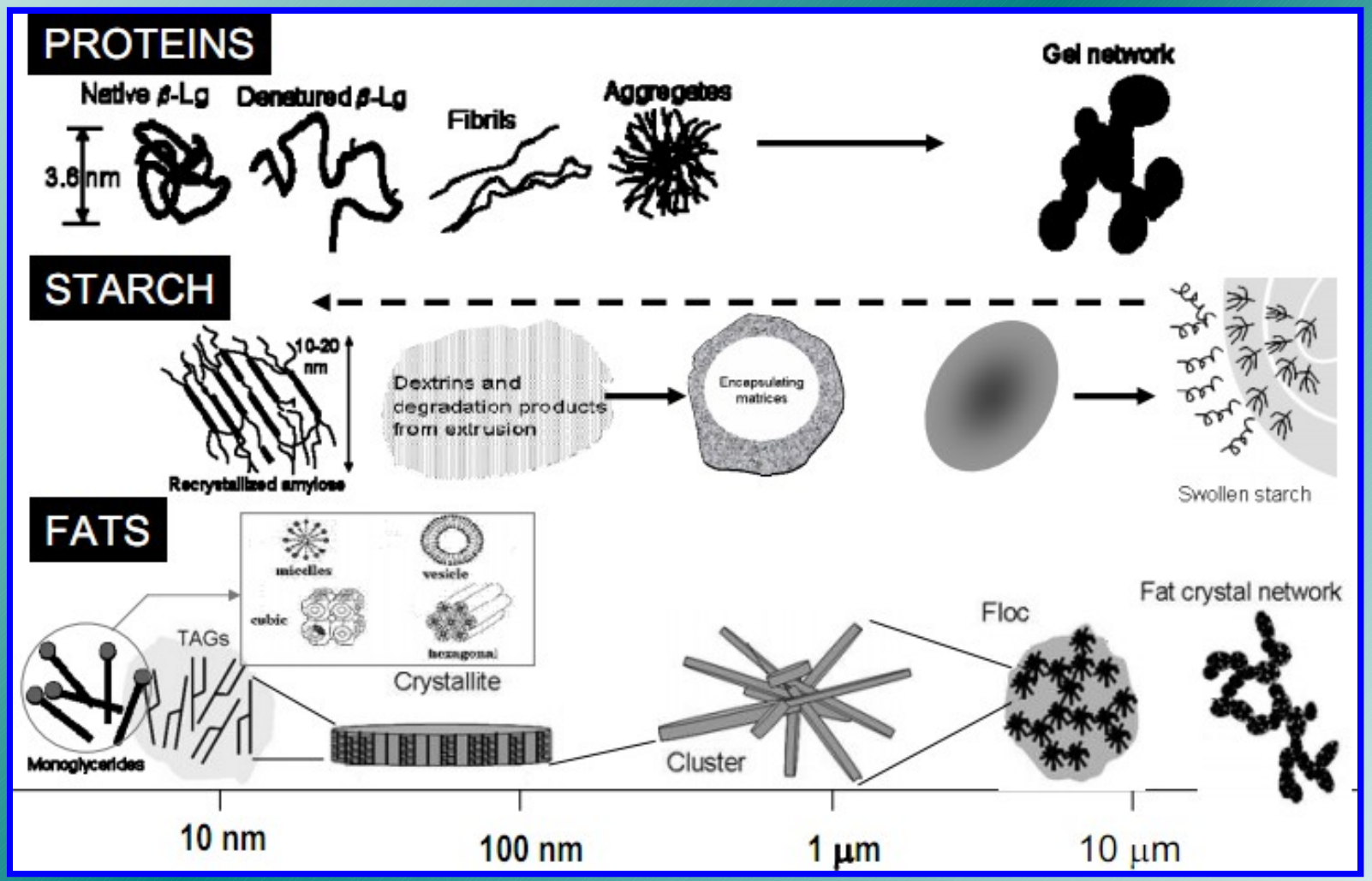
Structures: fibers, gels, emulsions, foams

Properties: texture, flavor, shelf life, bioavailability


Food product physics
Colloidal science
Polymer science
"Nano" sciences
Chemistry
Resolution of the eye
Detection in the mouth
Digesta
Gluten network
Microbial cells
Water 0.3 nm
Cocoa particles
Powder particles
Fiber
Flavors
Lipid micelles
Crystals
CHO polymers
Microbubbles
Ice crystals in icecream
Bubbles
Micro droplets
Plant cell walls
Fat droplets
Emulsifiers
Proteins
Plant cells
Grains
Network gels
Particle gels
Casein micelles
Starch
Cooked starch
Casein nanoparticles
FOOD PRODUCTS
1 nm
10 nm
100 nm
µ1m
10µm
100µm
1 mm
10 mm

IOM, 2008

Microstructural changes during processing



JMAguilera, 2009

How to build a food structure, a paradigm shift

Traditional

Future

FORMULATION

Molecules

Assembling

Interactions

Structure assembling

Structure stability

Matrix precursors

Elemental structures

Metastable structure

Arquitectura

Funcional structure

But .... What is the driving force for a food product development ?

Changes in consumer demand

Healthier food

Less fat

O% trans fats

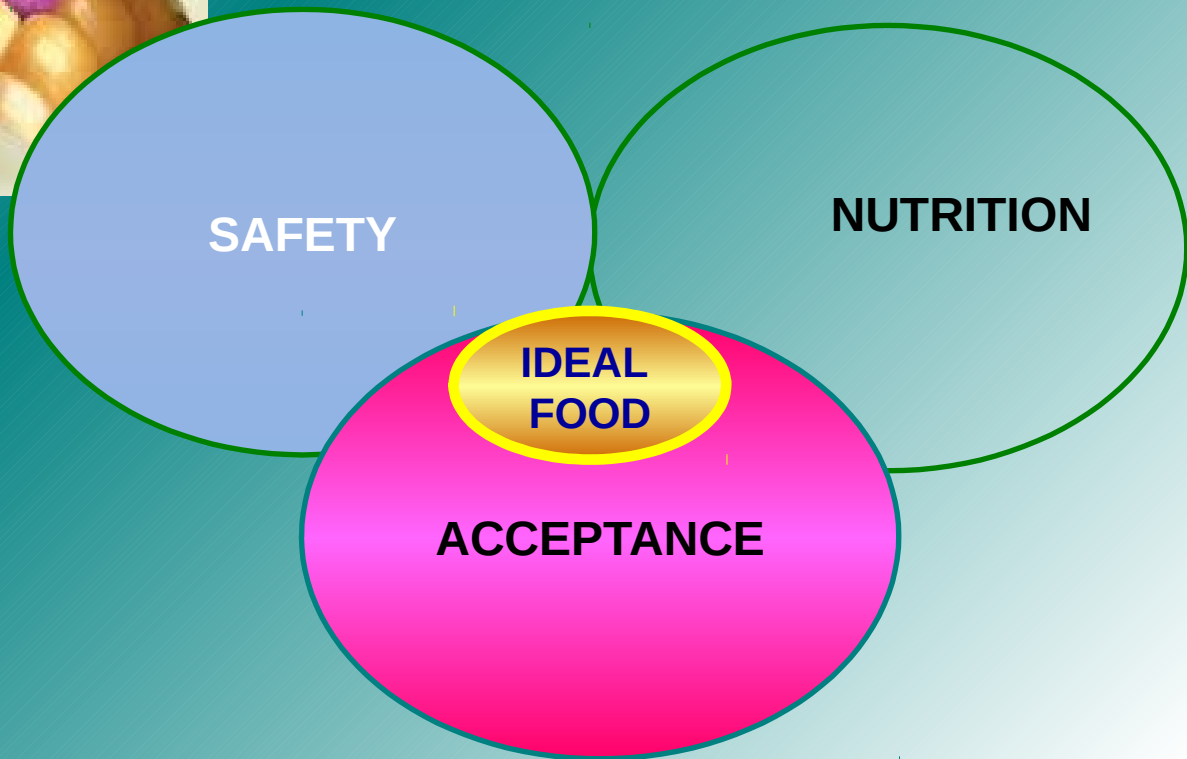
Less sugar

Low sodium

More fiber

w3, w6 Rich

APPLICATION OF THIS NEW CONCEPT



Application areas of nanotechnology in the food production chain

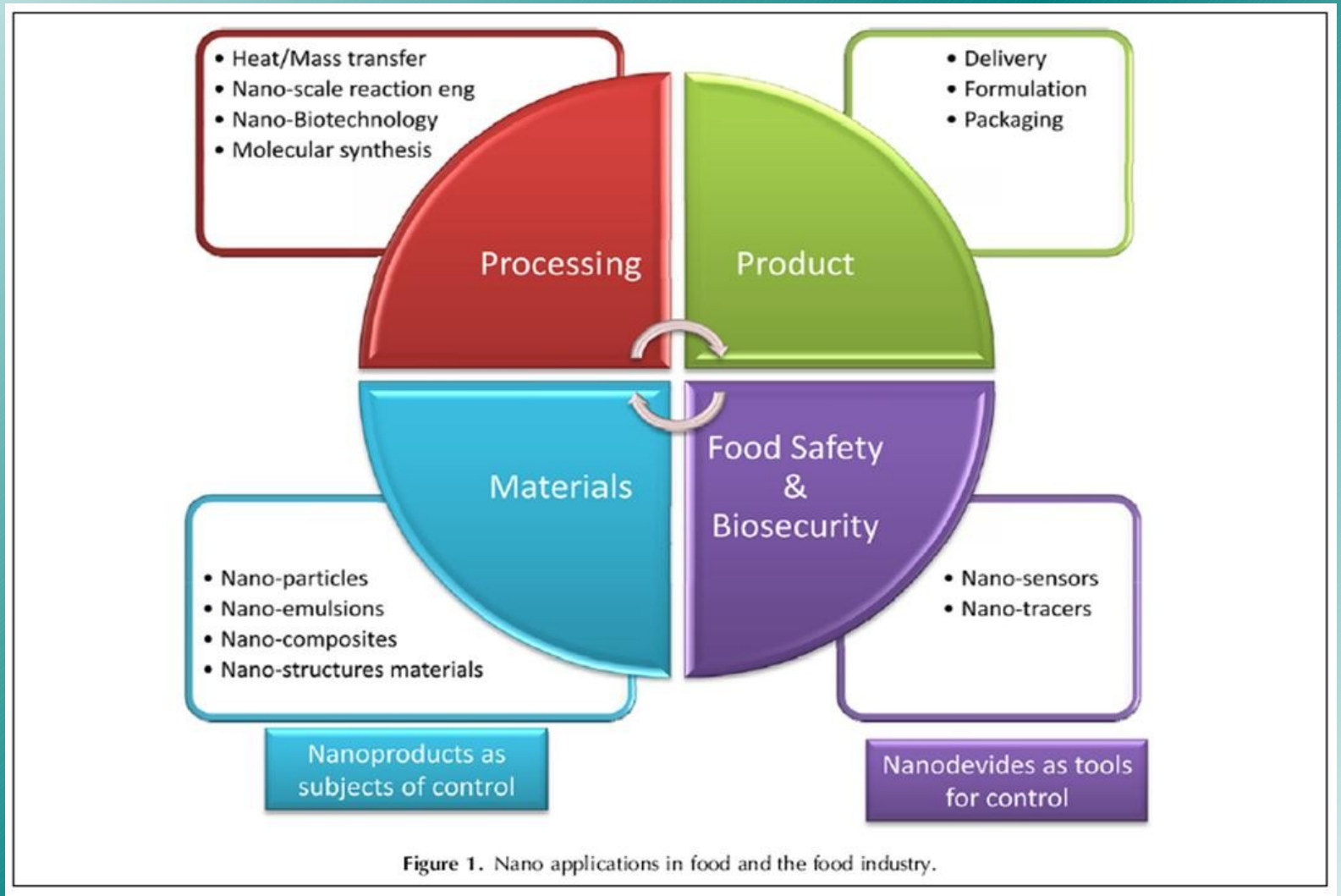


Figure 1. Nano applications in food and the food industry.

Blasco,C. and Picó, Y. 2011

Maillard-conjugation based core-shell co-assemblies for nanoencapsulation of hydrophobic nutraceuticals in clear beverages

Yoav D. Livney*, Gilad Markman, Jane Levinson, Yedidia Zaguri, and Sahar Halabi 2011

Figures

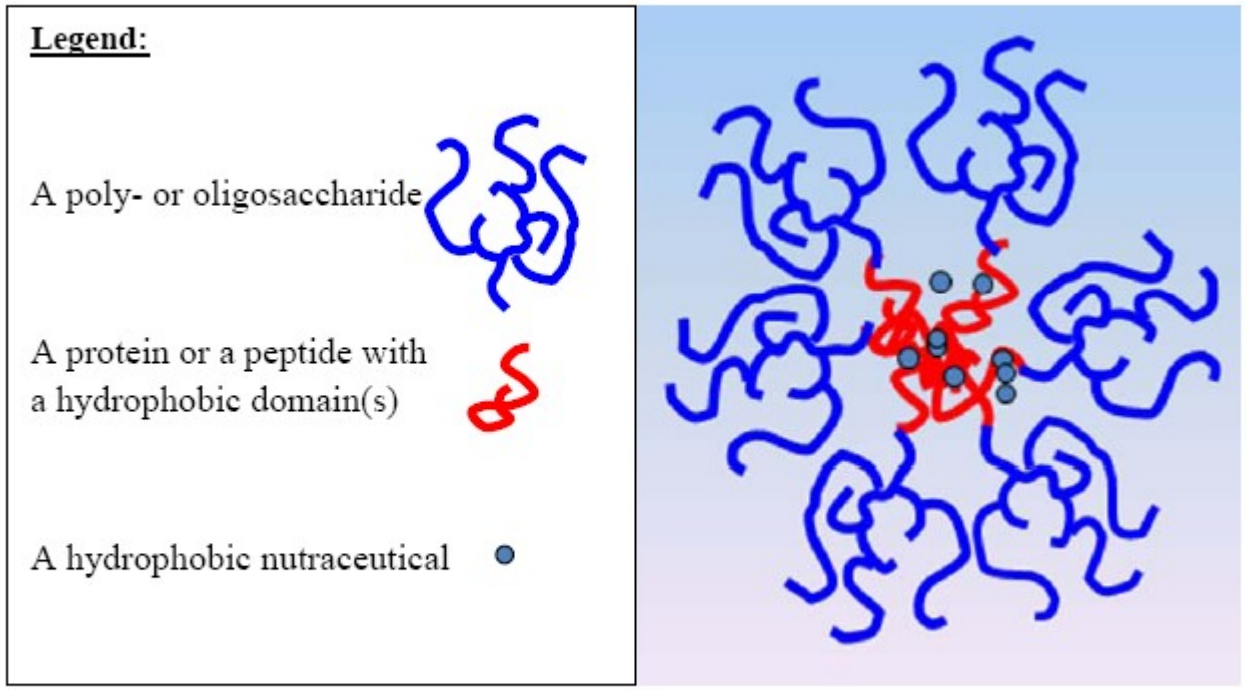
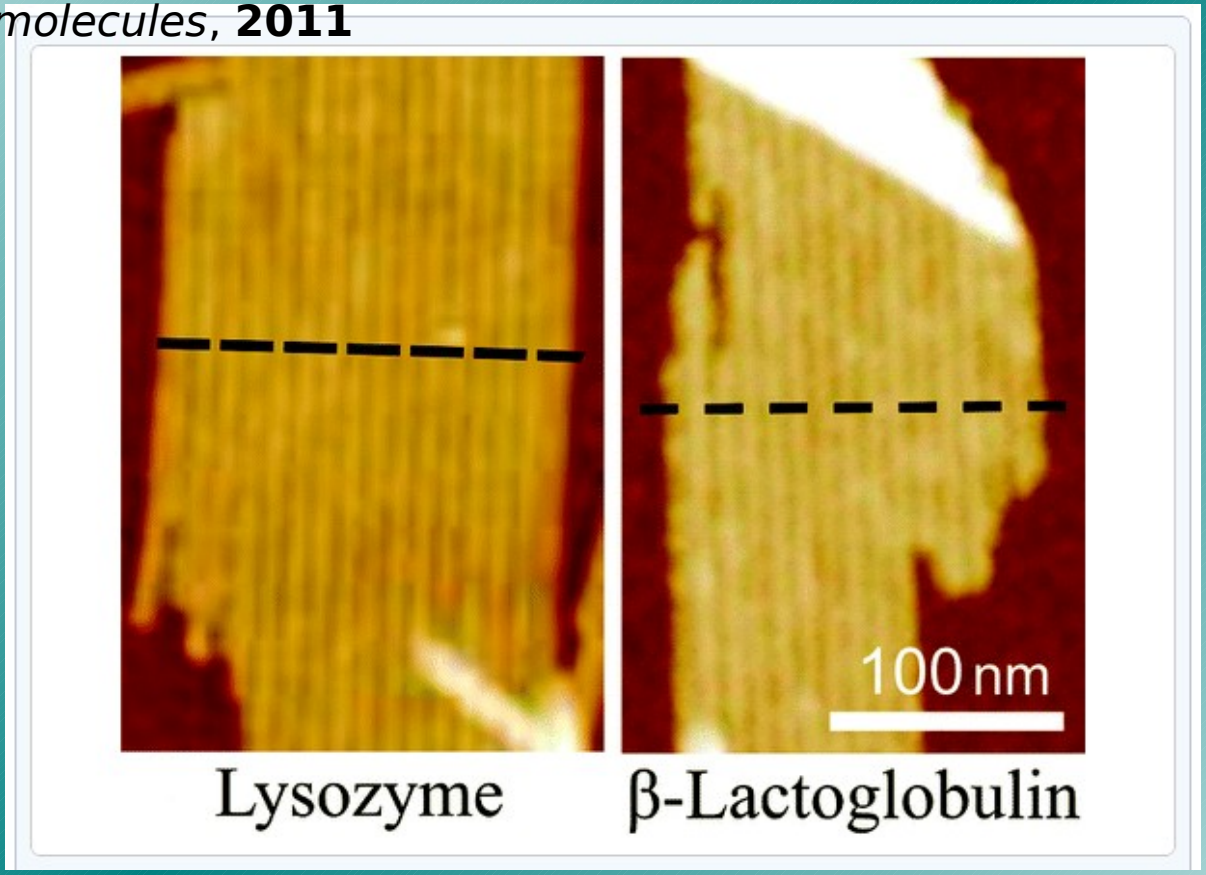


Figure 1. Schematic model of the Maillard-conjugation based core-shell co-assembled nanocapsule (Diameter ~ 10-50 nm)

“General Self-Assembly Mechanism Converting Hydrolyzed Globular Proteins Into Giant Multistranded Amyloid Ribbons”
Ccile Lara, Jozef Adamcik, Sophia Jordens, and Raffaele Mezzenga.
Biomacromolecules, **2011**



Formación de fibrillas de amiloide de proteínas globulares, se muestra la formación de gigantescas cintas multitrenzadas helicoidales de lisozima y β-lactoglobulina. Condiciones de cinética de fibrilación: condiciones de temperatura (90 ° C) y tiempo de incubación (0-30 h), y evaluación de los cambios estructurales durante la fibrilación por microscopía de fuerza atómica(AFM), dicroísmo circular (CD), y SDS-PAGE.

ENCAPSULATION

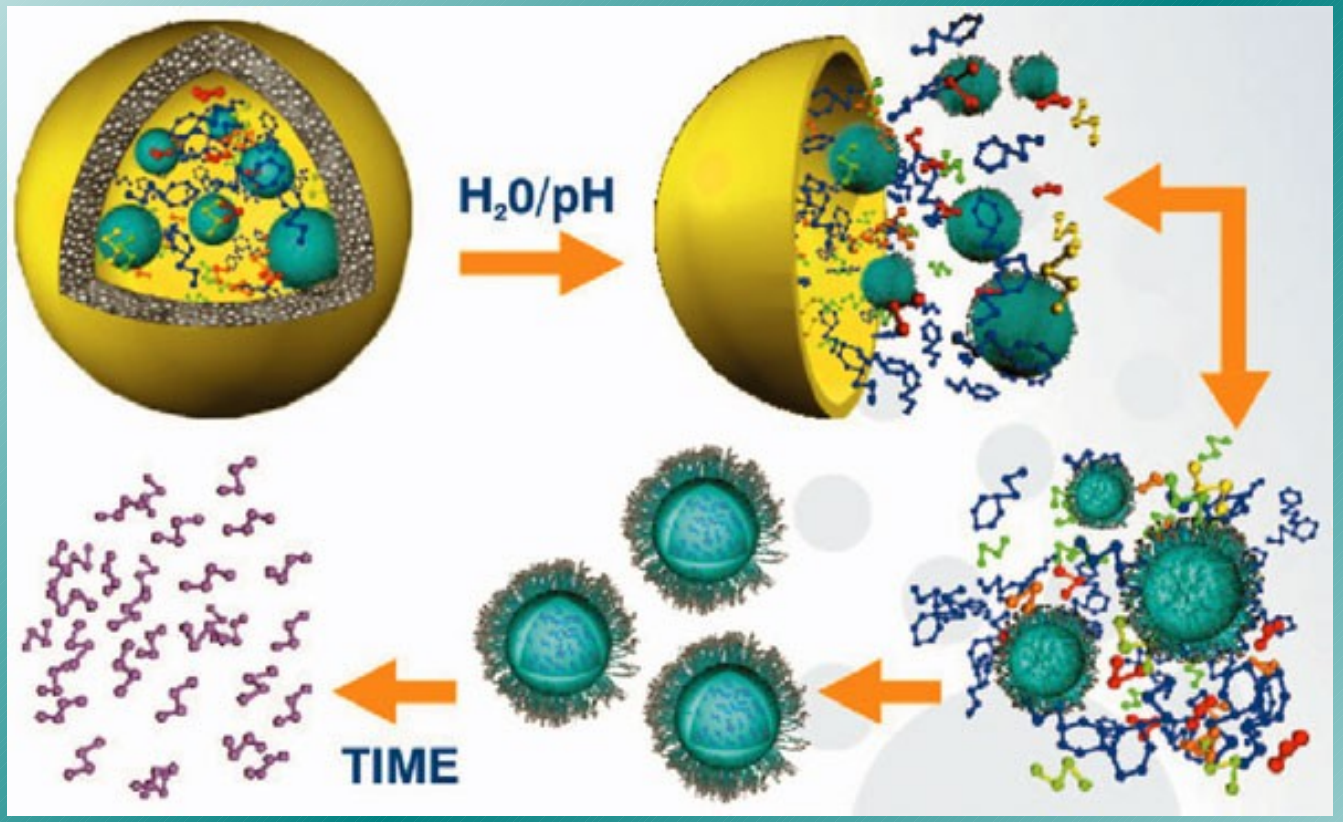
It is currently the most important application

The nano-encapsulation offers improvements in terms of:

- **better protection against moisture and oxygen,**
- **ingredients and additives controlled release**
- **flavor and tastes masking**
- **Improvement of ingredients and additives dispersibility**

Development of encapsulation nutrient systems:
bioactive compounds, additives, processing aids.

The premise is develop carriers and nanometric materials, in order to improve the absorption and therefore, the bioavailability of compounds such as vitamins, phytochemicals, nutrients and minerals.



Salvona Technologies developed a multi-component delivery system3,4,5. This system, MultiSal™, delivers multiple active ingredients that do not normally mix well, such as water-soluble and fat-soluble ingredients, and releases them consecutively.

Foodtech International, 2011

Controlling morphology of phase separated gelatin-maltodextrin gels in emulsion droplets

Sophia Wassén, Niklas Lorén, Anne-Marie Hermansson, 2011

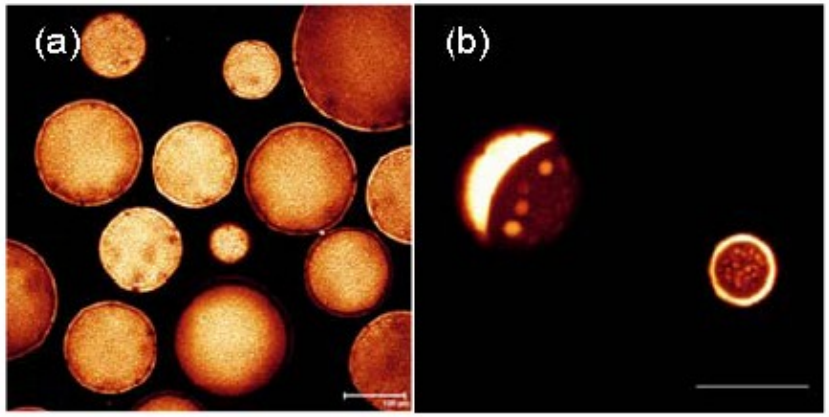


Figure 1. CLSM micrographs of emulsion droplets showing the effect of confinement on the internal morphology. The concentration is 4% w/w gelatin and 6% maltodextrin. The cooling rate was 55°C/min from 60°C to 20°C. The scale bars represent (a) 100µm (b) 25µm.

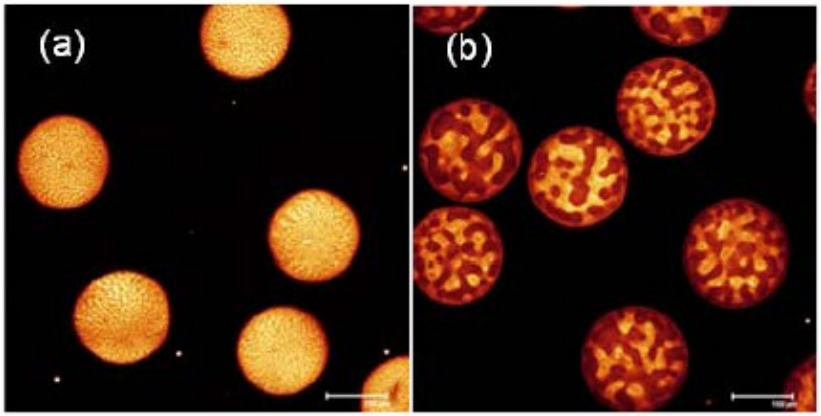


Figure 2. CLSM micrographs of microfluidic produced emulsion droplets. Different microstructures are obtained by changing the cooling rate (a) 90°C/min (b) 55°C/min. The concentration is 4% w/w gelatin and 7.3% maltodextrin. The scale bars represent 100µm.

CLSM (confocal laser scanning microscopy)

Flavors or Odors Masking

The addition of nanocapsules containing tuna oil, omega 3 fatty acids rich in bakery

The capsules are designed to open in the stomach, as the omega 3 is susceptible to oxidation.

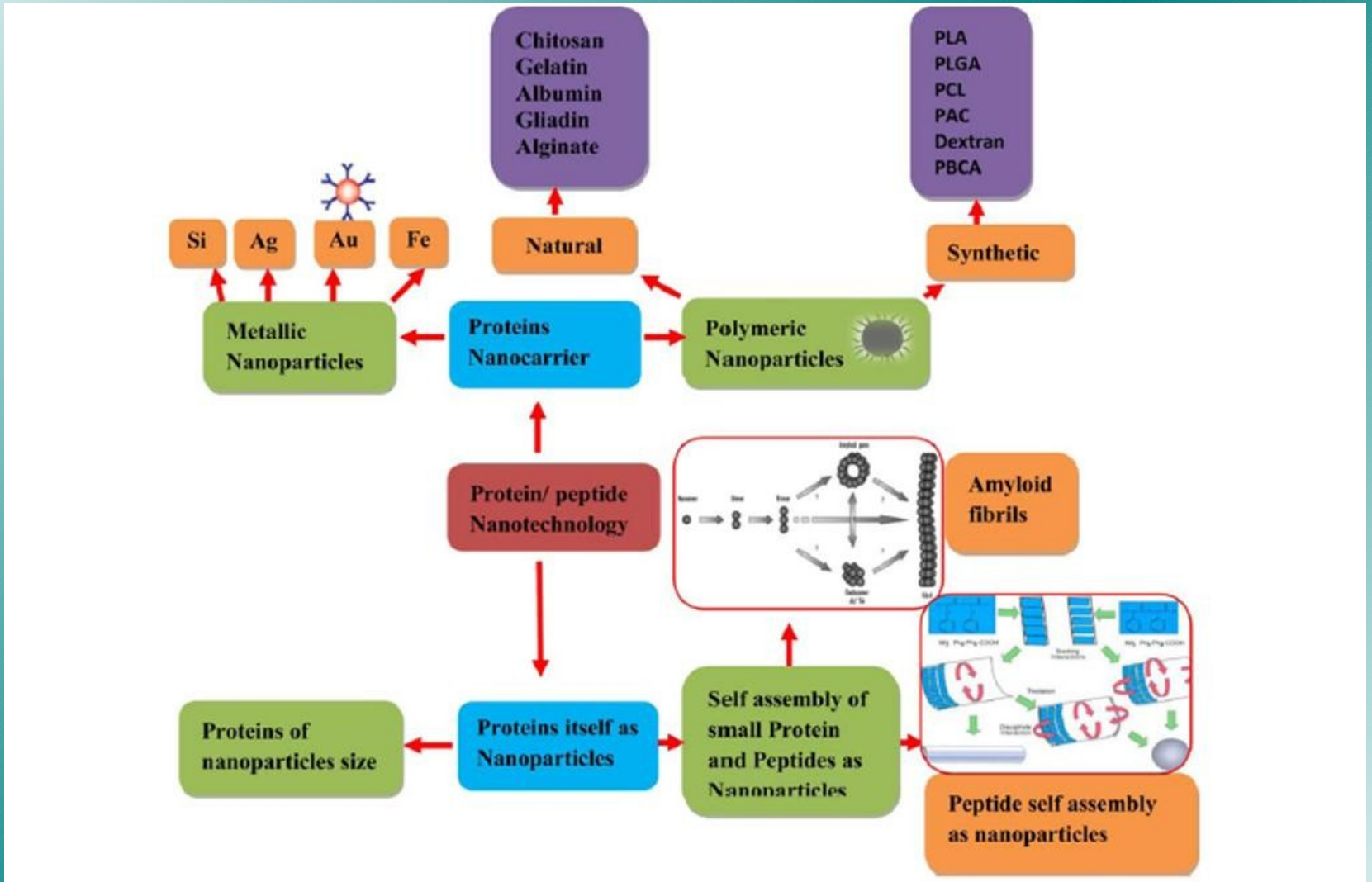
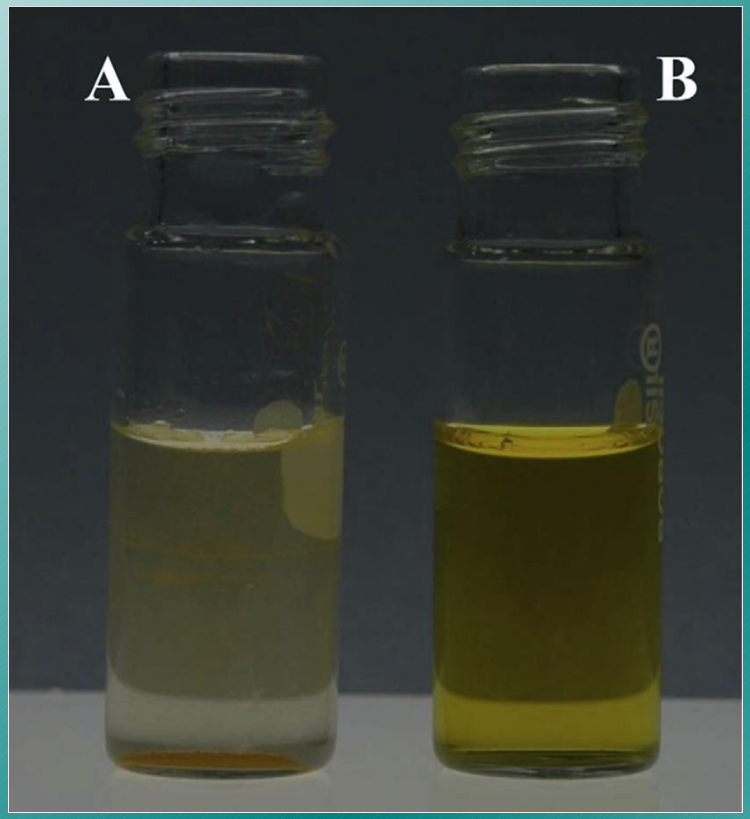


Fig. 2. Various protein nanocarriers as pillars of protein nanotechnology. Protein nanotechnology includes various nanocarriers system like metallic, polymeric and self assembly.

Yadav et al., 2011

Curcumin encapsulated in chitosan nanoparticles: A novel strategy for the treatment of arsenic toxicity

Abhishek Yadav , Vinay Lomash , M. Samim , Swaran J.S. Flora (2012)



Cambio de solubilidad

Water-soluble nanoparticles of curcumin were synthesized, characterized and applied as a stable detoxifying agent for arsenic poisoning.

Chitosan nanoparticles of less than 50 nm in diameter containing curcumin were prepared.

The particles were characterized by TEM, DLS and FT-IR.

The therapeutic efficacy of the encapsulated curcumin nanoparticles (ECNPs) against arsenic-induced toxicity in rats was investigated.

Nano Plastic Wrap	Songsing Nanotechnology	Nano zinc light catalyst	Biodegradable after use Compostable to European standards EN13432 Made from renewable and sustainable resources (non-GM corn starch) Water dispersible, will not pollute local groundwater systems or waterways In use since 2002	http://www.physorg.com/news717488335.html
Constantia multifilm N-COAT	Constantia Multifilm	Nanocomposite polymer	A clear laminate with outstanding gas-barrier proprieties developed primarily for the nuts, dry food and snack markets	http://www.constantia-multifilm.com/
DuPont Light Stabilizer 210	Du Pont	Nano TiO_2	UV-protected plastic food packaging	http://www2.dupont.com/Titanium_Technologies/en_US/products/dls_210/dls_210_landing.html
Adhesive form MacDonald's burger containers	Ecosynthetix	50–150 nm starch nanospheres	The adhesive requires less water as well as less time and energy to dry	http://www.physorg.com/news71748835.htlm
Food additives				
AdNano	Evonik (Degussa)	Nano ZnO (food grade)		www.advancednanomaterials.com
Aerosil, Sipernat	Evonik (Degussa)	Silica (food grade)	Free flow add for powdered ingredients in the food industry	www.aerosil.com
AquaNova NovaSol	AquaNova	Product micelle (capsule) of lipophilic, water-insoluble substances	An optimum carrier system of hydrophobic substances for a higher and faster intestinal and dermal resorption and penetration of active ingredients	http://www.aquanova.de/product-micelle.htm

Solu E 200 BASF	BASF	Vitamin E nano-solution using NovaSOl	Solubilization of fat-soluble vitamins	http://www.human-nutrition.basf
Synthetic Lycopene	BASF	LycoVit 10% (< 200 nm synthetic lycopene		http://www.human-nutrition.basf.com
Food and beverages				
Nano Tea	Shenzen Become Industry & Trading Co	Nanoparticles (160 nm)	Patent No.: 0100033.3 – Three-step preparation method and its application for nanotea Patent No.:02100314.9/ 00244295.7 – Multi-layer, swinging nano-ball milling procedures	http://www.369.comcn/Er/nanotea.htm
Nano Slim	Nano Slim	NAno-Diffuse Technology	Orosolic acid (derived from the Lagerstroemia spaciosa plant)	http://www.nanoslim.con/nanoslim-information.html
Nanoceuticals Slim Shake Chocolate	RBC Lifescience	Nanodusters		http://www.rbdifesciences.com/Meal_Replacement_Shakes.aspx
Nanoceuticals Slim Shake Vanilla	RBC Lifescience	Nanodusters		http://www.rbdifesciences.com/Meal_Replacement_Shakes.aspx
Fortified fruit juice	High Vive.com	300 nm iron (SunActive Fe)		http://www.highwive.com/sunactiveiron.htm
Daily Vitamin Boost	Jamba Juice Hawaii	300 nm iron (SunActive Fe)	22 essential vitamins and minerals and 100%, or more of your daily needs of 18 of them!	http://jambajuicehawaii.com/vita-boost.asp
Oat Chocolate Nutritional Drink Mix	Toddler Health	300 nm iron (SunActive Fe)	Toddler health is an all-natural balanced nutritional drink for children from 13 months to 5 years. One serving of Toddler	http://www.toddlehealth.net/OatChocolate.php

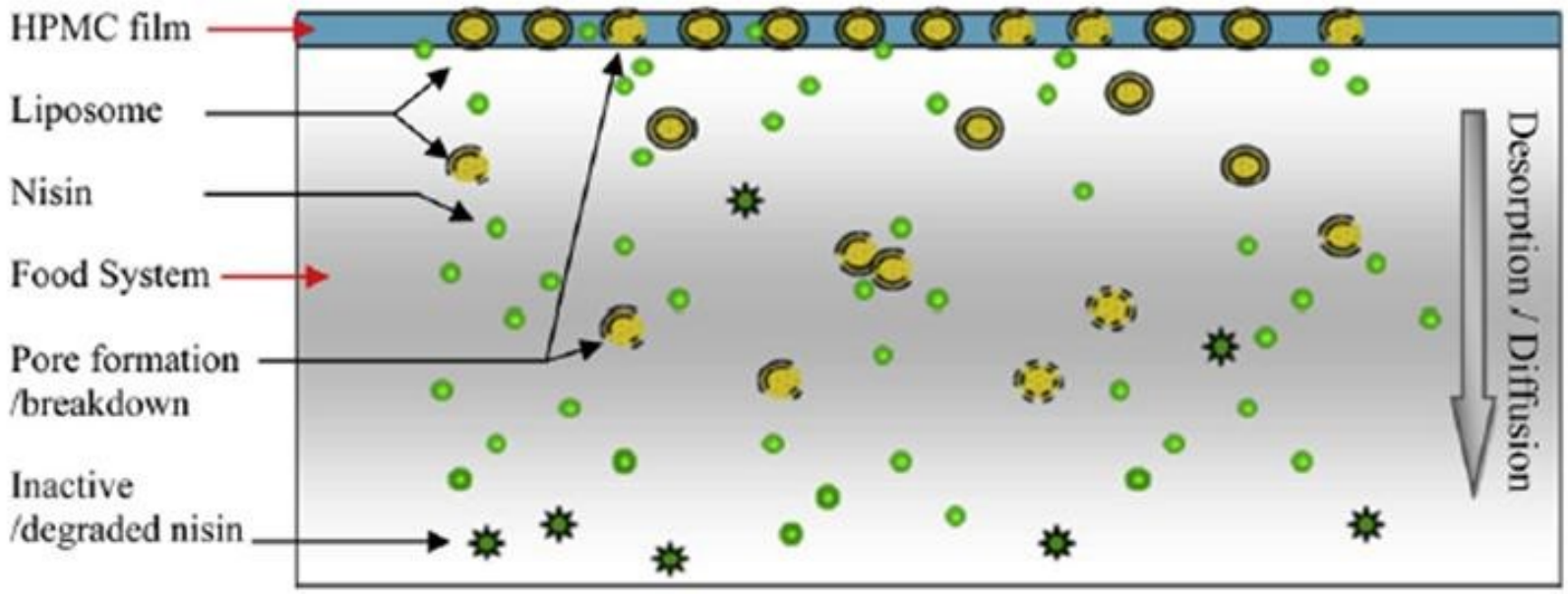
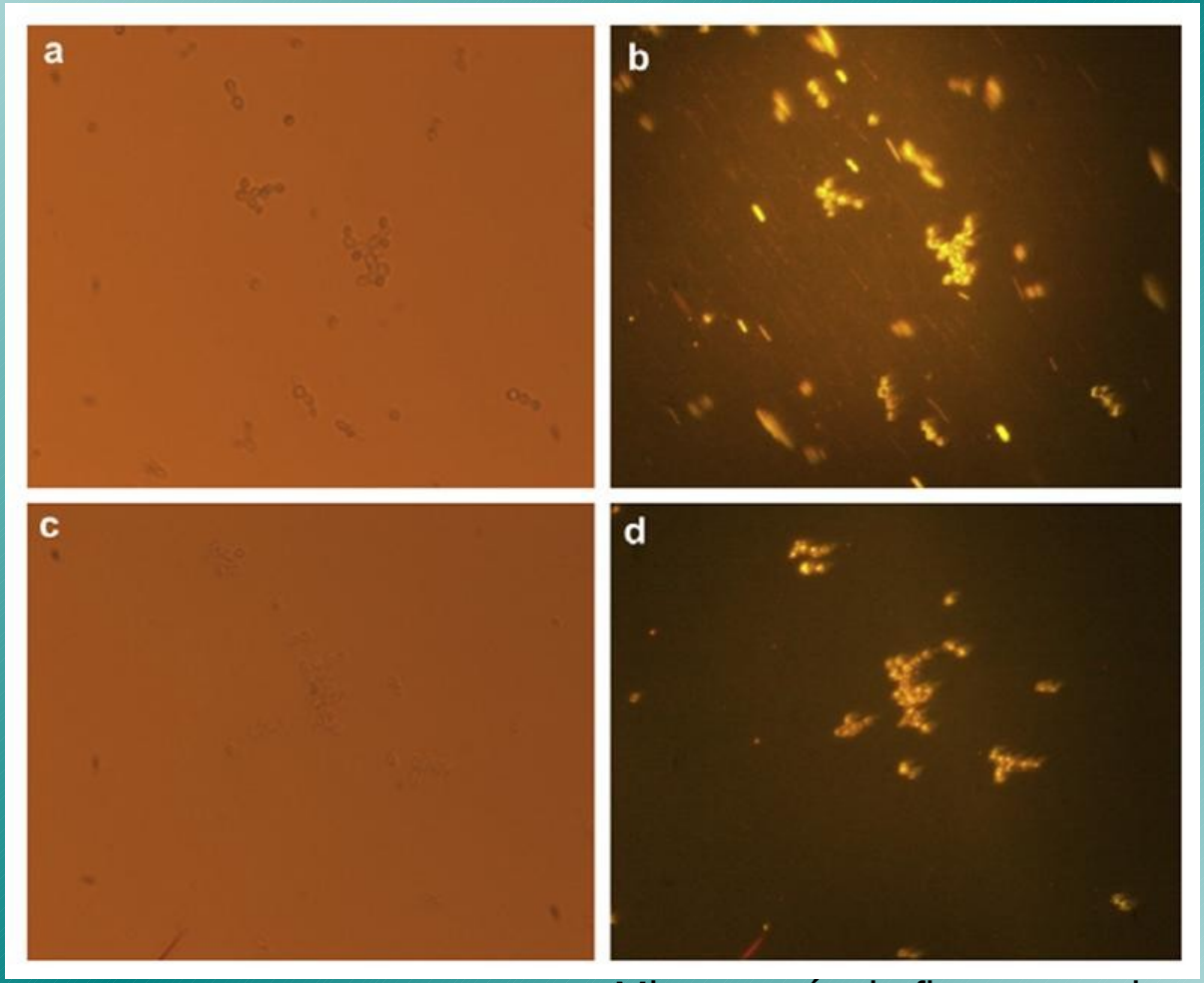


Fig. 1. The diffusion/release of liposome-encapsulated nisin embedded in HPMC nano-active films.

Microstructure and physico-chemical evaluation of nano-emulsion-based antimicrobial peptides embedded in bioactive packaging films

Imran, Revol-Junelles, René, Jamshidian, Javeed Akhtar, Arab-Tehrany, Jacquot, Desobry*, **2012**

Application on pear and orange juices (2011)



Microscopía de fluorescencia

Nanoencapsulation of essential oils to enhance their antimicrobial activity in foods

Francesco Donsì [a,*], Marianna Annunziata [b], Mariarenata Sessa [a], Giovanna Ferrari [a,b]

Relevant Nanomaterials in foods

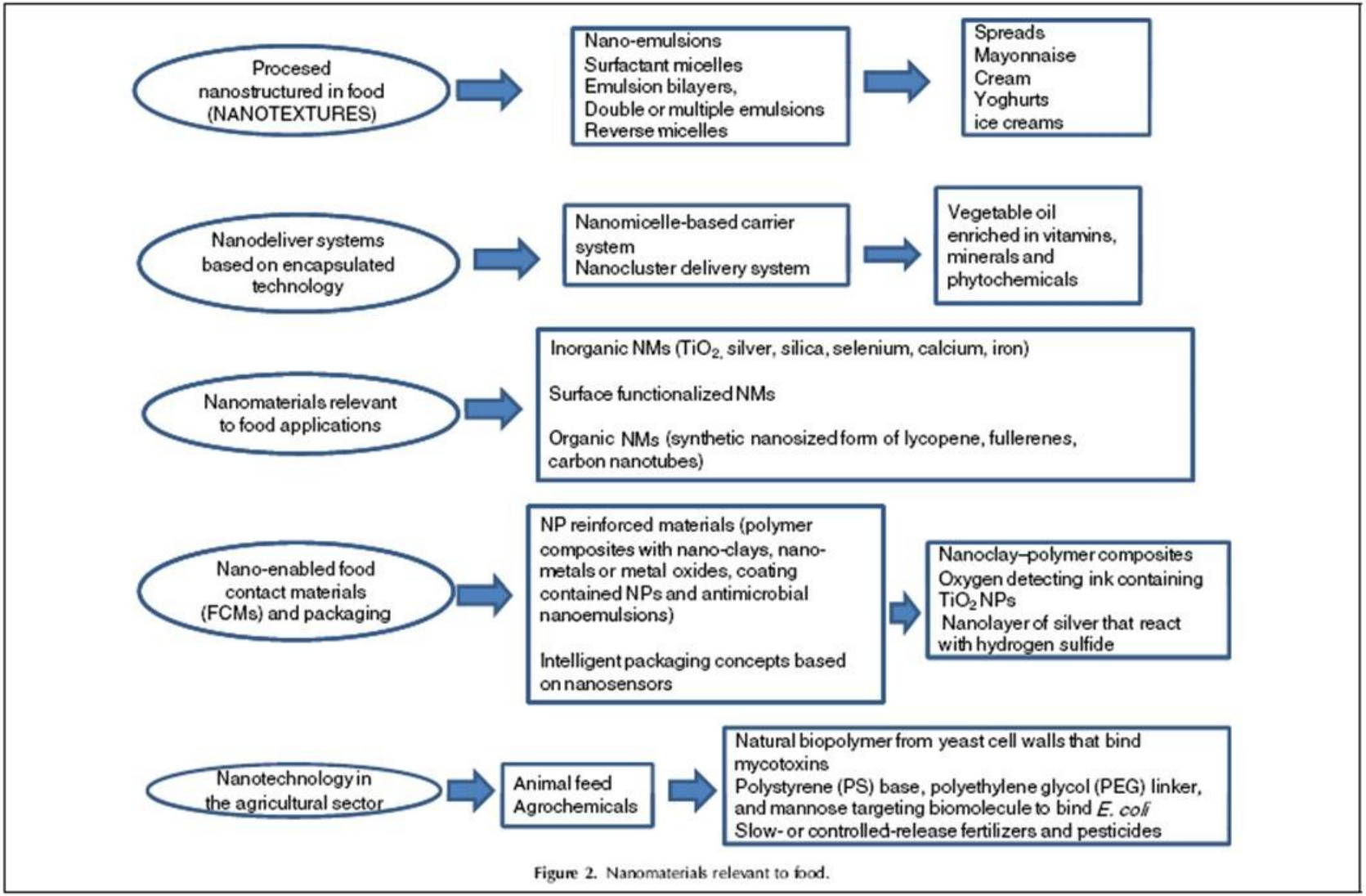


Figure 2. Nanomaterials relevant to food.

Trends in Analytical Chemistry, Vol. 30, No. 1, 2011

Nanocapsules with bioactive ingredients

Product	Description	Dietary Supplements	Functional Fo & Beverage	Food Additive	Cosmetics
NovaSOL A	Vitamin A-Solubilisate	X	X		
NovaSOL ADEK	Solubilisate of Vitamine A, D, E, K	X	X		X
NovaSOL ADEK-Q10	Solubilisate of Vitamine A, D, E, K & Coenzyme Q_{10}	X	X		X
NovaSOL βC	β-Carotene-Solubilisate		X	X	X
NovaSOL C	Ascorbic Acid- -Solubilisate			X	X
NovaSOL S	Ascorbic Acid - / DL-α- Tocopherol- Solubilisate (for processed meat/sausage)			X	
NovaSOL COF	Ascorbic Acid / DL-α- Tocopherol-Solubilisate (for oils / fats)			X	X
NovaSOL CT	Ascorbic Acid- / Mixed-Tocopherol- Solubilisate (for essential oils, flavors, fragrances, cosmetics)			X	X
NovaSOL Citric	Citric Acid-Solubilisate			X	
NovaSOL DS/4	Sorbic Acid-Solubilisate (preservation of food, drinks & cosmetics)			X	X
NovaSOL DC/12	Benzoic Acid-Solubilisate (preservation of cheese rind & sausage casings)			X	
NovaSOL DS/12	Benzoic Acid-Solubilisate (preservation of food, drinks & cosmetics)			X	X
NovaSOL DC/44	Sorbic acid / Benzoic acid-Solubilisate (preservation of cheese rind & sausage casings)			X	
NovaSOL DS/44	Sorbic acid / Benzoic acid-Solubilisate (preservation of food, drinks and cosmetics)			X	X
NovaSOL E	DL-α-Tocopherol-Vitamin E-Acetate-Solubilisate	X	X		X
NovaSOL ISO (source: soy isoflavones)	Isoflavone-Solubilisate, Capsule Grade	X			X
	Isoflavone-Solubilisate, Food Grade		X		
NovaSOL Lipoic	α-Lipoic acid-Solubilisate	X	X		X
NovaSOL Lutein	Lutein-Solubilisate	X	X		X
NovaSOL Omega	Omega 3-fatty acid- Solubilisate	X			X
NovaSOL Q	Coenzyme Q_{10} Basic-Solubilisate, – GRAS	X	X		X
	Coenzyme Q_{10}-Solubilisate, Soft Gel Grade,- GRAS	X	X		X
	Coenzyme Q_{10}-Solubilisate, Beverage Grade – GRAS	X	X		
NovaSOL Rosemary	Rosemary Extract - Solubilisate			X	

- Pharmaceutical products
- Protection of raw materials

Presentation

NovaSOL® products are offered in a variety of forms such as:

- Pure liquid bulk solubilisate
- Capsules in bulk
- Packaged Capsules (Full Service)

Documentation & Samples

On request we will supply you with:

- Product data sheets
- Certificates of analysis
- Material safety data sheets (MSDS)
- Summary bioavailability studies

NovaSOL® is available in ready to use products, which represent a broad variety of substances.. AQUANOVA's technology offers the dietary supplement, functional foods and drinks, as well as the cosmetics industries, great opportunities to supply new value added products with properties hitherto not possible.

NovaSOL® Solubilisates are liquid, at the same time water and fat soluble raw materials & ingredients with micelle structure for e.g.:

Vitamins
Omega-3 fatty acid
Coenzyme Q10 (with GRAS status)
Isoflavones, flavonoids, carotenoids
Phyto extracts
Essential oils
Preserving agents
Food coloring substances
Other bioactive substances

live the source®
science | nature | wellness

Become An Entrepreneur Now! USA CANADA

ENTREPRENE OR CUSTOM LOGIN

USA Make a Retail Purchase Here

CANADA Make a Reta Purchase He

home company products science business review events contact us

products > daily multi-vitamin

message from the CEO

USA Purchase Retail Now!

dailymulti-vitamin, Our Premier Product

An All Natural Nano-Encapsulated Multi-Vitamin, Mineral and Herbal Supplement

dailymulti-vitamin isn't just a vitamin supplement. It's a complete cocktail of health and well being. The specially selected vitamins, minerals and herbal compounds in **daily**multi-vitamin provide a substantial increase in nutritional value, first, due to their combination, and second, due to nano-encapsulation. Our **All Natural Patented Nanotechnology™** creates a particle size small enough to be absorbed with maximum efficiency.

The prefix 'nano' means one-billionth, so a nano-gram is one-billionth of a gram. Nanotechnology is the increasingly popular science of the incredibly small. It overlaps into medicine, food, robotics and virtually any other high-tech system now emerging from the scientific community.

IT'S NOT food!!

As it applies to food and nutritional supplements, nanotechnology is now being utilized to reduce the particle size of various compounds to a relatively small size for efficient absorption. One of the best ways to create nano size particles is through encapsulation. The technology literally separates, and then envelops molecules in the active compound. There are a number of different encapsulation technologies, but the most favorable type is natural – and that's why we've developed **All Natural Patented Nanotechnology ™**.

Well, what does this mean exactly? Why is "natural" nano encapsulation a better alternative?

The answer is quite simple. Our **All Natural Patented Nanotechnology ™** process uses only natural plant lipids as the basis for its nano-encapsulation. This ensures the compounds dissolve gradually, providing a sustained release of the vitamins, minerals and herbal compounds. By the time the body has absorbed the nutrients in this **safe and efficient manner**, the nano particle has completely dissolved. In other words, the plant lipids are metabolized just as any other food stuff would be.

For those unfortunate souls whose daily menus are limited by food allergies, look no further. **daily**multi-vitamin is allergen free of yeast, corn, wheat, lactose, dairy, citrus, egg, fish and nut products. It contains no sugar, artificial flavors, colors or sweeteners.

Please cite this article in press as: Chaudhry, Q., & Castle, L., Food applications of nanotechnologies: An overview of opportunities and challenges for developing countries, Trends in Food Science & Technology (2011), doi:10.1016/j.tifs.2011.01.001

Table 1. List of current and projected nanotechnology applications in the food and agriculture sectors[4]

Nature of application	Projected benefits	Potential risks	Comments
Processed nano-structured or nano-textured food products	Use of less fat and emulsifiers, stable emulsions, better tasting food products. A typical product of this type of application would be a nano-textured food (*e.g.* ice cream, mayonnaise, spread, *etc.*) which is low-fat but as "creamy" as the full-fat alternative. Such products would therefore offer 'healthy' but tasteful products to the consumer. Processing foodstuffs at submicron or nano-scale is also known to kill any microbial pathogens.	This application area is of least concern, as the food nanostructures are likely to be solubilised or digested in the GI tract and should not carry insoluble materials to the circulatory system.	Although the development of micro-emulsions is known to generate a range of droplet sizes – some in
Nano-Carrier systems for delivery of nutrients and supplements in the form of liposomes or biopolymer-based nano-encapsulated substances	Taste masking of certain ingredients/additives, such as fish oils, protection of certain ingredients during processing, improved optical appearance, improved bioavailability of nutrients and supplements, antimicrobial action, and other health benefits.	Increased absorption, uptake and bioavailability of certain additives and supplements may also alter tissue distribution of the substances in the body. ADME properties of some encapsulated substances may be different from conventional bulk equivalents.	
Organic nano-sized additives (many of them naturally occurring substances) for food, health-food supplements, and animal feed applications	Due to larger surface area, lesser amounts would be needed for a function or a taste attribute. Other claimed benefits include better dispersability of water-insoluble additives in food products without the need for additional fat or emulsifiers, and enhanced tastes and flavours due to greater surface areas of the nano-sized additives compared to bulk forms. Virtually all products in this category are also claimed for enhanced absorption and improved bioavailability in the body compared to conventional bulk equivalents.	Nano-sizing may lead to changes in the absorption and bioavailability of the additives and may	This type of application is expected to exploit a much larger segment of the food and health-
Inorganic nano-sized additives for food, health-food and feed applications	Essentially the same benefits as claimed for organic nano-sized additives (see above). Other projected benefits include increased food hygiene due to antimicrobial activity of nano-sized metal(oxide) additives.	Application area of n Some inorgan additi category may co insoluble, indigestible and potentia biopersistent nanoparticles.	is available for and food, feed Examples include iron, silica, titanium selenium, calcium, magnesium, platinum *etc.*

2012!!

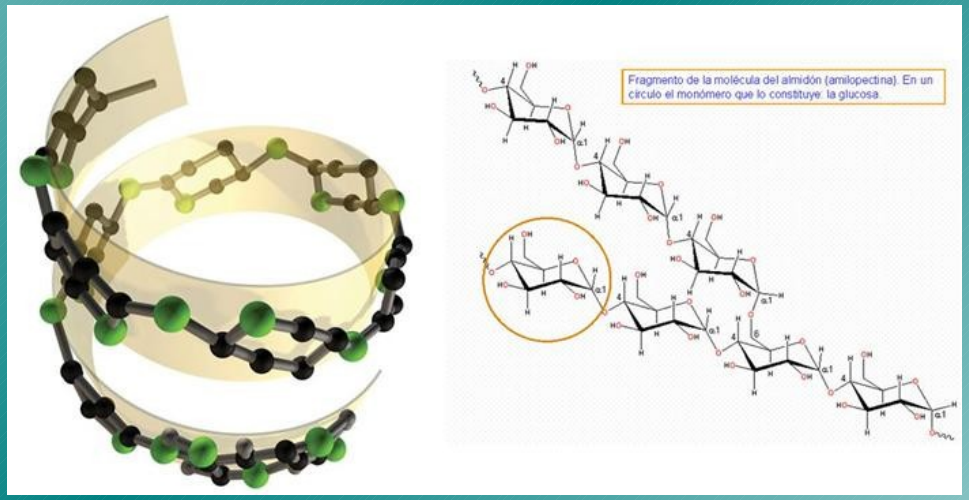
Micronized ingredients

Starch-based biodegradable polymers exhibit :

poor barrier properties against moisture → hydrophilic nature

Poor mechanical properties → when compare with plastics

Incorporation of nanoclays



(Avella et al., 2005; Chen; Evans, 2005; de Carvalho; Curvelo; Agnelli, 2001; Mcglashan; Halley, 2003; Park et al., 2003).

Nanocatalysts applications

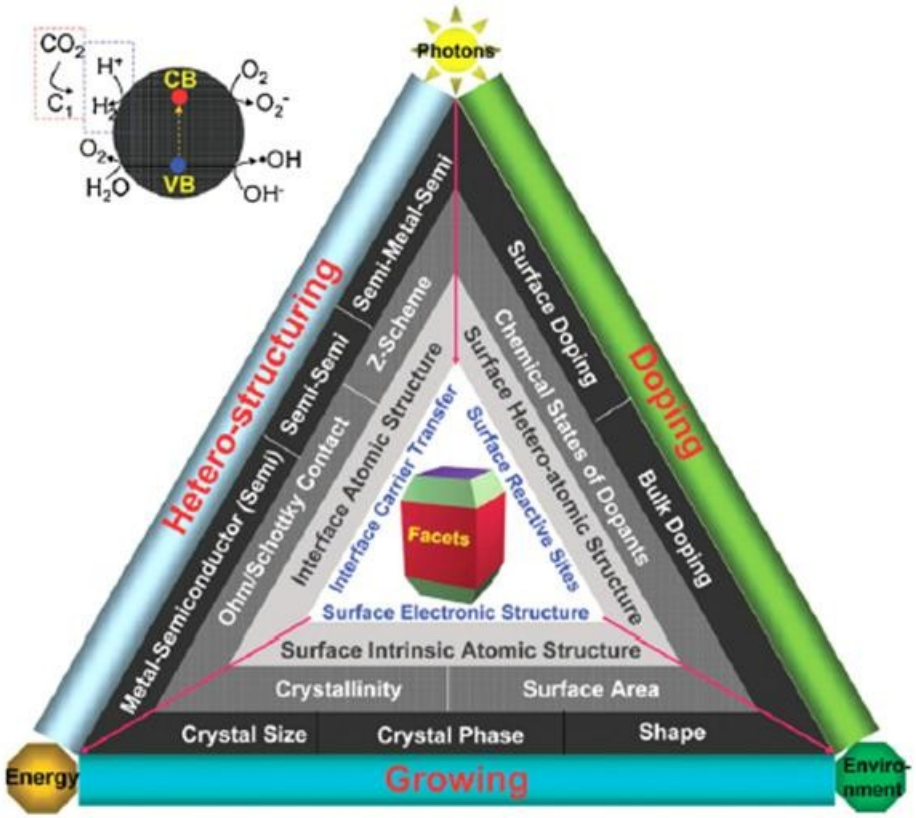


Fig. 9. This diagram illustrates the interrelationships between crystal structure, surface chemistry, and size of nanocatalysts [134]. (Reproduced with permission from Royal Society of Chemistry 2011.)

Some example applications:

N**anoFood:**

Nanocapsules and nano-objets for "on demand" preservatives, enriched food, flavour, smell, taste and colours

Interactive food: attractive surface treatment, glaziers and colours,

Improvement of food safety and quality, shelf-life extension

Nanocontrol of healthy digestion tube and micro-flora, digestion more compatible food

Improved cooking, food ingredients control

Alternative feeding : transmucosal, skin etc..

Special Food: Hospital Food, Space Food, Hot and Cold areas Food

Nanoparticle Controlled extraction and release

Nanocarriers for food and nutrient delivery

and more…

The application of high performance nanocatalysts provide advantages

- increase activity and selectivity by controlling pore size and particle characteristics,
- which improves the chemical reactivity and
- reduces process costs.

In this field it is foreseen a great application of ceramic materials in the enzymes immobilization.

New sizes……. New tools !!!!!

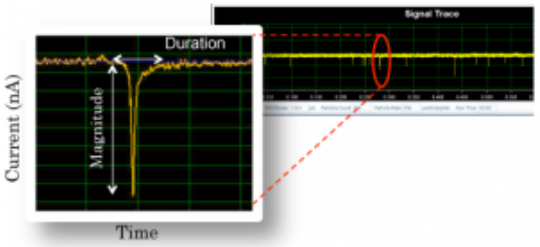
iZON

Home About Us Products & Applications Orders & Sales News Contact Us

Particle Sizing

Particle-by-particle measurement for accurate particle size and size distribution analysis of sample populations.

- Absolute size (40nm-10µm)
- Multiple populations
- Population resolution
- Size distribution
- Aggregation analysis



Background

Izon's SIOS technology platform offers a new and convenient solution for evaluation of particle size and size distribution of nanoparticle samples in a fluid. The single particle detection methodology of SIOS ensures an accurate size distribution output without the averaging effects inherent in other size analysis technologies.

A discrete blockade event signal is recorded by the system each time a particle traverses the nanopore. These individually discriminated measurements are built up into a total population view of the sample.

The magnitude of a measured blockade signal is a key indicator of the volume (or equivalent diameter) of the particle that has passed through the pore. This information allows:

- Evaluation of absolute particle size
- Particle size distribution and volume fraction analysis
- Resolution of distinct particle populations within a single sample

Product Group

ZETASIZER RANGE

- Zetasizer Nano Range
  - Zetasizer Nano S
  - Zetasizer Nano S90
  - Zetasizer Nano Z
  - Zetasizer Nano ZS
  - Zetasizer Nano ZS90
    - Overview
    - How it works
    - Specification
    - Accessories
  - Software features
  - Specifications
  - Applications
- Zetasizer APS
- Zetasizer μV

FURTHER INFORMATION:

- About Dynamic Light Scattering

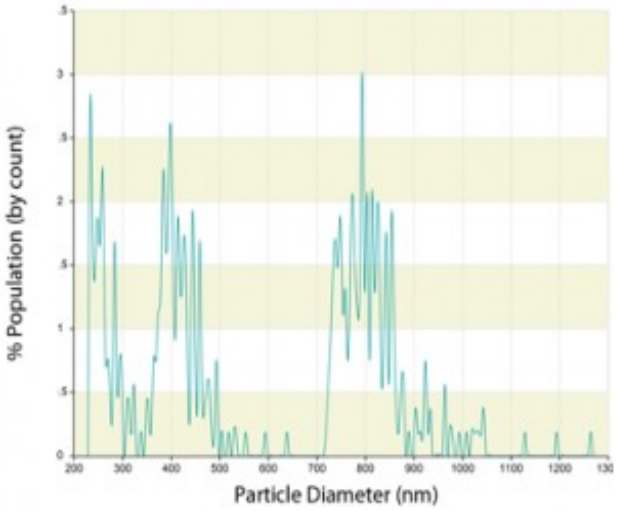
Zetasizer Nano ZS90

An entry level system for the measurement of particle size and molecular size at a 90 degree scattering angle using Dynamic Light Scattering, also with the ability to measure zeta potential and electrophoretic mobility using Laser Doppler Microelectrophoresis, and molecular weight using Static Light Scattering.

Overview | How it works | Specification | Accessories

The Zetasizer Nano ZS90 is the perfect lower cost solution when the ultimate in sizing sensitivity is not necessary, or where identical results to a legacy system with 90 degree scattering optics is required.

- Size measurement from 0.3nm (diameter) to 5 microns using 90 degree scattering optics
- Zeta potential of proteins and particles from 3.8nm up to 100 microns (diameter) using patented *M3-PALS* technology
- Molecular weight measurement down to 9,800Da
- A Quality Factor gives confidence in the data
- The Expert advice report gives help to improve sample preparation or the measurement procedure
- 21CFR part 11 software option enables compliance with ER/ES



Particle size distribution recorded from polystyrene particle sample demonstrates a trimodal response.

SEM image of polystyrene particle sample confirms the presence of three populations of 220nm, 400nm and 780nm diameter particles.

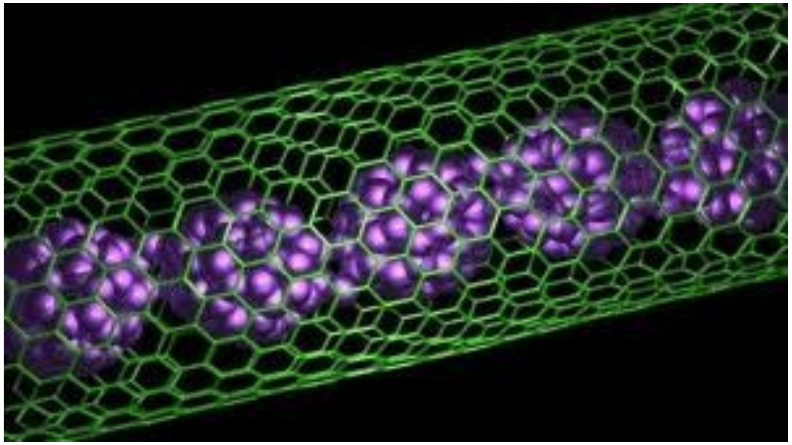
Particle-by-Particle Sizing

The example on the left demonstrates measurement of a polystyrene nanoparticle sample with three distinct size populations.

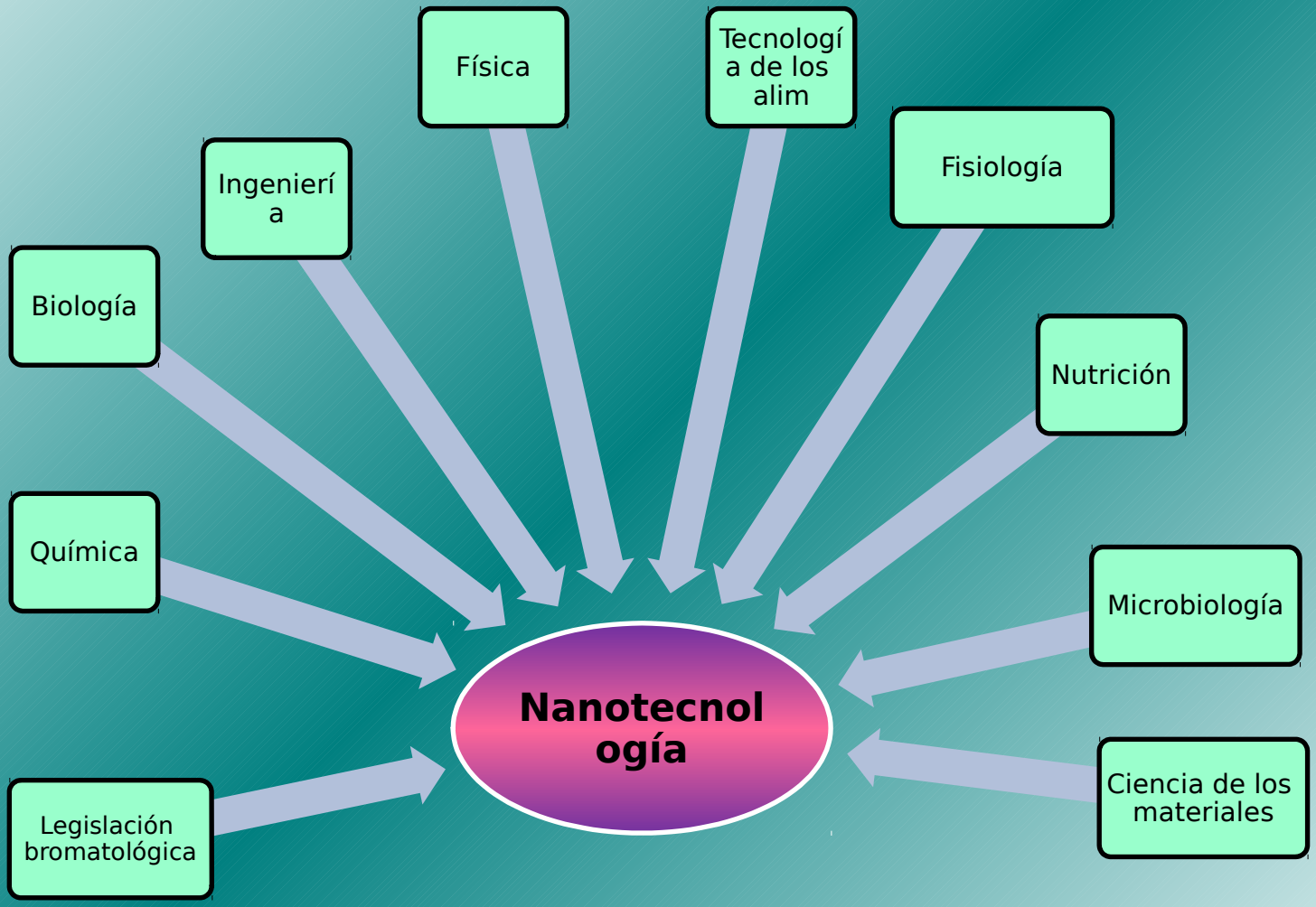
Individial particle signals are recorded. The relationship between measured blockade event magnitude (nA) and particle volume allows the determination of the absolute size of particles in a sample (nm). Particle-by-particle data is displayed as size-distribution graph for the sample.

The SEM image confirms the presence of three populations at 220nm, 400nm and 780nm diameter.

And FINALLY.....



Nanotechnology use requires a multidisciplinary work because it must necessarily involve the knowledge of biological, chemical and physical processes at molecular level.

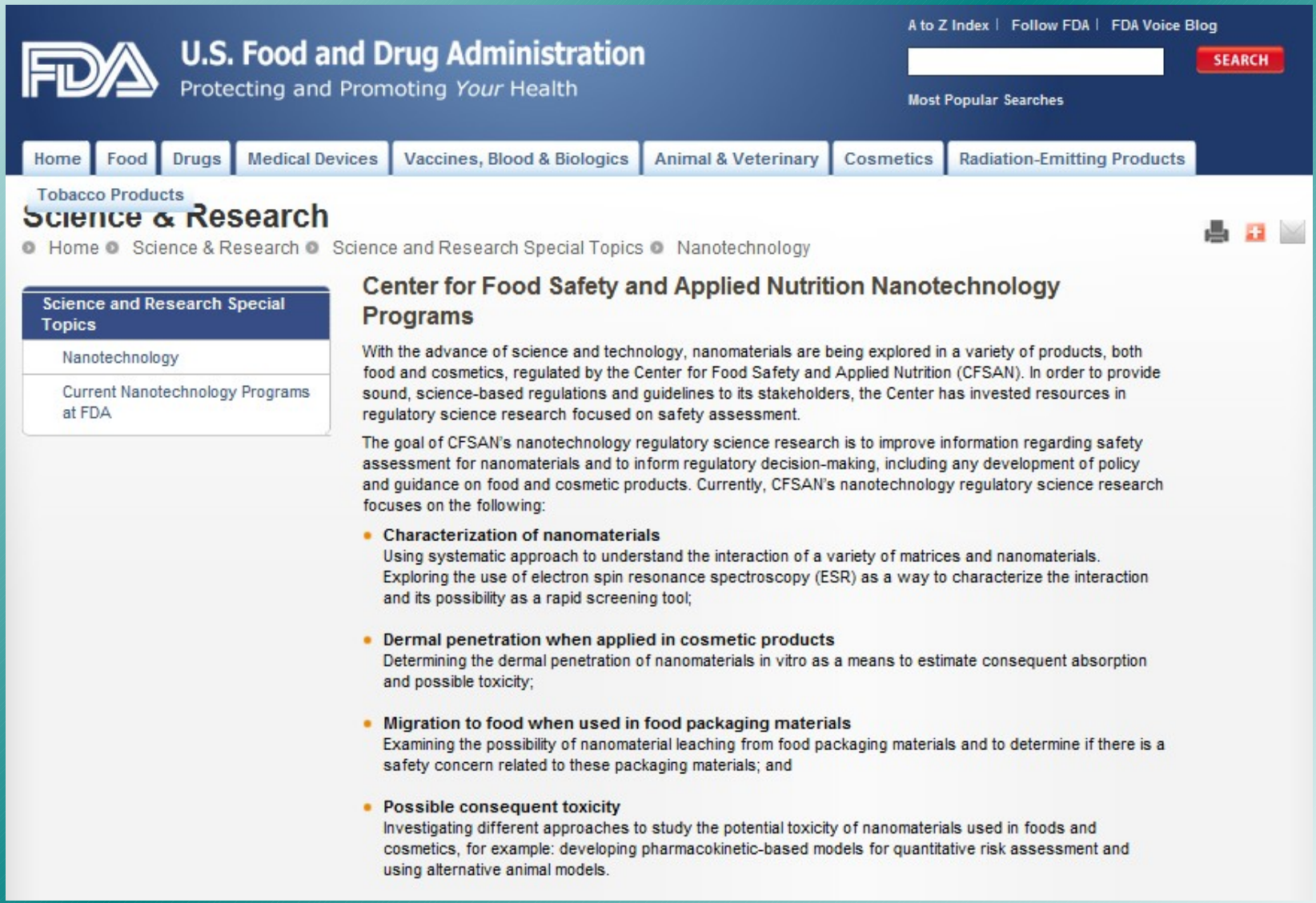

Física
Tecnología de los alim
Ingeniería
Fisiología
Biología
Nutrición
Química
Microbiología
Nanotecnología
Legislación bromatológica
Ciencia de los materiales

Risks and challen

- There are no data on nanotechnology application risks in the food sector.

- The biggest concern is that nanoparticles, because of its scale, form, could penetrate into the human body, and the impacts were not evaluated.

Regulations and standards



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- Nanotechnology
- Current Nanotechnology Programs at FDA

Center for Food Safety and Applied Nutrition Nanotechnology Programs

With the advance of science and technology, nanomaterials are being explored in a variety of products, both food and cosmetics, regulated by the Center for Food Safety and Applied Nutrition (CFSAN). In order to provide sound, science-based regulations and guidelines to its stakeholders, the Center has invested resources in regulatory science research focused on safety assessment.

The goal of CFSAN's nanotechnology regulatory science research is to improve information regarding safety assessment for nanomaterials and to inform regulatory decision-making, including any development of policy and guidance on food and cosmetic products. Currently, CFSAN's nanotechnology regulatory science research focuses on the following:

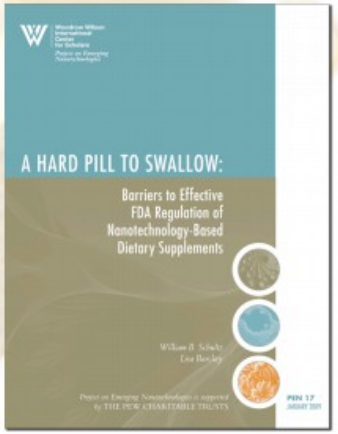
- **Characterization of nanomaterials**
  Using systematic approach to understand the interaction of a variety of matrices and nanomaterials. Exploring the use of electron spin resonance spectroscopy (ESR) as a way to characterize the interaction and its possibility as a rapid screening tool;
- **Dermal penetration when applied in cosmetic products**
  Determining the dermal penetration of nanomaterials in vitro as a means to estimate consequent absorption and possible toxicity;
- **Migration to food when used in food packaging materials**
  Examining the possibility of nanomaterial leaching from food packaging materials and to determine if there is a safety concern related to these packaging materials; and
- **Possible consequent toxicity**
  Investigating different approaches to study the potential toxicity of nanomaterials used in foods and cosmetics, for example: developing pharmacokinetic-based models for quantitative risk assessment and using alternative animal models.

A Hard Pill to Swallow: *Barriers to Effective Regulation of Nanotechnology-Based Dietary Supplements*

William B. Schultz
Lisa Barclay

January 14, 2009

Project on Emerging Nanotechnologies
Woodrow Wilson International Center for Scholars



Research priorities

NanoSafe Australia

NanoSafe Australia's current research priorities include the following areas:

- Toxicokinetics (including dermal penetration and distribution), toxicity testing and risk assessment of nanomaterials in sunscreens, specifically zinc oxide and titanium dioxide.
- The development of research tools for nanotoxicology research, specifically:
  - Appropriate physico-chemical characterisation methods for describing nanomaterial toxicity.
  - *In vivo* toxicokinetics and dermal penetration detection methods for nanomaterials.
  - Appropriate dosimetry models, dose-response relationships and mechanisms of action of nanomaterials.
  - High-throughput methods for rapid nanotoxicity screening.
- Evaluation of occupational health and safety (OHS) measures in the workplace for controlling exposure to engineered nanomaterials.

Many NanoSafe Australia participants are also members of the Australian Research Council Nanotechnology Network (ARCNN) and contributors to the Australian Consortium for the OECD Working Party on Manufactured Nanomaterials (WPMN).

Nanoscience and nanotechnology hand assembling structures of 1-100 nm, food technology does that for centuries using many types of molecules, although such "uncontrolled“ proccess.

• Applications of micro and nanotechnologies to food structure can provide tremendous benefits to the conventional and functional food industry. Some examples: development of new processes, creating new textures, flavors, design of low-calorie foods, increased nutritional value or nutritional "targeted" special diets (hypertension, obesity).

• If we want to take advantage of the opportunities offered by nanoscience and nanotechnology, will be necessary to increase the knowledge of how food structures are formed, how they break and how are digested and absorbed.

Thanks you for your attention

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