



# **NANOTECHNOLOGY IN COSMETICS**

**Periyanayaga Kristy.A**  
**M.Tech – Nanotechnology**

SRM Institute of Science and Technology



# Nanotechnology in textiles and cosmetics

## Definition of nanomaterials

- For the purposes of cosmetics “Nanomaterial “means an insoluble or biopersistent and intentionally manufactured material with one or more external dimensions, or an internal structure, on the scale from 1 to 100 nm.”
- ‘Cosmetic product’ means any substance or mixture intended to be placed in contact with the external parts of the human body (epidermis, hair system, nails, lips and external genital organs) or with the teeth and the mucous membranes of the oral cavity with a view exclusively or mainly to cleaning them, perfuming them, changing their appearance, protecting them, keeping them in good condition or correcting body odours.

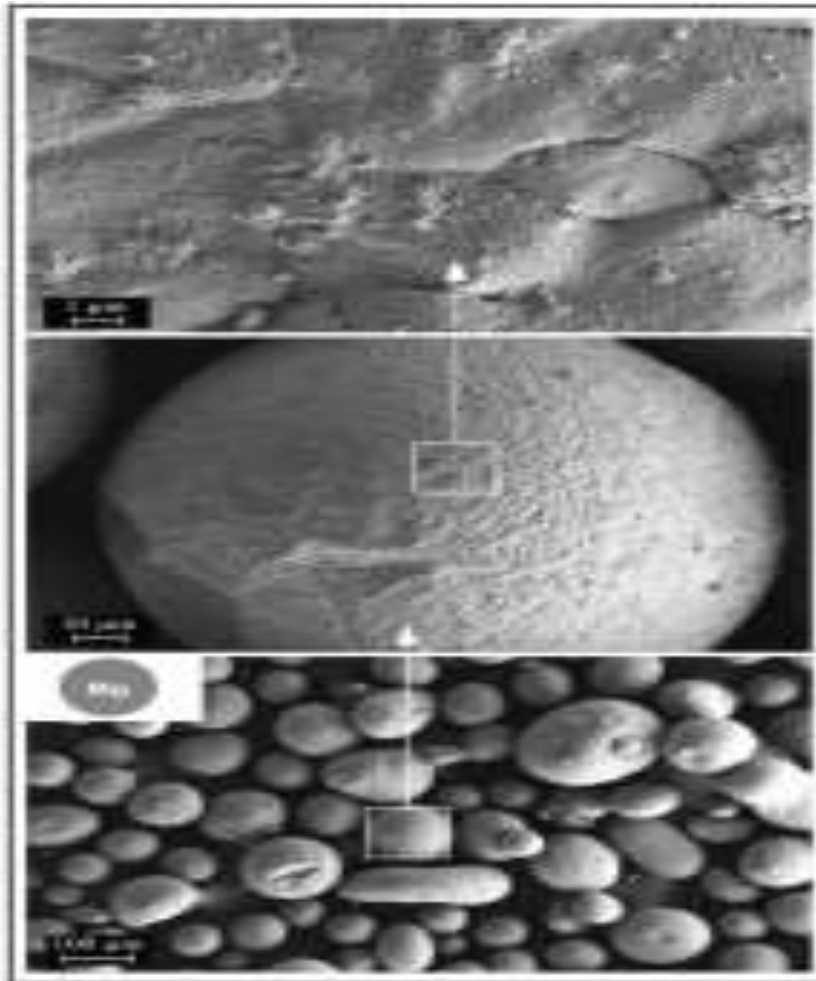
# Cosmetic

- Many cosmetic products include particulate material or emulsions.
- Some examples of cosmetic products consisting of or including particulates include facial powders, moisturizers, lipstick etc.

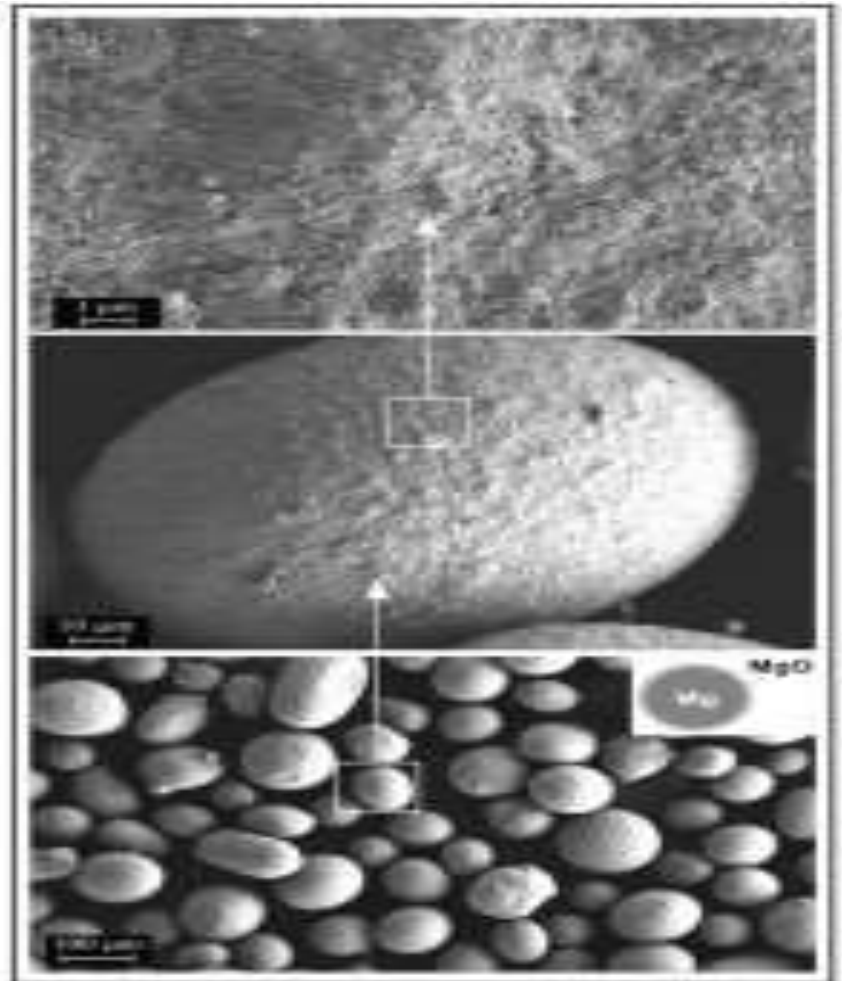
# Nanopowder

- Nanopowder are solid particles that measure on the nanoscale, usually comprised of three to five molecules together.
- Nanopowder have been of extreme interest in the Cosmetic field.
- Smaller particles mean better absorption by the body therefore less drug is needed.
- Because of a combination of these, side effects are lessened due to better use of cosmetics.

# Nanopowder



(a)



(b)

# Facial powders

- Face powders may include talc, kaolin, iron oxide, zinc oxide, titanium dioxide.
- In addition to appearance enhancement, face powders can also provide sunscreen protection with the inclusion of strong light scattering components such as zinc oxide.
- The particle size distribution of these components affects appearance, stability, and sunscreen protection

# Facial powders

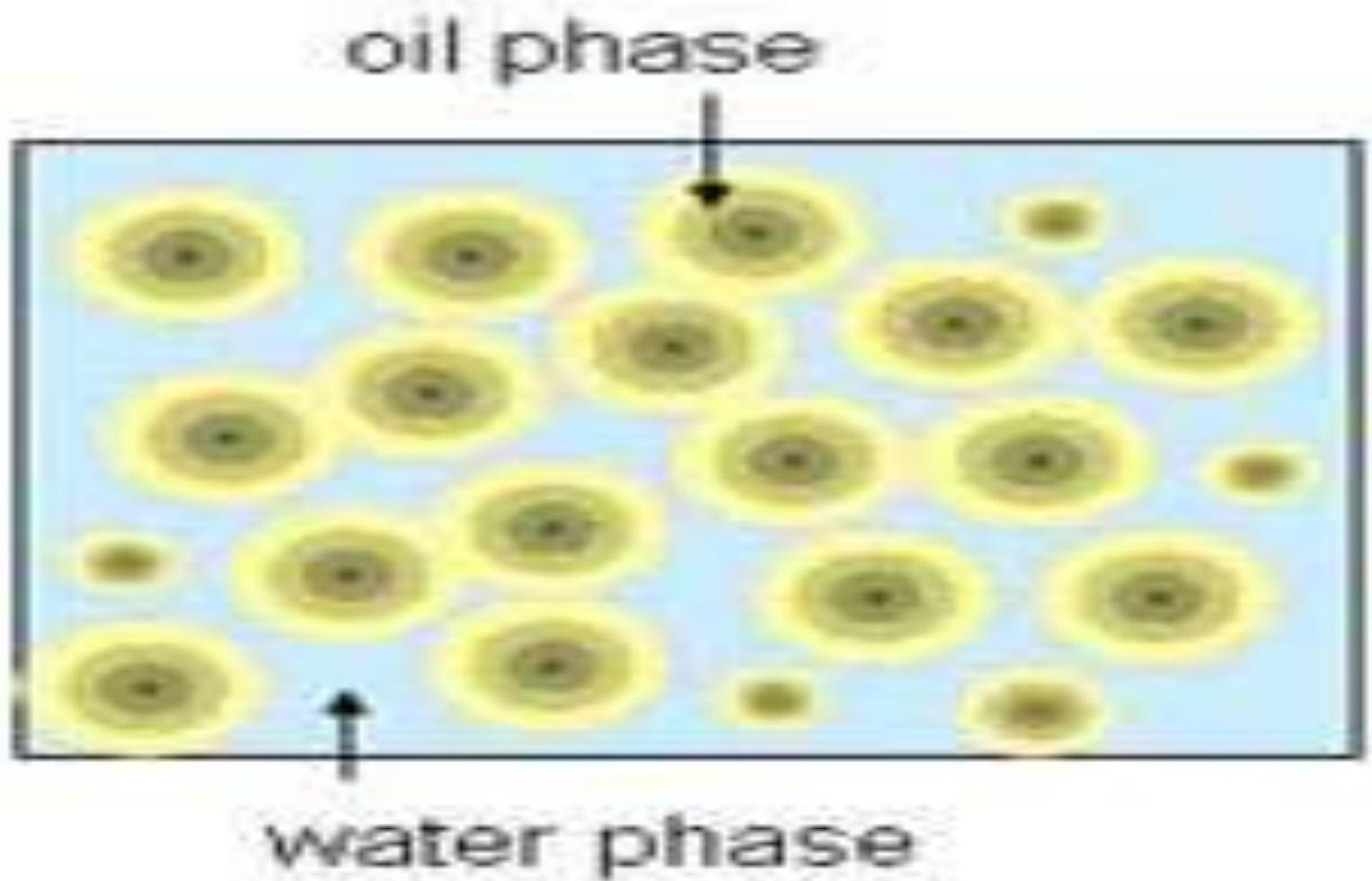


# Moisturizers

- Moisturizers are applied to the skin to improve hydration, protect from drying, and improve appearances.
- Most moisturizers are oil in water emulsions with additives to improve stability or provide additional benefits such as sun screening properties.
- Formulating oil in water emulsions often requires knowledge of both the size distribution of the dispersed phase (oil) and the charge on the surface of the droplets (the zeta potential).



# Nanoemulsion



# Lipstick

- The selection of pigments used for lipstick plays an important role in the final appearance.
- Many pigments used in lipstick are particulate including effect pigments that add silk or pearlescent attributes.
- Smaller particles create satin and silky effects while larger particle sizes create high luster effects such as sparkle.
- Pearlescent pigments also add a shine to the appearance of the lipstick.

# Lipstick



# Nanotechnology Based Cosmetic Product

- Moisturisers
- Hair care products
- Make up and sunscreen

# Use of nanoparticles as UV filters

- Titanium dioxide ( $\text{TiO}_2$ ) and zinc oxide ( $\text{ZnO}$ ) are the main compounds used in these applications.
- Organic alternative to these have also been developed



# Use of nanotechnology for delivery

- Nanoliposomes and Nanoniosomes are used in the cosmetic industry as delivery vehicles.
- Solid lipid nanoparticles (SLN) and nanostructured lipid carriers (NLC) have been found to be better performers than liposomes
- NLCs have been identified as a potential next generation cosmetic delivery agent that can provide enhanced skin hydration, bioavailability, stability of the agent and controlled occlusion

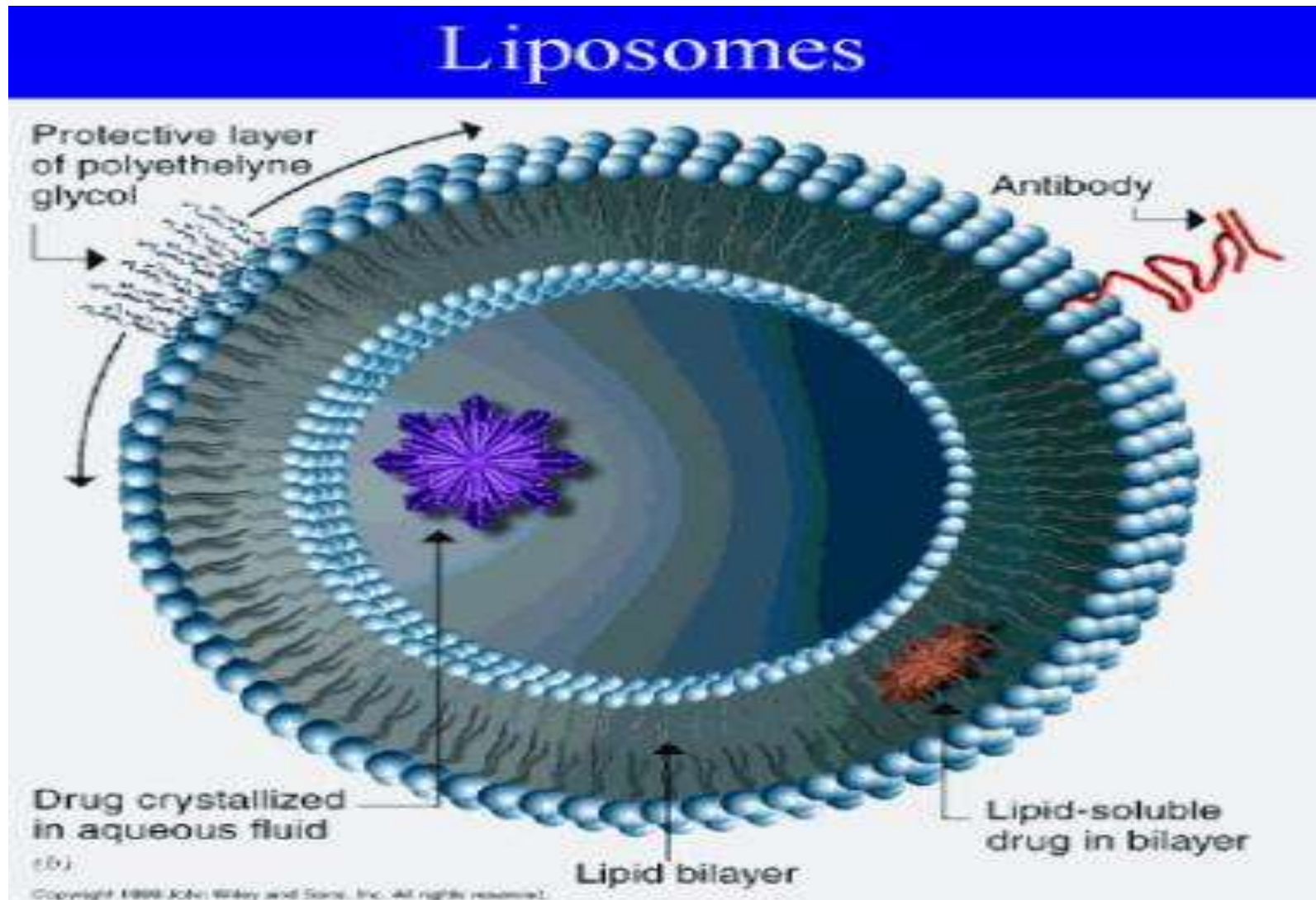
# Vesicular Delivery Systems

- Nanoliposomes
- Nanoniosomes

# Nanoliposomes

- Liposomes are vesicular structures with an aqueous core surrounded by a hydrophobic lipid bilayer, created by the extrusion of phospholipids.
- Phospholipids are GRAS (generally recognised as safe) ingredients, therefore minimising the potential for adverse effects.
- The first liposomal cosmetic product to appear on the market was the anti-ageing cream 'Capture' launched by Dior in 1986.

# Nanoliposomes

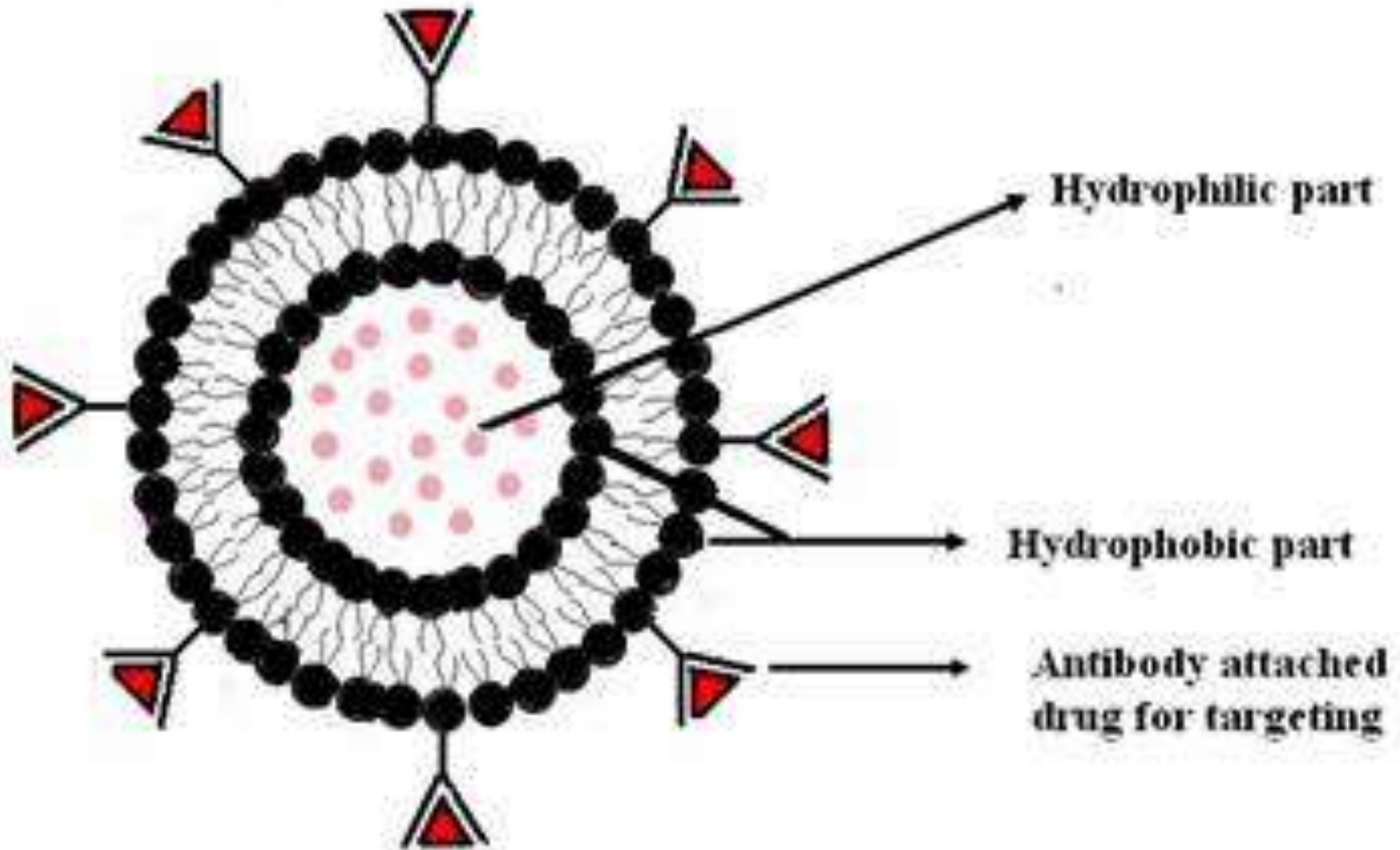


# Nanoniosomes

- Niosomes are non-ionic surfactant based vesicles that have a similar structure to that of phospholipid vesicles like liposomes.
- They can be used to encapsulate aqueous solutes and act as drug and cosmetic carriers.
- 
- They are formed by the self-assembly of non-ionic surfactants in aqueous media.
- The first product 'Niosome' was introduced in 1987 by L'Oréal company.



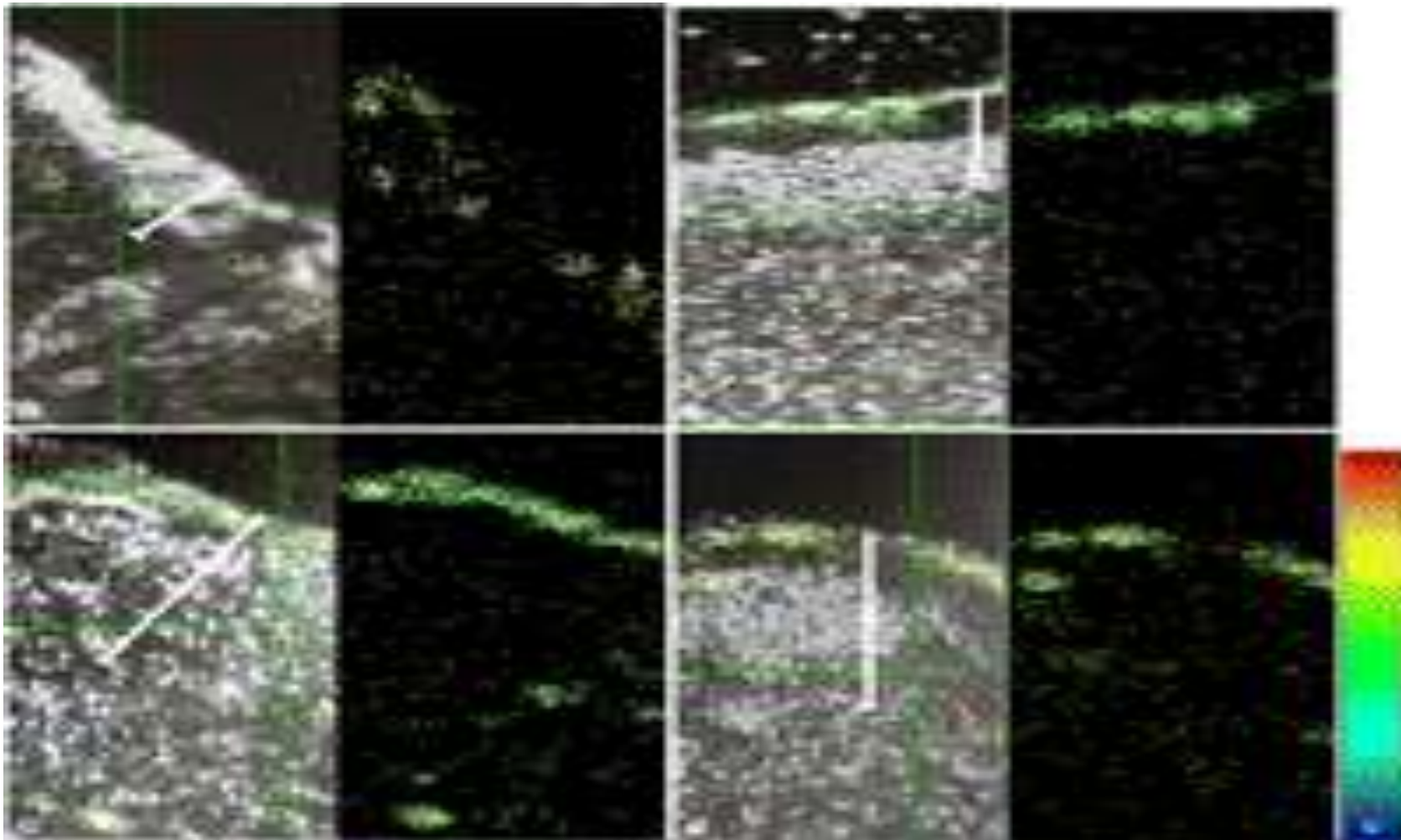
# Nanoniosomes



# Nanotechnology for UV protection

- Zinc oxide (ZnO) and titanium dioxide (TiO<sub>2</sub>) particles have been widely used for many years as UV filters in sunscreens.
- Products using nanoparticles of ZnO or TiO<sub>2</sub> are transparent so have increased aesthetic appeal, are less smelly, less greasy and more absorbable by the skin.
- Many sunscreens and moisturisers available now use these nanoparticles, including products from Boots, Avon, The Body Shop, L'Oréal, Nivea and Unilever

# ZnO and TiO<sub>2</sub> Nanoparticles



# Nanomechanical and Nanotribological study of hair

- Nanotechnology has been used to study the mechanical characteristics of hair.
- Understanding the differences between hair types allows cosmetic companies to create products to suit individual hair types (e.g. ethnic differences between Caucasian, Asian and African hair) as these can respond differently to activities like shampooing, styling or colouring.
- The hair care industry is also interested in the effect of water on the nanomechanical properties of hair

# Nanomaterials in cosmetics

- Nanomaterials used in cosmetics differ from nanomaterials used by other industries.
- They differ by their shape, their molecular structure, their mode of use and their specific interactions with the living world and the environment.
- Nanomaterials in cosmetics are nanoemulsions , nanosomes and nanopigments.
- These nanomaterials are used for example in sunscreens, skin creams and oral hygiene products.



# Cosmetics

Sunscreen

-nano Zinc Oxide

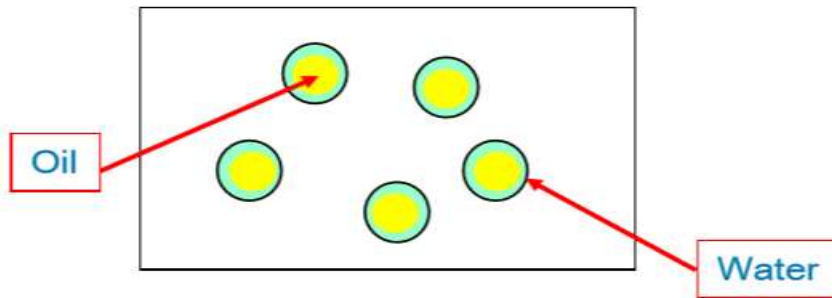
-Anti-Aging Creams



# Nanoemulsions and nanosomes

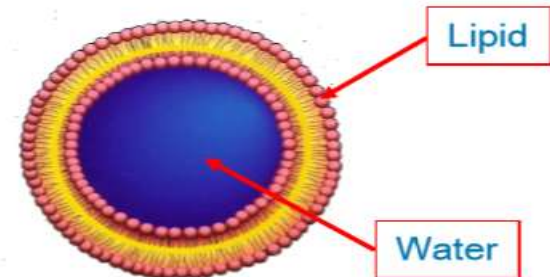
- Nanoemulsions are macroscopic preparations which contain droplets of water and oil reduced to the nanometric size to increase the content of nourishing oil, and to preserve the transparency and the lightness of the formula.
- Sometimes active ingredients that are fragile in air — such as vitamins — are protected and kept fresh inside nanometric bubbles (capsules) or nanosomes (liposomes).
- The active ingredients are released upon contact with the skin at the time of the application where the nanoemulsions and nanosomes open.
- Nanoemulsions and nanosomes are not included in the legal definition of a nanomaterial for cosmetics.

# Nanoemulsions, Nanosomes & Nanocapsules

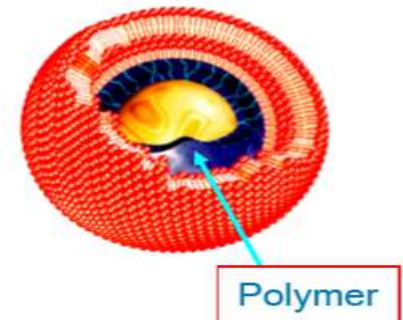


**Nanoemulsion**  
50-80 nm  
(Nourishing oils, unique texture & transparency)

**Illustration by**  
**Francis Quinn Ph. D.**  
L'Oréal Research  
14 November 2008



**Liposome**  
150-300 nm  
(Caffeine)



**Nanocapsule™**  
150-600 nm  
(Vitamin A, E)

# Nanopigments

- Nanopigments are minerals already present in our natural environment, in the form of clay and sand for example.
- Titanium dioxide ( $\text{TiO}_2$ ) is one of the best known. It is a totally insoluble, inert material. It is a reference of non toxicity which is why we find it used widely in foodstuffs (colouring agent E171) as well as dental/oral hygiene products including toothpaste.
- Another well known is zinc oxide ( $\text{ZnO}$ ).
- Both  $\text{TiO}_2$  and  $\text{ZnO}$  are used in sunscreens because they are known to reflect and scatter UV light, and protect skin against adverse effects of UV light, including skin cancers.

- Carbon black, an intense cosmetic colorant, can be used in the nano-form and is a good example of how reducing the pigment particle-size can alter the strength and opacity of colour.



# Nano-Challenges

- Nano-sizing materials may change their risk profile – Exposure and dose may be influenced by particle size, shape, and surface properties

Hazard may depend on scale-associated properties in addition to chemical identity

- Nanotechnology has the potential to blur the boundary between cosmetics and drugs



# Action Points

- Criteria are needed for defining new materials for legal or regulatory purposes • Relevant regulatory trigger-points are needed
- Nanomaterial-specific knowledge is needed – Through targeted research – Through information-sharing by industry
- Transparency is essential

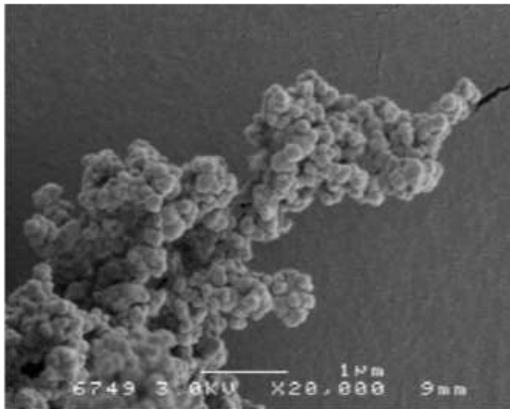
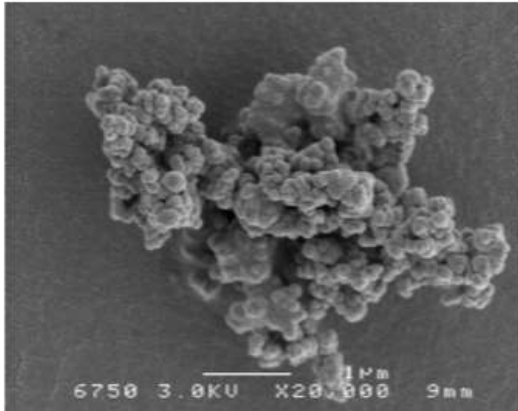
# Safety of titanium dioxide

- In sun creams titanium dioxide is present in the form of aggregates and agglomerates (size much greater than 100 nm) on the surface of the skin.
- A large number of studies have demonstrated that titanium dioxide nanopigments do not cross the skin barrier after topical application.
- Studies, including those carried out within the framework of the European research program NANODERM, have clearly shown that nanopigments do not cross the skin barrier of either healthy skin or compromised skin (psoriasis).

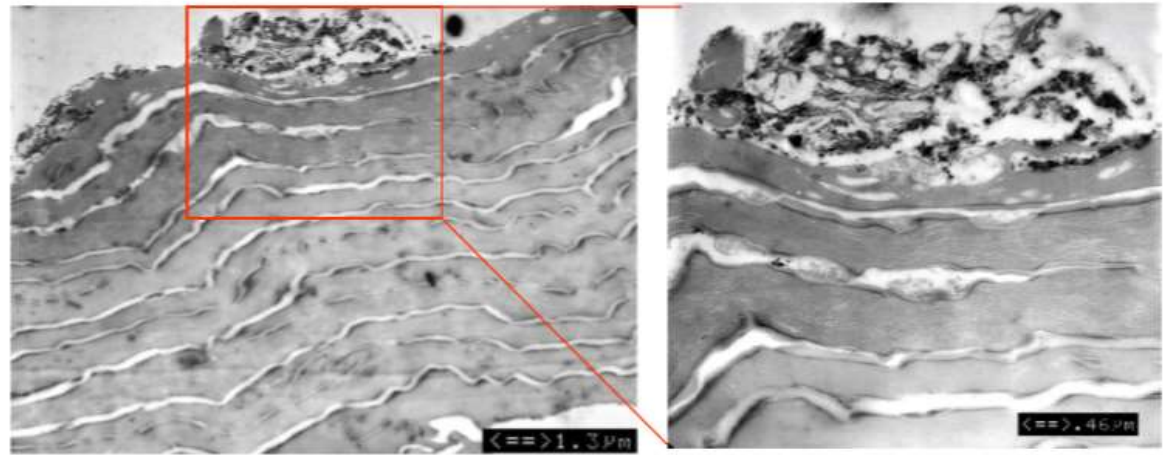
# Safety of titanium dioxide

- Furthermore, recent studies carried out by the US FDA (Food & Drug Administration) and in Europe, have demonstrated that even in the case where titanium dioxide nanopigments are injected into the blood stream, no adverse effects are observed

# Titanium Dioxide Nanopigments



**Nano titanium dioxide  
agglomerate**  
© L'Oréal Recherche



**Nano titanium dioxide agglomerate  
from a sun cream on the skin surface**  
© L'Oréal Recherche



# Safety of zinc oxide

- Scientific Committee on Consumer Safety (SCCS) has recently issued an opinion on the safety of nano ZnO (SCCS/1489/12 ).
- There is no evidence for the absorption of ZnO nanoparticles through skin and via the oral route.
- Nano ZnO-containing cosmetic formulations are likely to contain a small proportion of solubilized zinc, a further small proportion of which may be absorbed through skin and other routes.
- The rate and amount of the absorbed zinc is, however, likely to be insignificantly small compared to the large zinc pool already present in the body.

# Safety of zinc oxide

- Although the current evidence in relation to potential genotoxicity of ZnO is not conclusive, the use of nano ZnO in cosmetic products should not pose a risk to the consumer in the absence of a significant systemic exposure.
- ☐ Different particle sizes, surface modifications, and crystalline structures and morphologies investigated by SCCS do not significantly alter the uptake, bioavailability and overall safety profile.
- ☐ The different typical formulations do not change the overall safety profile of the tested ZnO nanoparticles.

# Safety of zinc oxide

- In summary, it is concluded on the basis of available evidence that the use of ZnO nanoparticles with the characteristics as indicated below, at a concentration up to 25% as a UV-filter in sunscreens, can be considered not to pose a risk of adverse effects in humans after dermal application.
- This does not apply to other applications that might lead to inhalation exposure to ZnO nanoparticles (such as sprayable products).
- The assessment only applies to ZnO nanoparticles that are included in this dossier, or are similar materials.

# Legal framework

## Regulation of the use of nanomaterials in cosmetics

- For every cosmetic product that contains nanomaterials, a high level of protection of human health shall be ensured.
  - EU Cosmetics Regulation 1223/2009/EC, Art 16 – Cosmetic manufacturers have to demonstrate the safety of any ingredient used in cosmetics. – SCCS guidelines for safety assessment of nanomaterials. – Cosmetics industry guidelines for nanomaterials.
- In addition to the normal notification, cosmetic products containing nanomaterials shall be notified to the Commission by the responsible person by electronic means six months prior to being placed on the market.

# Regulation of the use of nanomaterials in cosmetics

- Environmental safety is under the scope of the REACH Regulation.
- As of summer 2013 nano-ingredients will be labelled with the word 'nano' in the ingredients list for consumer information.

# Nanomaterial notification data shall contain at least the following:

- a) the identification of the nanomaterial including its chemical name (IUPAC) and other descriptors as specified in point 2 of the Preamble to Annexes II to VI;
- b) the specification of the nanomaterial including size of particles, physical and chemical properties;
- c) an estimate of the quantity of nanomaterial contained in cosmetic products intended to be placed on the market per year;
- d) the toxicological profile of the nanomaterial;
- e) the safety data of the nanomaterial relating to the category of cosmetic product, as used in such products;
- f) the reasonably foreseeable exposure conditions.

# Notification of nanomaterials under the EU Cosmetics Regulation

- In case of safety concerns: The SCCS (Scientific Committee on Consumer Safety) should give opinions, where appropriate, on the safety of use of nanomaterials in cosmetic products.
- These opinions should be based on full information being made available by the responsible person.
- – The SCCS provides opinions on health and safety risks (chemical, biological, mechanical and other physical risks) of non-food consumer products (e.g. cosmetic products and their ingredients, toys, textiles, clothing, personal care and household products) and services (e.g. tattooing, artificial sun tanning).
- [http://ec.europa.eu/health/scientific\\_committees/consumer\\_safety/index\\_en.htm](http://ec.europa.eu/health/scientific_committees/consumer_safety/index_en.htm)    ☐ Pre-authorisation of positive list materials supersedes nanonotification (colorants, UV-filters or preservatives).



# Timetable of nanomaterial provisions under the EU Cosmetics Regulation

- 11 January 2013 –11 July 2013 Notification of existing nanomaterials to the Commission. New nanomaterials will always be notified six (6) months prior to marketing.
- By 11 January 2014, the Commission will make available a list of all nanomaterials used in cosmetic products, including those used as colorants, UV-filters and preservatives. The list will be regularly updated.

# Timetable of nanomaterial provisions under the EU Cosmetics Regulation

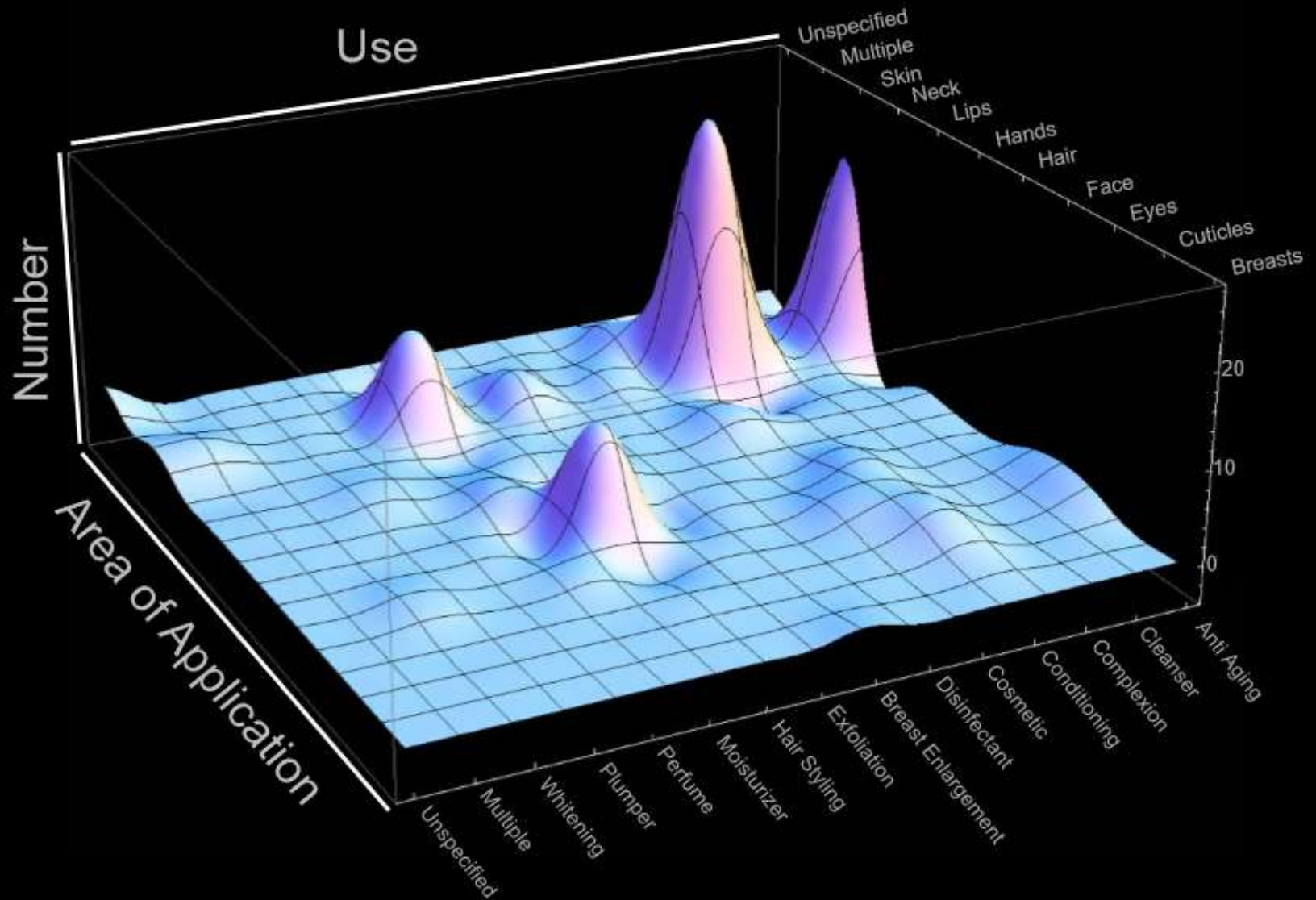
- By 11 July 2014, the Commission will publish a report on the use of nanomaterials in the European Union in different cosmetic product groups, including those used as colorants, UV-filters and preservatives. The report shall be updated annually.
- The Commission shall regularly review the provisions of this Regulation concerning nanomaterials in the light of scientific progress and shall, where necessary, propose suitable amendments to those provisions. The first review shall be undertaken by 11 July 2018.

# Nanotechnology R&D in Cosmetics

- Vesicular Delivery Systems (Nanoliposome & Nanoniosome)
- Nanoemulsions
- Solid Lipid Nanoparticles
- Nanostructured Lipid Carriers
- Dendrimers & Hyperbranched polymers
- Nanocrystals & Nanopowder
- Nanoencapsulation and controlled release
- Cubosomes
- Nanotechnology for UV protection
- Nanomechanical and Nanotribological study of hair
- Fullerenes

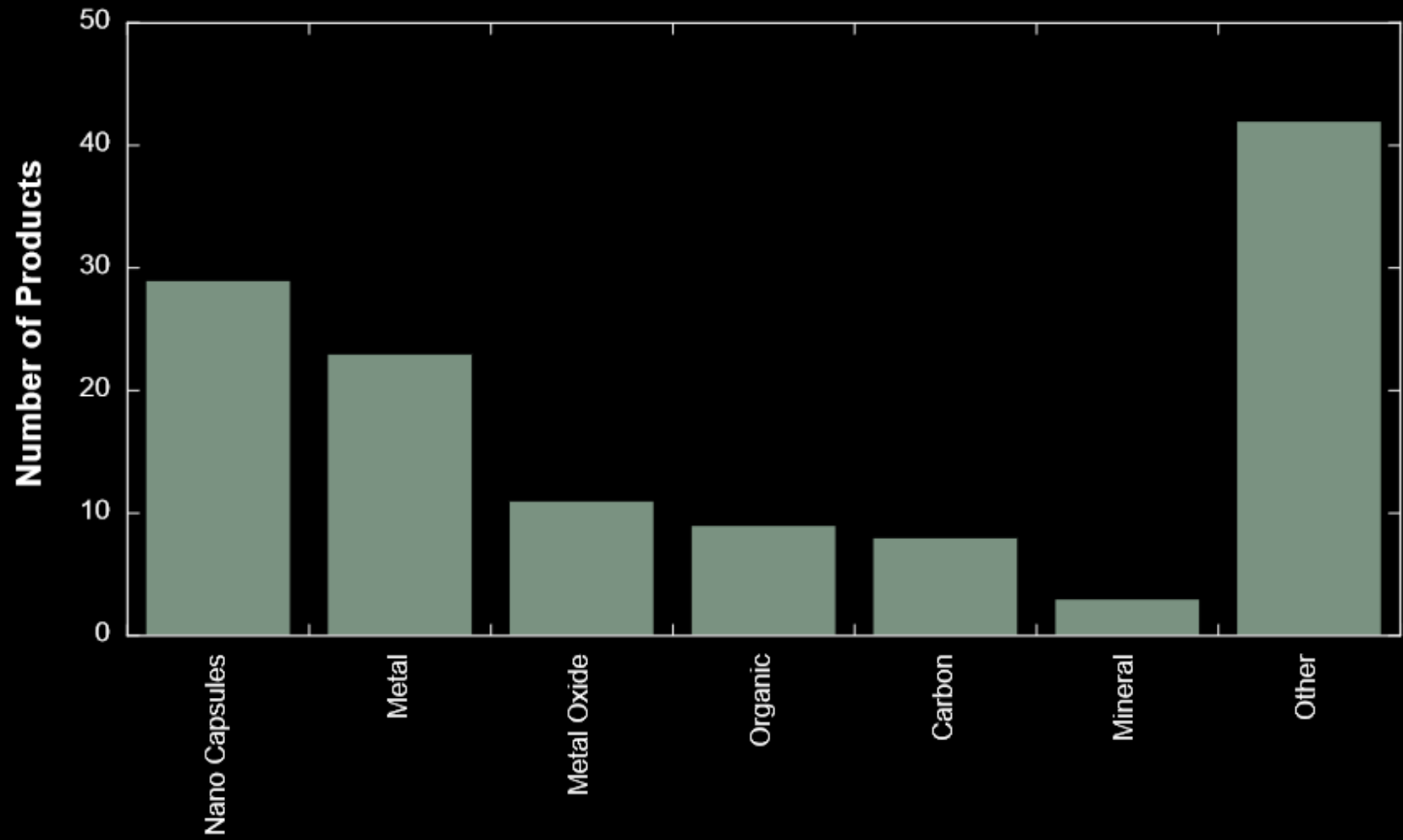
Current State of Knowledge on Nano-Cosmetics

# Product Functions & Application Areas



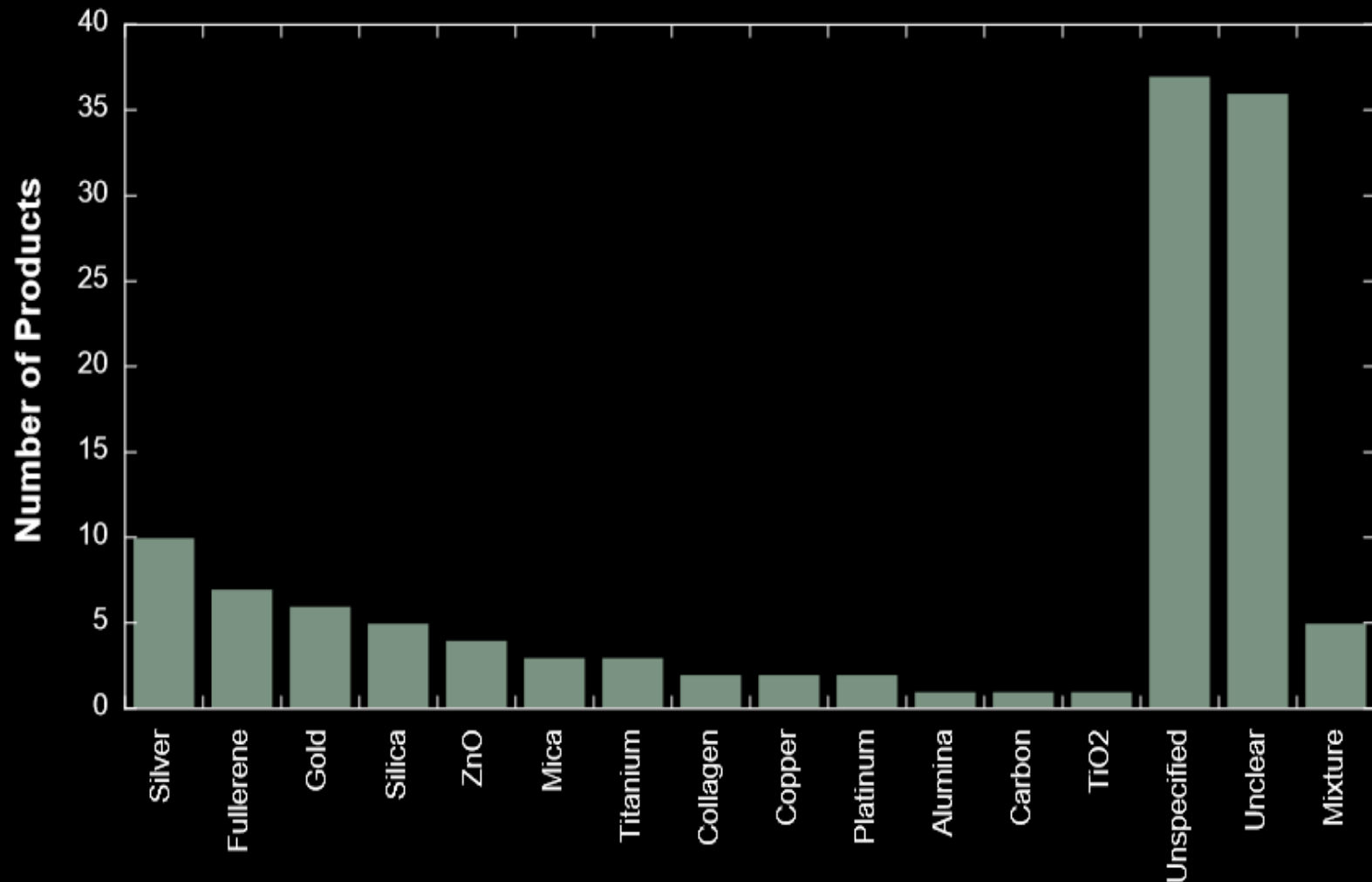
Current State of Knowledge on Nano-Cosmetics

# Nanomaterial Category



# Current State of Knowledge on Nano-Cosmetics

## Principle Nanomaterials Used



# Patents for Nanotechnology in Cosmetics

Company	Application Title	Key Language/Abstract (relevant claim in bold)	Date of Filed	Published Application/ Patent Number
Colgate-Palmolive	Deodorant with small particle zinc oxide	This invention comprises a one phase cosmetic composition which can be made as a stick, gel or cream	February 9, 2001	6358499
L'Oreal	Cosmetic composition comprising a <u>polyglycerolated</u> silicone elastomer	Nanoparticles are between 5 nm and 600 nm in size	March 22, 2005	2005220728



# Concluding remarks

- Nanoemulsions and nanopigments are the only nano-scale materials used in cosmetics. These applications have been proven safe in various studies. – There is no established specific risk for nanomaterials. Size alone is not in itself an indicator of toxicity.
- All cosmetic products, including those containing nanomaterials, are subject to rigorous safety testing and evaluation. This is regulated by an exhaustive EU regulatory framework.
- Cosmetics industry supports development of international standards for nanotechnologies relevant to different industries.

Thank you

