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# A REVIEW: ROLE AND FUTURE OPPORTUNITIES OF NANOTECNOLOGY BASED COSMECEUTICAL

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## ABSTRACT

This review has overviewed the nanotechnology approaches and safety concerns in cosmetics. Nanotechnology based cosmeceuticals have been widely use in cosmetics for recent few years such as in sunscreens, hair products, skincare products, etc. However debate on their definition and insufficient quantification methods are major problems still occur in the cosmeceutical field. Moreover the frequent use of cosmetics, safety of nanoscale ingredients of them has gain importance mainly by means of their dermal exposure. Although the proposed benefits that may occur by incorporating nanoparticles in cosmetics are increased efficiency, transparency, unique texture, protection of active ingredient, and overall higher consumer compliance, there still have not enough studies proved whether they are completely safe or not. As a conclusion major issues related cosmeceutical such as developing, using and researching is going to increase in the near future due to their economically importance

**KEYWORDS:** Nanotechnology, Nanomaterials, Cosmetics.

## INTRODUCTION

Nanotechnology is the art and science of manipulating matter at the nano scale to create new and unique materials and products with enormous potential to change society. The term "nanotechnology" was invented by Professor Norio Taniguchi at the University of Tokyo in 1971. Nanotechnology is science, engineering and technology conducted at the nano scale, which is about 1 to 100 nanometers. Nanotechnology is the engineering of functional systems at the molecular scale. This covers both current work and concepts that are more advanced. Nanotechnology breakthrough research in cosmeceutical Industry. Nanotechnology, a field of science and technology that aims to control matter at the atomic and molecular level. There are 25,400,000 nanometers in an inch. sheet of newspaper is about 100,000, nanometers thick. Nanotechnology is nothing but the fundamental understanding about how materials react or works at nano scale (i.e. at atomic, molecular or subatomic level) in the creation and utilization of structures, devices and systems that have novel properties and functions. Nanotechnology deals with manipulation of structures of matter in the size range of 1-100 nanometers. Particles of these size ranges are called as nanoparticles which are having one or more external dimensions or an internal structure, on the nanoscale and could exhibit novel characteristics compared to the same material without nanoscale features. Nanotechnology is a key technology leading to product innovation. Nanotechnologies use materials on an incredibly small scale so that they take on new properties compared to their larger form. Nanospheres are microscopic fragments used to deliver ingredients into the deep layers of the skin. To achieve this, cosmetic companies need to manipulate materials at the atomic level this is called "nanotechnology".

The technology has the potential to transform many of the everyday consumer products that we use and a wide range of products are already on the market. Nano-cosmetics is one area of particular interest as new types of products can be made using nano materials. UV filters used in sunscreens produced in nano form, these materials could be more hazardous and behave differently in the body compared to larger forms. Nanotechnology entered the field of cosmetics and health products nearly 40 years ago with liposome moisturizing creams. The increased usage of nanomaterials in

cosmetic products is indicative of the huge potential nanotechnology represents for the cosmetics industry and its consumers. A number of nanomaterials types are already in use, including nanoemulsions and nanoparticles of minerals present in our natural environment, such as titanium dioxide (TiO2), zinc oxide (ZnO), alumina, silver, silicon dioxide, calcium fluoride and copper. The unique properties and behaviour of nanomaterials mean that nanotechnologies could profoundly transform industry and everyday life. Nanoemulsions, for example, are transparent and have particular rheological properties that have yet to be obtained by other formulation methods. This allows them to increase the content of nutritious oils while preserving not only the transparency but also the lightness of formulas. Certain mineral nanoparticles, such as TiO2 and ZnO, are highly efficient UV-filters, able to reflect and scatter the visible part of solar radiation while absorbing UV light. Given these properties, they are extensively used in sunscreens. Other examples of nanocosmetic products on the market include body firming lotion, bronzer, exfoliant scrub, eye liner, and styling gel, etc. Nanoemulsions have recently become increasingly important as potential vehicles for the controlled delivery of cosmetics and for the optimized dispersion of active ingredients in particular skin layers. In the present day, this escalating technology plays a significant role in rising above the traditional drawbacks related to cosmetics and allied products.[1-8]

**Advantages Of Nanotechnology**

1. Use of nanotechnology in cosmetics is aimed to make fragrances last longer, sunscreens more effective and anti-ageing creams.
2. To optimize manufacturing conditions for skin care formulation, a multi component system.
3. To prevent hair from turning grey and also for prevention of in treatment of hair loss & used to preserve active ingredients, such as vitamins and anti-oxidants, and their lightness and transparency.
4. To improve the UV protection in combination with organic sunscreens such as 2- hydroxy-4-methoxy benzophenone this allows a reduction of the concentration of the UV absorber.
5. Nano materials used as UV filters in sunscreen products do have to be independently assessed, but we found nano zinc oxide in use, although it has not yet been fully assessed.[9]

**Disadvantages of Nanotechnology**

1. Smaller particles have a greater reactivity, are more chemically reactive and produce greater numbers of reactive oxygen species.
2. It may result in oxidative stress, inflammation, and consequent damage to proteins, membranes and DNA.
3. Nanomaterial has proved toxic to human tissue and cell cultures, resulting in increased oxidative stress and cell death.
4. Photo-activated Nanoparticles titanium dioxide has been demonstrated to cause oxidative damage to DNA in cultured human fibroblasts.
5. Photo-activated titanium dioxide nanoparticles were toxic to skin fibroblasts and nucleic acids and to human colon carcinoma cells.
6. Inhaled ultrafine particles induce pulmonary inflammation when the particles are quartz, minerals, dust, coal, silicate, and asbestos. These can induce pulmonary fibrosis, cytotoxicity, and even malignancy.[10]

**Need of Nanomaterials In Cosmetics**

The increased usage of nanomaterials in cosmetic products is indicative of the huge potential nanotechnology represents for the cosmetics industry and its consumers because of their advantages. A number of nanomaterial types are already in use, including nanoemulsions, and nanoparticles of minerals present in our natural environment, such as titanium dioxide (TiO2), zinc oxide (ZnO), alumina, silver, silicon dioxide, calcium fluoride and copper. The rationale for the use of nanomaterials in cosmetic products is, of course, that they offer added value in terms of product performance. The unique properties and behaviour of nanomaterials mean that nanotechnologies could profoundly transform industry and everyday life. In formulation of cosmetics, Titanium dioxide (TiO2) and Zinc Oxide (ZnO) nanopigments are the main compounds used as highly efficient UV-filters, able to reflect and scatter the visible part of solar radiation while absorbing UV light. Given these properties, they are extensively used in sunscreens. Other examples of nanocosmetic products on the market include body firming lotion, bronzer, exfoliant scrub, eye liner, and styling gel, to name but a few. The nanomaterials found its next use as encapsulated carrier for topical delivery of photolabile and skin sensitizing compounds. Liposomes and Niosomes are used in the cosmetic industry as delivery vehicles to **improve:**

- Direct interaction of sensitive agents with skin.
- The delayed release of sensitizing agents.
- Reduction in the amount of agents and additives.
- Increased lifespan and hence greater product acceptability.

Nanocrystals, microemulsions, nanoemulsions, Fullerenes and dendrimers are also being explored in modern cosmetic and beauty care applications. Nanopigments are custom built to stay on the surface of the skin and are a major component of some sunscreens. Nanoemulsions are oil and water droplets often protecting fragile active ingredients (like vitamins). Unstable Vitamins can be suspended in nanoemulsions. The industry calls them nanocapsules, liposomes, lyphazones, etc. and nanoemulsions release the entrapped load upon contact with the skin on application.

**Recent Advances In Cosmetics Formulation Technology**

- Nanoliposomes
- Nanoemulsions
- Microemulsions
- Nanocapsules
- Solid lipid nanoparticles
- Nanocrystals
- Nanosilver and Nanogold
- Dendrimers
- Cubosomes
- Niosomes
- Lipid Nanoparticle
- Transfersomes

**There are number of innovative cosmetic delivery systems used in cosmetic products**

**1. Nanoliposomes**

Liposomes are vesicular structures with an aqueous core surrounded by a hydrophobic lipid bilayer, created by the extrusion of phospholipids. They are most widely known cosmetic delivery systems. Liposomes can vary in size, from 15 nm up to several μm and can have either a single layer (unilamellar) or multilayer (multilamellar) structure. The first liposomal cosmetic product to appear on the market was the anti-ageing cream 'Capture' launched by Dior in 1986. Phosphatidylcholine, one of the main ingredients of liposomes, has been widely used in skin care products and shampoos due to its softening and conditioning properties.

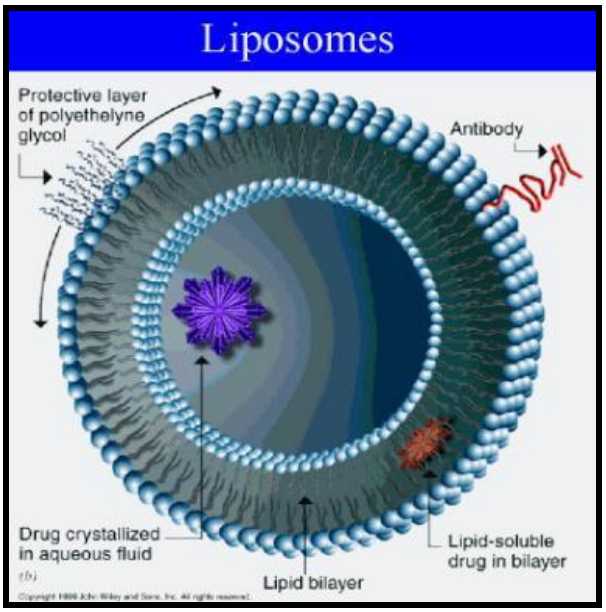


**Figure 1: Liposome.**

Liposomes have been formed that facilitate the continuous supply of agents into the cells over a sustained period of time, making them an ideal candidate for the delivery of vitamins and other molecules to regenerate the epidermis. They have also been used in the treatment of hair loss. Minoxidil, a vasodilator, is in the active ingredient in products like Regaine that claim to prevent or slow hair loss. The skin care preparations with empty or moisture loaded liposome reduce the transdermal water loss and are suitable for the treatment of dry skin. They also enhance the supply of lipids and water to stratum corneum.[11]

**2. Nanoemulsion**

Nanoemulsions can be defined as "ultrafine emulsions" because of the formation of droplets in the submicron range. The average droplet size of nanoemulsions has been ranging from 50 to 1000 nm. They have attracted considerable attention in recent years for application in personal care products as potential vehicles for the controlled delivery of cosmetics. Nanoemulsions are transparent due to the droplets tiny size and they also remain stable for a longer period of time. They are mostly used in deodorants, sunscreens, shampoos, and skin and hair care products. The nanoemulsions are easilyvalued in skin care because of their good sensorial properties i.e. rapid penetration, merging textures and their biophysical properties especially, hydrating power. A significant improvement in dry hair aspect (after several shampoos) is obtained with a prolonged effect after a cationic nanoemulsion use. Hair becomes more fluid and shiny, less brittle and non-greasy.[12-13]

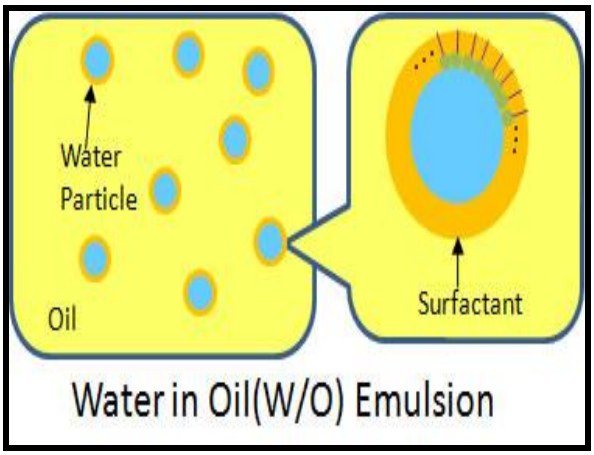


**Figure 2: Nanoemulsion.**

**3. Microemulsion**

Hoar and Schulman introduced the term microemulsion in 1943. Microemulsion is currently defined as nano – sized emulsion of water oil and amphiphile, an optically isotropic and thermodynamically stable liquid, containing particles with diameters of 100nm and less. In many cosmetic applications such as skin care products, hair products etc., emulsions are widely used with water as the continuous phase. Cosmetic microemulsions of silicone oils, produced by emulsion polymerization are not thermodynamically stable products because of low solubility of silicone oil in the surfactants. Eli Lilly and Company had been assigned a patent for their stable w/o microemulsion i.e., non-irritating moisturizing composition which when applied to skin promoted the penetration of moisturizers into the skin and leave little residue on the surface of the skin.[13]

**4. Nanocapsules**

are submicroscopic particles that are made of a polymeric capsule surrounding an aqueous or oily core. It has been found that the use of nanocapsules decreases the penetration of UV filter octyl methoxycinnamate in pig sk.in when compared with conventional emulsions.[14]

**5. Solid lipid Nanoparticles**

They are oily droplets of lipids which are solid at body temperature and stabilized by surfactants. They can protectnthe encapsulated ingredients from degradation, used for the controlled delivery of cosmetic agents over a prolonged period of time and have been found to improve the penetration of active compounds into the stratum corneum. In vivo studies have shown that an SLNcontaining formulation is more efficient in skin hydration than a placebo. They have also been found to show UVresistant properties, which were enhanced when a molecular sunscreen was incorporated and tested. Enhanced UV blocking by 3, 4, 5-trimethoxybenzoylchitin (a good UV absorber) was seen when incorporated into SLNs.[15-21]

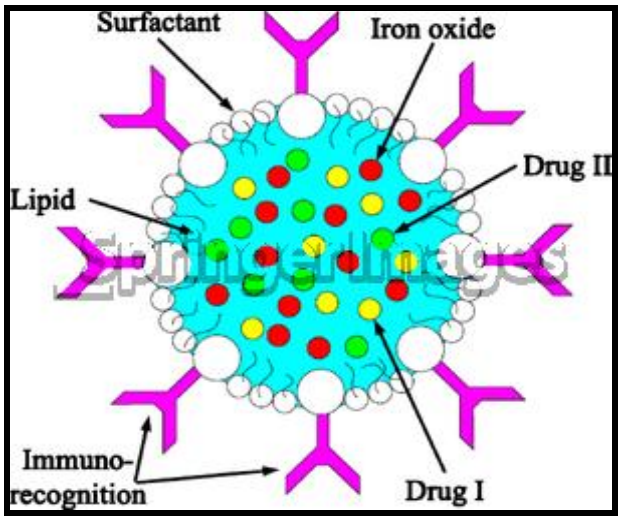


**Figure 3: Nanoemulsion.**

**6. Nanocrystals**

Nanocrystals are crystals having size less than 1µm. They are aggregates comprising several hundred to tens of thousands of atoms that combine into a "cluster". Typical sizes of these aggregates are between 10-400 nm. Nanocrystals of poorly soluble drugs can also be incorporated in cosmetic products where they provide high penetration power through dermal application. The first cosmetic products appeared on the market recently; Juvena in 2007 (rutin) and La Prairie in 2008 (hesperidin). Rutin and hesperidin are two, poorly soluble, plant glycoside antioxidants that could not previously be used dermally. Once formulated as nanocrystals, they became dermally available as measured by antioxidant effect. The nanocrystals can be added to any cosmetic topical formulation, e. g. creams, lotions and liposomal dispersions.[22-23]

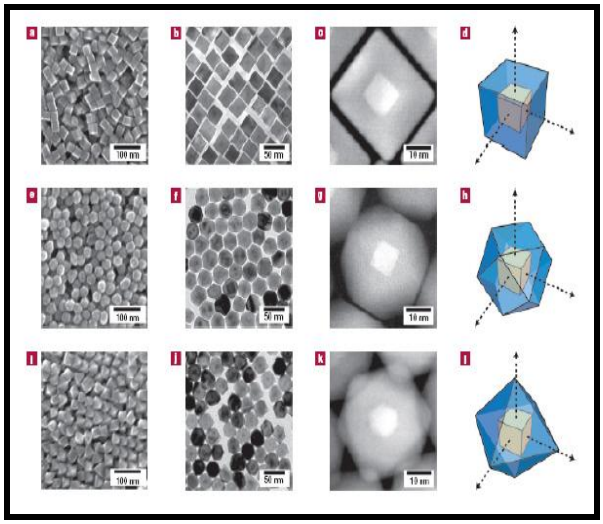

**Figure 4: Nanocrystal.**

**7. Nanosilver and Nanogold**

Cosmetic manufacturers are harnessing the enhanced antibacterial properties of nanosilver in a range of applications. Some manufacturers are already producing underarm deodorants with claims that the silver in the product will provide up to 24-hour antibacterial protection. Nano-sized gold, like nanosilver, is claimed to be highly effective in disinfecting the bacteria in the mouth and has also been added to toothpaste.[24]

**8. Dendrimers**

Dendrimers are unimolecular, monodisperse, micellar nanostructures, around 20 nm in size, with a well-defined,regularly branched symmetrical structure and a high density of functional end groups at their periphery. A dendrimeris typically symmetric around the core, and often adopts a spherical three-dimensional morphology. One of the veryfirst dendrimers, the new kome dendrimer, was synthesized in 1985. Dendrimers have also been considered for use in the cosmetic industry. Several patents have been filed for the application of dendrimers in hair care, skin care and nail care products. Due to their versatility, both hydrophilic and hydrophobic drugs can be incorporated into dendrimers.[25-26]

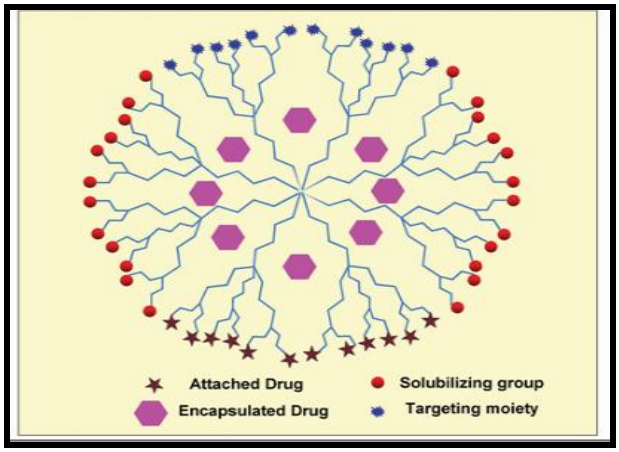


**Figure 5: Dendrimers.**

### 9. Cubosomes

Cubosomes are discrete, sub-micron, nanostructured particles of bi-continuous cubic liquid crystalline phase. It is formed by the self assembly of liquid crystalline particles of certain surfactants when mixed with water and a microstructure at a certain ratio. Cubosomes offer a large surface area, low viscosity and can exist at almost any dilution level. They have high heat stability and are capable of carrying hydrophilic and hydrophobic molecules. Combined with the low cost of the raw materials and the potential for controlled release through functionalization, they are an attractive choice for cosmetic applications as well as for drug delivery.[27-28]

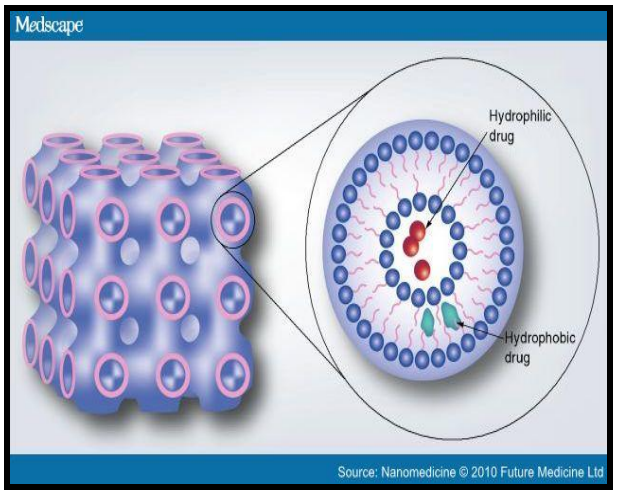


**Figure 6: Cubosomes.**

### 10. Niosomes

These are vesicles composed of nonionic surfactants. The niosomes have been mainly studied because of their advantages compared with the liposomes: higher chemically stability of surfactant than phospholipid, require no special conditions for preparation and storage, they have no purity problems and the manufacturing costs are low. The advantages of using niosomes in cosmetic and skin care applications include their ability to increase thenstability of entrapped drugs, improved bioavailability of poorly absorbed ingredients and enhanced skin penetration.[12]

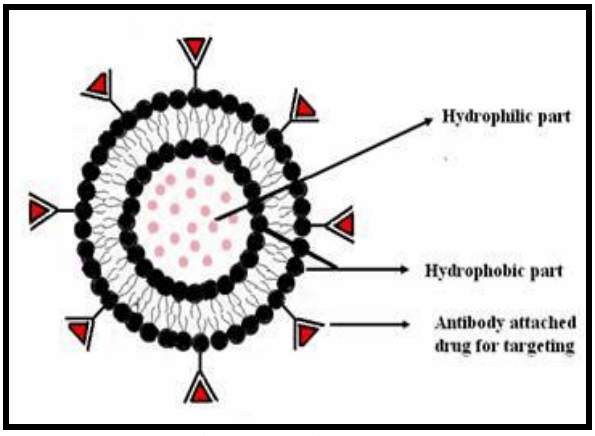


**Figure 7: Niosomes.**

### 11. Lipid Nanoparticle

The first generation of solid lipid nanoparticles (SLN) was developed at the beginning of the nineties as an alternative carrier system to emulsions, liposomes and polymeric nanoparticles. Solid lipid nanoparticles (SLNs) are nanomaterial sized particles with a solid lipid matrix. They are oily droplets of lipids which are solid at body temperature and stabilized by surfactants.[43] In the second generation technology of the nanostructured lipid carriers (NLC), the particles are produced by using a blend of a solid lipid with a liquid lipid, this blend also being solid at body temperature. SLNs have occlusive properties making them ideal for potential use in day creams. NLC were developed to overcome some potential limitations associated with SLN. Compared to SLN, NLC show a higher loading capacity for a number of active compounds, a lower water content of the particle suspension and minimize potential expulsion of active compounds during storage. Solid lipid nanoparticles (SLNs) and nanostructured lipid carriers (NLC) are novel colloidal delivery systems with many cosmetic and dermatological features; such as skin adhesive properties when applied to the skin resulting in occlusion, enhanced skin hydration, whitening effects, protection against degradation, absorption increasing effects, active penetration enhancement, and controlled release properties.[29]

### Future Opportunities In The Cosmetics Industry

1) TiO2 and ZnO are widely used in cosmetic formulations. However, there is a need for an in-depth toxicity study these materials as the studies so far have brought mixed results.
2) Liposomes and nanoemulsions do not disturb the integrity of the skin lipid bilayers and are not washed out while cleansing the skin. So, these formulations are believed to have a great future in the cosmetic science.
3) Acceptability of microemulsions, however, would be governed by the use of safer surfactants, which do not appreciably change the permeability of membrane over repeated use.
4) Encapsulation techniques and trigger-release mechanisms have been developed for the active delivery of cosmetic molecules. However, there is a need for reliable, cost effective triggers for controlled release.
5) Improvements in the drug loading efficiency of lipid based nanoparticles (SLNs and NLCs) and nanocapsules are required.
6) Better understanding of how lipid nanoparticles modify drug penetration into the skin, how they affect the drug penetration and how they interact with lipids of the stratum corneum is required.
7) Fundamental conditions for the formation of SLNs and NLCs and the effect of surfactants used for modifications need to be studied further.
8) Further in vivo studies on the effect of cosmetics that contain nanomaterials.

## CONCLUSION

Growth of cosmeceutical industry is increasing day by day as the cosmeceuticals market is highly diversified, with products coming from major and small manufacturers and local. companies around the world. Nanotechnology represents the key technologies of the twenty-first century, offering excellent opportunities for both research and business. The rapid spread and commercialization of nanotechnology in cosmeceuticals have given rise to great technical and economic aspirations but also question about the emerging risks to health and safety of consumers. Thus, cosmeceutical products based on nanotechnology should be designed and sold in a way that fully respects the health of consumers and the environment.

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