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A Review on Nanotechnology in Cosmetics

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Review Article

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ABSTRACT

Biotechnology and nanotechnology are the two most significant technologies of the twenty-first century, with enormous potential for growth and advancement. The academic and industrial goals of these technologies include the synthesis of nanoscale biomolecular compounds and analytical instruments for cellular and molecular cell biology research. Thanks to developments in nanotechnology, the area of aesthetic dermatology will be able to develop new biocompatible and biodegradable treatments, delivery systems and more effective chemicals. Cosmetics are mostly used to maintain a flawless appearance, change appearance or get rid of body odour while maintaining the health of the skin and its surrounds. In light of the evolving realities of skin care products, cosmetic dermatology must therefore emphasise the functional aspects of cosmetics by assessing their effectiveness and safety in enhancing health cosmetic dermatology.

Keywords: Nanotechnology; Biotechnology; Biodegradable; Biocompatible; Dermatology

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INTRODUCTION

The field of technology known as nanotechnology is concerned with building structures no larger than 100 nm [1]. It involves working with materials on an atomic or molecular scale in at least one dimension with a size between 1 and 100 nm [2]. Because it encompasses fields like molecular biology, surface science and organic chemistry, applied science is immensely diverse. At several cellular levels, nanotechnology assists in slowing down the ageing process [3]. To protect the skin from the damaging effects of sunlight, cosmetics are being formulated using nanotechnology. Liposomes, niosomes, Solid Lipid Nanoparticles (SLN), nanospheres, nanoemulsions, gold nanoparticles, dendrimers and other sorts of nanomaterials/nanocarriers are among the many types of nanomaterials/nanocarriers used in cosmetics. The item that is used to enhance the skin is called cosmetics. Cosmetics are the outside substances used on the outside of the body. "Particles meant to be applied to human bodies or any portion thereof for cleansing, beautifying, increasing attractiveness, or adjusting the look" is how the Food and Drug Administration (FDA) describes cosmetics. In modern world, cosmetics are viewed as necessities. They not only draw people to them, but they also have physiological effects. It has gotten a lot of attention from both men and women during the previous two to four decades. Creams and powders are the most often used cosmetics [4]. The term "cosmeceutical" refers to a cosmetic product that may also have therapeutic or drug-like effects. It can be created using chemicals or it might come from a natural source. In the 1990's, the terms cosmetics and pharmaceutics were combined to form the term cosmetics (Figures 1-3).

Figure 1. Advantages.

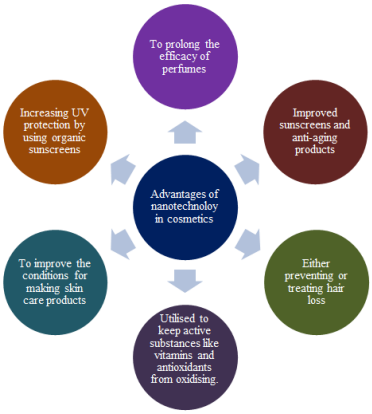

Figure 2. Disadvantages.

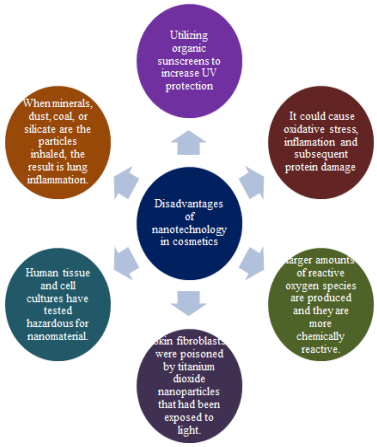

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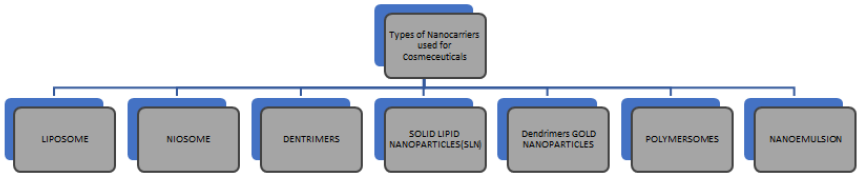
Figure 3. Types of nanocarriers used for cosmeceuticals.



Liposome

- Biodegradable liposomes.
- Natural and non-toxic.
- A vesicle made of a lipid bilayer that contains an aqueous compartment is known as a liposome (also known as a lipid body).
- Phospholipid is the lipid that is most frequently employed, while sphingolipids, glycolipids and sterols have all been used to make liposomes.
- They range in size from 25 nm to 5000 nm. You can create liposomes by rupturing the biological membrane (such as by sonication).

Niosome

- Niosomes are cholesterol and non-ionic surfactants arranged in tiny lamellar structures.
- With polar portions outside and within the vesicles where hydrophilic medications will be caught and non-polar regions formed inside the bilayers where hydrophobic pharmaceuticals will be entrapped, the niosomes have an amphiphilic bilayer structure [5].

Dendrimers

- Dendrimers are artificial polymers with branching architecture that are bedded.
- Their name refers to the special arrangement of polymer molecules and is derived from the Greek word "dendron," which means "tree."
- Due to their numerous unique properties, including as their nanoscale size, monodispersity, water solubility, multivalency and manipulable surface modification, they have mostly been employed in drug delivery investigations.
- In 1978, Fritz Vögtle and R.G. Denkewalter of Allied Corporation developed the first dendrimers. A number of identical shards known as dendrons are discovered after the dendrimer's core has been removed.
- In comparison to dendrimers from lower generations, those from higher generations are bigger, more branched and have more finish groups at their edges.

Solid Lipid Nanoparticles (SLN)

- Submicron colloidal carriers, or SLN, are composed of particles dispersed in water or an aqueous surfactant solution, with sizes ranging from 50 to 1000 nanometers. The body contains lipids.

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Advantages of SLN

- Improved control over the kinetics of chemical release from capsules.
- No more solvent is necessary.
- Exceptionally great long-term stability.

Disadvantages of SLN

- Unexpected gelatine trend.
- Growth of particles.

Gold nanoparticles

- Colloidal gold is another name for tiny gold particles, also known as gold nanoparticles, that disperse in water and have a diameter of 1 to 100 nm.
- By modifying the size, shape and surface chemistry of gold nanoparticles, their electrical and optical characteristics can coexist.
- Gold nanoparticles have developed into a desirable substance in the cosmetic sector due to their potent antifungal and antibacterial capabilities.

Polymersomes

- Polymersomes are a type of artificial vesicle, which are minuscule hollow spheres that contain solutions.
- The vesicle membrane of polymersomes is constructed of synthetic block copolymers that are amphiphilic and should have a radious of 50 nm to 5 m or more.
- Compared to liposomes, they exhibit greater stability due to the hard and thick bilayer. The majority of polymersomes that have been identified have an aqueous solution in the centre, which makes them ideal for encapsulating and protecting delicate compounds including medicines, enzymes, other proteins and peptides, DNA and RNA fragments, as well as other molecules.

Nanoemulsion

- It usually consists of an oily phase that is dispersed in an aqueous phase or an aqueous phase that is distributed in an oily phase, creating droplets or oily phases of nanometric sizes. Nanoemulsions are isotropically dispersed systems of two non-miscible liquids.
- In comparison to microemulsions, nanoemulsions often have a higher loading capacity for oleophilic active substances, which may be advantageous in particular applications.
- In contrast to microemulsions, certain nanoemulsions need substantial energy to generate, making them thermodynamically unstable systems.

The most popular ways to make nanoemulsions are these three:

- High-pressure homogenization
- Microfluidization
- Phase-inversion temperature methodology.

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LITERATURE REVIEW

Methods of preparation

There are several ways to make nanoparticles, including below steps (Figures 4-8) [6]:

Figure 4. Different ways for the preparation of nanoparticles.

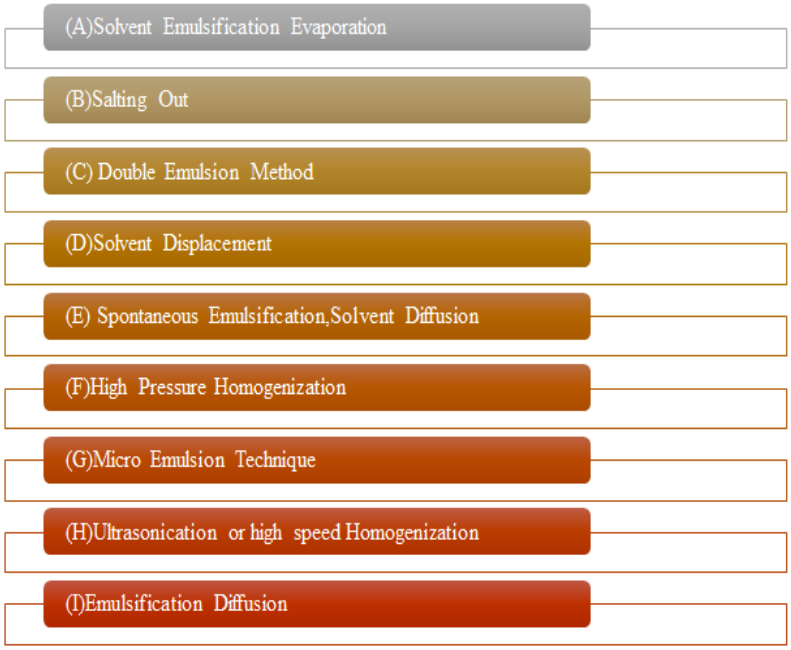

Figure 5. Solvent emulsification evaporation.

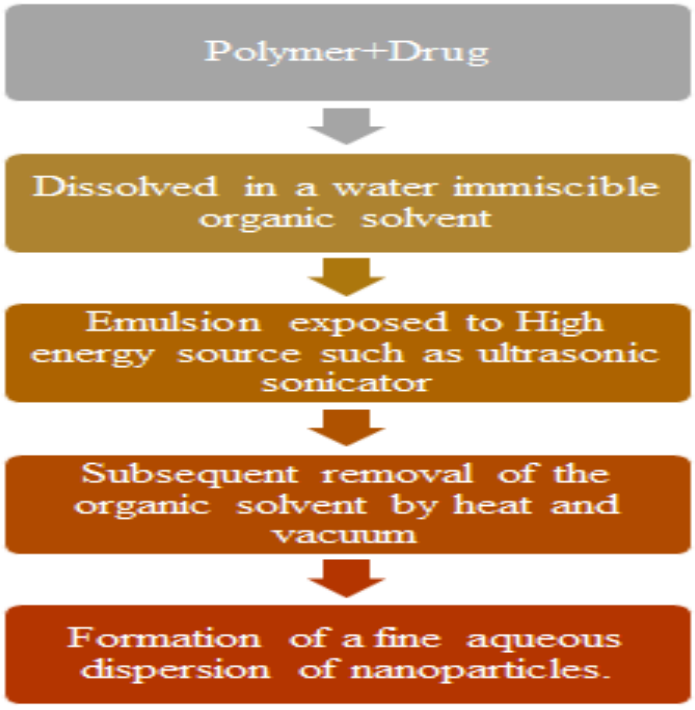

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Figure 6. Salting out.

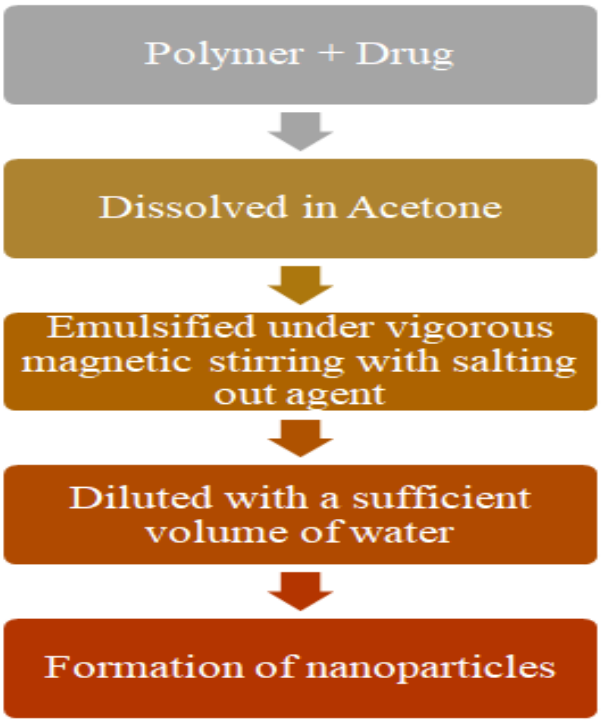

Figure 7. Double emulsion technique.

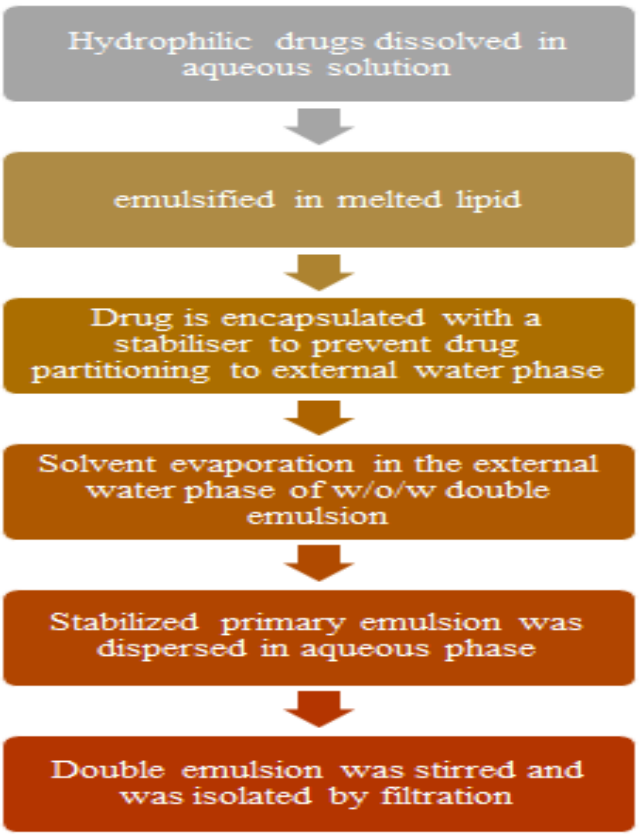

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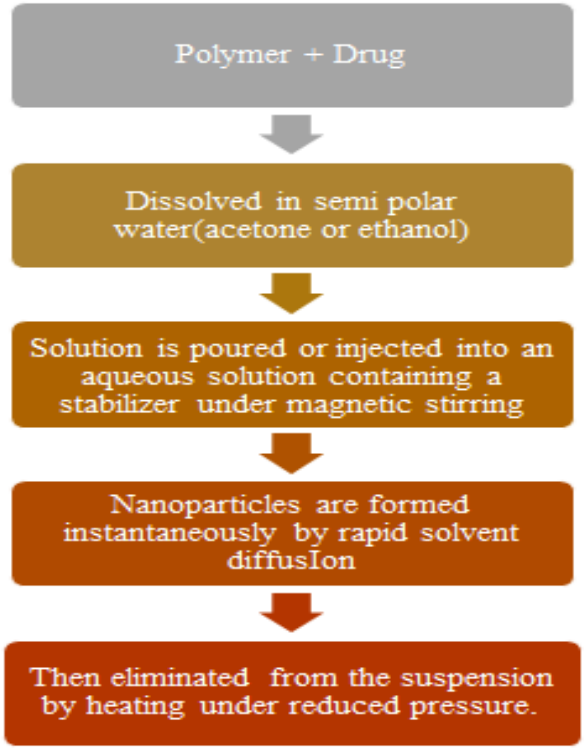
Figure 8. Solvent displacement.



Different nanomaterials used for preparing cosmetics and cosmeceuticals [7].

Sunscreen

Nanomaterials: Inorganic particles (TiO_2, ZnO)

Uniqueness: Reflect or absorb UV light

Advantage: Biocompatible, stable, and hydrophilic

Disadvantage: Respiratory toxicity

Commercially available product: Lotus professionals Phytorx UV Defense Sun Block SPF 100

Lipstick

Nanomaterials: Silica (SiO_2)

Uniqueness: Used to fill the majority of the cosmetic formulation as filler

Advantage: Hydrophilic, high cost of production

Disadvantage: Respiratory toxicity

Commercially available product: Used to fill the majority of the cosmetic formulation as filler

Facemask/Mascara

Nanomaterials: Carbon black

Uniqueness: A colouring agent

Advantage: Low Cost, high chemical and thermal stability, and light weight

Disadvantage: Cytotoxicity, which modifies the ability of macrophages to phagocytose

Commercially available product:"

- Face masque —Carbon BAE [8]
- Mascara black—Lakme

Sunscreen

Nanomaterials: Nano-organic (tris-biphenyl triazine)

Uniqueness: Optimum UVB and UVA 2 filter

Advantage: Strong and stable filter

Disadvantage: Potentially harmful to aquatic environments

Commercially available product: Extra UV Gel—Allie

Toothpaste

Nanomaterials-Nanohydroxyapatite

Uniqueness-secure in children's toothpaste

Advantage-Dental polish and desensitizers that remineralize teeth

Disadvantage-extreme brittleness

Commercially available product:

- Kinder Karex Hydroxyapatite
- APAGARD M plus-Sang

Facemask/anti-aging cream

Nanomaterials: Gold and silver nanoparticles

Uniqueness: Enhanced Raman scattering on the surface

Advantage: Chemical stability, standardised pharmacokinetics and biodistribution, uniform shape, size, and branch length, antibacterial and antifungal activities

Disadvantage: High dosages cause DNA and cell damage in humans; lung toxicity

Commercially available product:

- Gold radiance peel off mask–VLCC
- Nano gold firming treatment—Chantecaille

Face cream

Nanomaterials: Buckyballs (buckminsterfullerene/C60)

Uniqueness: Powerful free radical scavenger

Advantage: Demonstrates antioxidant activity, thermostability, and photostability; guards against various oxidative stress-related skin issues

Disadvantage: Lung toxicity, damage to brain cells, and extreme hydrophobic

Commercially available product: Brightening Essence—Juva skincare.

DISCUSSION

Properties of nanoparticles

- They serve as a conduit between bulk materials and atomic or molecular structures.
- While at the nanoscale size-dependent features are sometimes observed, a bulk material should have constant physical characteristics at all sizes.
- Compared to all the atoms in bulk materials larger than one micrometre, the percentage of atoms close to the surface is tiny (or micron).
- The high surface area-to-volume ratio of nanoparticles serves as a strong diffusion driver, especially at high temperatures. Sintering can happen at lower temperatures and for shorter periods of time than with larger particles.
- Because the particle surface's strong enough contact with the solvent to overcome changes in density—which would otherwise cause a material to sink or float in a liquid—nanoparticle suspensions are possible.
- As a result of their capacity to generate quantum effects and confine electrons, nanoparticles often exhibit unexpected optical properties. Gold nanoparticles in solution, for example, appear dark red to black.
- Half hydrophilic and half hydrophobic, janus particles are a special kind of nanoparticle that work well at stabilising emulsions. At the water/oil interface, they can self-assemble and perform the role of solid surfactants.
- It is essential to confirm that the photocatalytic activity of the nanoparticles does not result in the composite system self-destructing before adding them to a polymer matrix.

CONCLUSION

Nanotechnology is a rapidly emerging field with many promising applications in business, health, cosmetics and society. Nanomaterials are included in many skin care products as a way to take use of the unique properties of matter at the nanoscale. Dermatologists who have a close relationship with skin health should be knowledgeable about this new technology, teach their colleagues about it and actively participate in its evaluation and the creation of guidelines and policies that will ensure its appropriate and advantageous usage.

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