



Contribution of Nanocarriers in Effective Development of Cosmeceuticals

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ABSTRACT

Nanoparticles have emerged as a powerful drug-delivery material to enhance the specificity of drug actions, while reducing the systemic side effects. These particles range from 1 to 100nm with one or more dimensions. These are mainly classified into the organic, inorganic and carbon based particles. The objective of this study is the ultimate goal of the cosmetic industries when using nanocarriers is to deliver the right amount of ingredients to the desired parts of the body, and to attain long term stability. Research within the cosmetics industry has revealed that when nanomaterials are engineered into cosmetic products, they can enhance the benefits of active ingredients. Constantly more and more innovative application of materials resulting from the use of nanotechnology is being recognized. An exceptionally unique nanomaterial, carbon nanobuds have been identified with combined properties of carbon nanotubes and fullerenes.

Keywords: Nanocosmeceuticals, liposomes, dendrimers, apoptosis.

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Advantages

- Improving oral bioavailability.
- Reduction in hepatic first pass metabolism.
- Protecting drug from intra-enterocyte metabolism.
- Preventing undesired plasma peak.
- Better controlled drug release.
- Enhanced AUC and MRT values.
- Has high encapsulation efficiency.
- High ocular permeation.
- Sustained and controlled release property.
- Enhancing drug corneal permeability with pre-corneal retention time.
- Lower clearance rate and smaller volume of distribution.³⁻⁴

Disadvantages

- Drug expulsion during storage.
- High cost.
- Limited loading capacity for hydrophilic drugs.
- Polymorphic transition occurs.
- Particle size growth during storage time.
- Cytotoxicity occurs.
- Retinal toxicity during ocular administration occurs.⁵⁻⁶

INTRODUCTION

Cosmeceuticals are the fastest growing segment of the personal care industry, and a number of topical cosmeceutical treatments for skin conditions such as photo aging, hyperpigmentation, wrinkles, and hair damage have come into widespread use. In the cosmeceutical arena nanotechnology has played an important role. Using new techniques to manipulate matter at an atomic or molecular level, they have been at the root of numerous innovations, opening up new perspectives for the future of cosmetic industry. Nanotechnology-based cosmeceuticals offer the advantage of variety of diversity in products, and increased bioavailability of active ingredients and increase the aesthetic appeal of cosmetic products with prolonged effects. However rapid increase in use of nanotechnology in cosmetic industry raised concern about the possible penetration of nanoparticles through the skin and also the potential hazards to the human health.^{1,2}

PROPERTIES OF NANOPARTICLES

Nanoparticles have emerged as a powerful drug-delivery material to enhance the specificity of drug actions, while reducing the systemic side effects.



Ideal Properties of Nanocarriers

- It should be biocompatible inert nontoxic and non-immunogenic.
 - Should be physically and chemically stable in in-vitro and in vivo conditions.
 - Restrict drug distribution to non-target cells or tissues or organs and have uniform distribution.
 - Controllable rate of drug release.
 - Must allow minimal drug leakage during transit.
- Drug release should not affect the drug.

CHARACTERISTICS FEATURES OF NANOPARTICLES

The nanoparticles show enhanced properties such as high reactivity, strength, stability, etc. because of their various characteristics features.

Size

Nanoparticles are particles between 1 and 100 nano meters in size and are made up of carbon, metal, metal oxides or organic matter. A nanoparticle can be a zero dimensional where the length, breadth and height is fixed at a single point for example nano dots, one dimensional where it can possess only one parameter for example graphene, which has two dimensional where it has length and breadth for example carbon nanotubes, three dimensional where it has all the parameters such as length, breadth and height for example goldnanoparticles.^{1,5}

Shape

The nanoparticles are of different shape, size and structure. It can be spherical, cylindrical, tubular, conical, hollow core, spiral, flat, etc. or irregular. The surface can be a uniform or irregular with surface variations. Some nanoparticles are crystalline or amorphous with single or multi crystal solids either loose or agglomerated.

Surface area

As the size of the particle decreases, their surface area increases leading to an increase in their reactivity. Nanomaterials are highly reactive due to their high surface area-to-mass ratio, providing more area by weight for chemical reactions to occur. Research studies have revealed that because of this increased reactivity, some nanoscale particles may be potentially explosive and some are photoactive. For example, some nanomaterials such as nanoscale titanium dioxide and silicon dioxide may explode and if finely dispersed in the air and they come into contact with a sufficiently strong ignition source.⁸

Physical Properties

The include optical property such as the colour of the nanoparticle, its light penetration, absorption and reflection abilities, and UV absorption in a solution or when coated onto a surface. It also includes the

mechanical properties such as elastic, ductile, tensile strengths and flexibility that play a significant role in their application. Other properties like hydrophilicity, hydrophobicity, suspension, diffusion and settling characteristics are also taken into consideration. Electrical and magnetic properties such as conductivity, semi conductivity and resistivity has led a path for the nanoparticles to be used in various other applications.⁹

Chemical Properties

The chemical properties such as the reactivity of the nanoparticles with the target and stability and sensitivity to factors such as moisture, atmosphere, heat and light determine its applications in manufacturing of cosmetic products. The anti- bacterial, anti-fungal, disinfection, and toxicity, properties of the nanoparticles are ideal for biomedical applications. Characteristics property such as corrosive, anti-corrosive, oxidation, reduction and flammability determine their respective usage.^{5,8}

1. TYPES OF NANOCARRIERS

Nanocarriers are classified mainly into two types organic and inorganic nanocarriers. Organic nanoparticles involves liposomes, niosomes, dendrimers, micelles, solid lipid nanoparticles, nano emulsion etc. Whereas inorganic nanoparticles involves metal based, metal oxide based and carbon-based nanoparticles.¹⁰⁻¹¹

Liposomes

Liposomes are concentric bi layered vesicles in which the aqueous volume is entirely enclosed by a hydrophobic lipid bilayer as depicted in **fig 1**, composed of natural or synthetic phospholipids which are GRAS (generally regarded as safe) products. The lipid bilayer of liposomes can fuse with other bilayers such as the cell membrane, which promotes release of its contents, making them useful for cosmetic delivery applications. To protect the drug from metabolic degradation, liposome encapsulates the drug and releases active ingredients in a controlled manner. Liposomes can deliver both hydrophilic and hydrophobic components and the size of liposomes varies from 15nm to several micrometer.

Use of liposomes in Cosmetics

In 1986 the first liposomal cosmetic product introduced in market was anti-aging cream called 'capture'. Powders (1988) where the first make-up product containing liposomes followed by mascara and other make-up products. Phosphatidylcholine is the key component of liposomes which has been used in various skin care formulations like moisturizer creams and so on and hair care products like shampoo and conditioner due to its softening and conditioning properties. As esterified essential fatty acid is present in the vegetable phospholipid they are used in cosmetics and dermatology.¹²



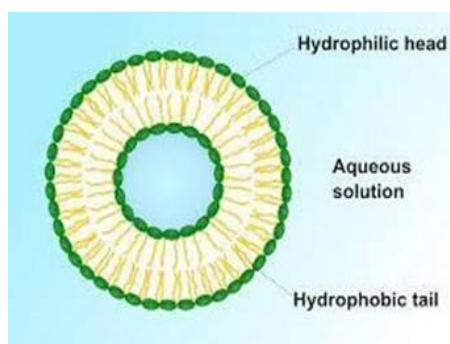


Figure 1: Structure of Liposome

Niosomes

Niosomes are defined as vesicles having a bilayer structure that are made up by self-assembly of hydrated non-ionic surfactants, with or without incorporation of cholesterol or their lipids. The niosomes have amphiphilic bilayer structure as shown below in **fig 2**, in a way that polar region is oriented outside and inside the vesicles where the hydrophilic drug will be entrapped and non-polar region is formed within the bilayer where hydrophobic drug can be entrapped. Niosomes are suitable for delivery of both hydrophobic as well as hydrophilic compounds. Niosomes can be multilamellar or unilamellar vesicles in which an aqueous solution of solute and lipophilic components are entirely enclosed by a membrane which are formed when the surfactant macromolecules are organized as bilayer. Size ranges from 100 nm to 2 μm diameter. Size of small unilamellar vesicles, multilamellar vesicles, and large unilamellar vesicles ranges from 0.025–0.05 μm , \Rightarrow 0.05 μm , and 0.10 μm , respectively.

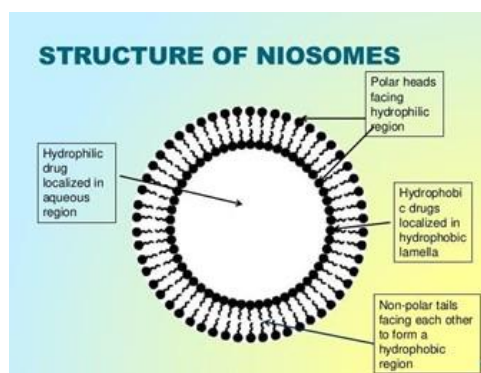


Figure 2: Structure of Niosome

Use of niosomes in cosmetics

Niosome as a carrier in dermal drug delivery: niosome where used for dermatology purpose in 1975 in cosmetic industry. Lancome niosome launched the first niosomal cosmetic product i.e. anti-aging creams.

Niosomes are used in cosmetics and skin care applications since skin penetration of ingredients is enhanced because it possesses the property of reversibly reducing the barrier resistance of the horny layer, allowing the ingredient to reach the living tissues at greater rate. Topical formulations of niosomes which are developed recently

are local anesthesia, psoriasis, Hyperpigmentation, acne, etc.^{8,13}

Dendrimers

Dendrimers are nano-sized, radially symmetric molecules with well-defined, homogeneous, and monodisperse structure consisting of tree-like arms or branches. Typical dendrimer structure consists of a core molecule, multiple layers or generations of branched molecules, and surface molecules.¹⁴

Use of dendrimers in Cosmetics

The first synthetic procedure for producing these structures was published in 1978 by Vögtle, who used a procedure described as a “cascade” synthesis.

The various application of dendrimers in cosmeceuticals are due to their control release property. TDD systems were formulated using PAMAM dendrimers to assist the delivery of various cosmetic products.

The various patented dendrimers used in cosmetic are

Carbosiloxane dendrimer as surface treatment agent for powders comprising of skin care, hair care, antiperspirant, deodorant product or a UV-ray protective agent published on 2016 by Dow Corning to ray co Ltd.

Dendrimer with thiol function used as the antioxidant preservative in haircare, skin care and other makeup products was published on 2002 by lorealcompany.¹⁵⁻¹⁷

Micelles

Nano micelles are typically spherical, but can sometimes take other shapes, such as cylinders and ellipsoids. The small size and shape of nano micelles is only possible due to the molecular geometry of the particle. The shapes formed also depend on the ionic strength, surfactant concentration, and pH strength of the solutions they are placed in nano micelles are formed when amphiphilic molecules assemble themselves to create a globular structure that is only around 5 to 100nm in diameter. The particles may be formed in aqueous or non-aqueous solutions where the nonpolar region forms the interior and the polar region forms the exterior. Because of this, nano micelles are able to take on both hydrophilic and hydrophobic agents.

Use of micelles in Cosmetics

Micellar nanoparticles technology is considered as one of the efficient and latest nanotechnology-based cosmeceutical that has been enormously implemented in skin cleanser product segments Micellar nanoparticle (MNP) technology was invented in the mid-1990s Scientists at Novavax developed and patented MNP technology and subsequently rolled out the first nano-engineered transdermal lotion product in 2003.¹⁸⁻¹⁹

Nano Emulsion

Nano emulsions are typically oil-in-water or water-in-oil

colloidal dispersions, which contain droplets that range from a few nanometers to 200 nm in diameter. An increase in patent-protection activities related to nano emulsions shows growing industrial interest in it. The small size of the droplets can provide the desirable optical, stability, rheological, and ingredient delivery properties, which are superior to conventional emulsions. Nano emulsions tend to be transparent and stable. Nano emulsions could significantly influence the permeation profiles of molecules as a function of their physicochemical properties, and in particular, O/W nano emulsions significantly improved the permeation profiles of a polar ingredient in comparison to conventional emulsions.

Use of nano emulsions in Cosmetics

Nano emulsions containing products are a growing market in cosmetics as they allow an enhanced delivery of active compounds. Nano-emulsions are attractive systems for use in the cosmetics, pharmaceutical, food, and other industries due to the properties described previously, such as their low amount of surfactant, stability against sedimentation/creaming, lack of toxicity or irritant characteristics, low viscosity, good appearance, and versatility of formulation as foams, creams, liquids, and sprays.²⁰

Solid Lipid Nanoparticles

SLNs are composed of a single layer of shells, and the core is oily or lipoidal in nature. The small size of SLNs ensures close contact with the stratum corneum, which increases the penetration of ingredients through the skin. They can help to increase the water content on the skin and can also act as potential UV blockers. NLCs can carry more active ingredients but SLNs can improve chemical stability. They exhibit easy scalability, in addition to their well-established production methods. They also show skin penetration improvement, biocompatibility and stability being an effective carrier delivery agent.²¹

Use of SLN in Cosmetics

Solid lipid nanoparticles (SLN) were developed at the beginning of the 1990s. The application of SLN as physical sunscreens and as active carriers for molecular sunscreens has also been investigated. products. Solid lipid nanoparticles (SLN) have been introduced as carriers for active cosmetic ingredients and pharmaceutical drugs. It has been shown that they act as active carriers for sunscreens due to their particulate character, i.e. they represent physical sunscreens on their own.^{8,22}

Metal Based

Nanoparticles that are synthesized from metals to nanometric sizes either by destructive or constructive methods are metal based nanoparticles. Almost all the metals can be synthesized into their nanoparticles [6]. The commonly used metals for nanoparticle synthesis are Aluminium (Al), cadmium (Cd), cobalt (Co), copper (Cu), gold (Au), iron (Fe), lead (Pb), silver (Ag) and zinc (Zn). The

nanoparticles have distinctive properties such sizes as low as 10 to 100nm, surface characteristics like high surface area to volume ratio, pore size, surface charge and surface charge density, crystalline and amorphous structures, shapes like spherical and cylindrical and colour, reactivity and sensitivity to environmental factors such as air, moisture, heat and sunlight etc.

Use of Metal based Nanoparticles

Gold and silver nanoparticles have been studied as a valuable material in cosmeceutical industry for their strong antibacterial and antifungal properties. These particles are widely used in cosmeceutical products like deodorant, face pack, antiaging cream, and so forth.

Metal Oxide Based

The metal oxide-based nanoparticles are synthesized to modify the properties of their respective metal based nanoparticles, for example nanoparticles of iron (Fe) instantly oxidises to iron oxide (Fe₂O₃) in the presence of oxygen at room temperature that increases its reactivity compared to iron nanoparticles. Metal oxide nanoparticles are synthesized mainly due to their increased reactivity and efficiency. The commonly synthesized are Aluminium oxide (Al₂O₃), Cerium oxide (CeO₂), Iron oxide (Fe₂O₃), Magnetite (Fe₃O₄), Silicon dioxide (SiO₂), Titanium oxide (TiO₂), Zinc oxide (ZnO). These nanoparticles have possess an exceptional properties when compared to their metal counterparts.

Use of Metal Oxide Based

Some commercial skin care products containing nanoparticle are Facial moisturizer/facial cleanser containing AuNPs, ZnONPs, TiO₂NPs, AgNPs used for Antibacterial/anti-inflammatory properties, prevention of skin ageing and restoring skin elasticity, Antiaging cream, around-eye cream containing AuNPs, AgNPs, ZnONPs and are used for Regeneration and rebuilding skin through improvement ability to penetrate across the skin by proteins which are responsible for stimulating cell to proliferation and collagen production and antioxidant protection, Sunscreens containing ZnONPs, TiO₂NPs Protects skin from UVA and UVB sun rays.

Carbon Based

The nanoparticles made completely of carbon are known as carbon based. They can be classified into fullerenes, graphene, carbon nano tubes (CNT), carbon nanofibers and carbon black and sometimes activated carbon in nano size.

Fullerenes

Fullerenes (C₆₀) is a carbon molecule that is spherical in shape and made up of carbon atoms held together by sp² hybridization. About 28 to 1500 carbon atoms forms the spherical structure with diameters up to 8.2 nm for a single layer and 4 to 36 nm for multi-layered fullerenes.



Graphene

Graphene is an allotrope of carbon. Graphene is a hexagonal network of honeycomb lattice made up of carbon atoms in a two-dimensional planar surface. Generally, the thickness of the graphene sheet is around 1nm.

Carbon Nano Tubes (CNT)

Carbon Nano Tubes (CNT), a graphene nanofoil with a honeycomb lattice of carbon atoms is wound into hollow cylinders to form nanotubes of diameters as low as 0.7 nm for a single layered and 100 nm for multi-layered CNT and length varying from a few micrometers to several millimeters. The ends can either be hollow or closed by a half fullerene molecule.²³

Carbon Nanofiber

The same graphene nano foils are used to produce carbon nanofiber as CNT but wound into a cone or cup shape instead of a regular cylindrical tubes.

Carbon black

An amorphous material made up of carbon, generally spherical in shape with diameters from 20 to 70 nm. The interactions between the particles are so high that they bound in aggregates and around 500 nm agglomerates are formed.

Use of Carbon-Based Nanoparticles

Carbon based nanoparticles are widely used in the sunscreen products. Other than this fullerenes have an important role in cosmeceuticals. It is used in products which give antioxidant as well as antiageing property.

These carbon based nanocarriers are used in moisturizers, creams.²⁴

NANOPARTICLES IN COSMECEUTICALS

In the cosmetic arena it is believed that the smaller particles are rapidly absorbed into the skin and repair damage easily and more efficiently. Incorporation of nanotechnology in cosmetics (**chart 1**) is aimed at making incense of perfumes last longer, sunscreens to protect the skin, antiaging creams to fight back the years, and moisturizers to maintain the hydration of the skin. Some of the nano technology based innovations are nano emulsions (which are transparent and have some unique tactile and texture properties), nano capsules (which are used in skin care products), nano pigments (that are transparent and also increases the efficiency of sunscreen products), liposome formulations (which contain small vesicles consisting of conventional cosmetic materials that protect oxygen or light sensitive cosmetic ingredients), dendrimers, nanocrystals, solid lipid nanoparticles, carbon nanotubes, fullerenes, and niosomes. The primary advantages of using these nanoparticles in cosmeceuticals include the improvement in the stability of cosmetic ingredients (e.g., vitamins, unsaturated fatty acids, and some antioxidants) by encapsulating within the nanoparticles; efficient protection of the skin from harmful ultravioletrays; aesthetically pleasing products (e.g., in mineral sunscreens, using smaller particles of active mineral allows them to be applied without leaving a noticeable white coloured cast); targeting of active ingredient to the desired site and controlled release of active ingredients for prolonged effect at a particularsite.²⁵⁻²⁶

Major Classes of Nano cosmeceuticals

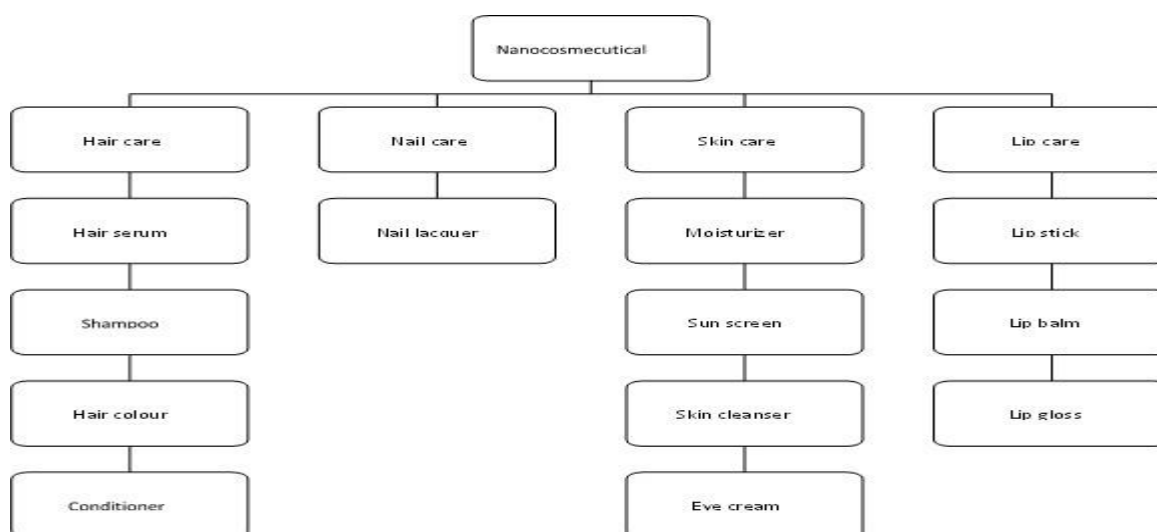


Chart – 1

Skincare

Nanotechnology is a novel arena with widely promising applications in the field of medicine and even

cosmeceuticals too, especially pharmaceuticals for safe and targeted drug delivery. The skin is a phenomenal tool for investigation of nanocarriers for drug delivery for topical and dermatological application.²⁷

Sunscreen

Sunscreen as in **fig 3**, that uses zinc oxide nanoparticles to block ultraviolet rays while minimizing the white coating on the skin. Sunscreen that uses nanoparticles generated by ivy plants. Recent research has shown that these ivy nanoparticles are more effective than oxide nanoparticles in blocking ultraviolet rays.²⁸⁻³⁰



Figure 3: Sunscreen

Skin creams

Skin creams contains those proteins to derived from stem cells to prevent aging of the skin. These proteins are encapsulated in liposome nanoparticles which merge with the membranes of skin cells to allow delivery of the proteins at target site. These creams as shown below in **fig 4**, are used as an anti-aging and in treatment of acne.³¹



Figure 4: Skin cream

Skin care lotions

These are those in which nutrients are encapsulated in nanoparticles suspended in a liquid, making up a nanoemulsion. The small size of the nanoparticles, compared to particles in various other conventional emulsions, allows the nanoparticles to penetrate deeper into the skin, delivering the nutrients to more layers of skin cells. Lotions that use nanoparticles called as ethosomes to deliver nutrients that promotes hairgrowth.³²

Haircare

Nanomaterials have potentially changed the ways in which hair cosmetics provide their benefits.

Shampoo

Shampoos have incorporated nanomaterials (**fig 6**) in order to optimize resident contact time with the scalp and hair follicle, allowing active agents time to form a protective film, sealing moisture within the cuticles (i.e., preventing trans follicular water loss). This results in enhancing hair moisture, gloss and lubrication. The advantage of this formulation is that it does not destroy the cuticle of the hair fibers, but rather its nanosize allows for penetration into the hydrolipid emulsion layer.

Conditioners

It significantly improves dry hair, after repeated shampooing. The emulsion allowed for hair to appear shiny, less brittle and non-greasy. Incorporation of nanomaterial into this formulation improves ingredient deposition into the hair and directly impacts amino acid synthesis and keratin formation (**fig 5**) in order to repair the damaged cuticle and cortex.



Figure 5: Conditioner



Figure 6: Shampoo

Hair Color

The majority of consumers purchase permanent hair dyes, a product that has gained significant popularity due to its lasting effect, ease of application and changeability (i.e., allows any color to be achieved)The use of nanotechnology to color hair dates back to when Greek and Roman civilizations were able to synthesize quantum dots within the hair shaft using a recipe of litharge, slaked lime and water to blacken hair.³³⁻³⁴

Hair Growth Stimulators

Nanotechnology has become a promising drug delivery system, allowing for enhanced permeation into the hair pores with sustained effects. Zhou et al. reported that fullerene nanomaterials were capable of potentiating new hair growth and inducing new hair follicle formation within the dermis and human skin. The effect is thought to

be due to the ability of fullerenes to scavenge free radicals, inhibiting the oxidative stress associated with hair follicle apoptosis and aging. Nanomaterials are successful carriers for hair-altering ingredients, representing a potentially new therapeutic opportunity for hair loss and hairremoval.³⁵⁻³⁶

Lip care

Lip care products in nano cosmeceuticals comprises of lipstick, lip balm, lip gloss, and lip volumizer. Nanoparticles can be incorporated into lipstick and lip gloss as shown in **fig 7 and fig 8** which will soothe the lips by preventing trans epidermal water loss. Wide range of colors using gold or silver nanoparticles is made by mixing in various compositional ratios and whose color can be maintained for a long period of time. Once applied, lip volumizer containing liposomes increases lip volume, hydrates and outlines the lips, and fills wrinkles in the lip contour and prevent the pigments from migrating or bleeding into the fine line of lips.³⁷

Nail Care

Nano cosmeceuticals-based nail care products have greater superiority over the conventional products in these days. The nail paints based on nanotechnology have merits such as improved toughness, fast dryness, durability, chip resistance, and ease of application because of elasticity. Nail paints (**fig 9**) having nanosized particles improve toughness, mar resistance, and impact resistance of the mammalian nails. It prevents from

cracking, scratching, and also from chipping.⁸



Figure 7: Lip Balm



Figure 8: Lipstick



Figure 9: Nail Polish

Various Nanotechnology Based Cosmeceuticals Products In Market

Product	Proposed used	Manufacturer	Marketing claims
Hydra flash Bronzer daily Face Moisturizer	Moisturizer	LANCOME	Nanocapsules of pure vitamin E provide powerful antioxidant protection. A light touch of self-tanner ensures a natural, healthy glowing skin.
Hydra Zen Cream	Moisturizer	LANCOME	Containing Nanoencapsulated Triceramide s, Hydra Zen helps restore perfect comfort and softness and renew skin's healthy look. Protected from signs of daily stress and fully hydrated, your skin is beautifully soft and smooth all day long.
Nano in hand and nail moisturizing serum and Foot Moisturizing Serum	Moisturizer	NANO INFINITY NANOTECH	Fine crystals of ZnO nanoparticles will go straight into skin tissue to prevent hand and nails from being hurt and restore skin health
Lancomerenergie Microlift	Antiwrinkle	LANCOME	Formulated with colloidal silica and soy protein nanoparticles to provide the closest possible face-lift effect.
Revita Lift Anti Wrinkle and Firming Face and Neck Countour Cream	Antiwrinkle	LOREAL	The Revitalift formula is enriched with Pro-Retinol A, a powerful antiwrinkle agent, which is encapsulated in nanosomes. Nanosomes penetrate deep into the epidermis to work at the heart of wrinkles.
Revitalift Double Lifting	Antiwrinkle	LOREAL	It contains nanosomes of Pro- Retinol A. Revitalift Double Lifting is a unique dual action treatment that instantly retightens skin and effectively fights wrinkles.
Eye Tender	Antiwrinkle	KARA VITA	contains nanospheres, delivers 13 bioactives including proven, wrinkle-reducing peptides to stimulate fibroblasts, build collagen, brighten skin, and reduce inflammation for a younger, healthier appearance

Eye Contour Nanolift	Antiwrinkle Antiaging	EUOKO	It is based on nanocapsules technology. Lifting nanocapsules join seven other immediate and long-term fighters of fine lines, wrinkles, and puffiness. It provides instant and long-term smoothness, gives the eye area more radiance, and diminishes the appearance of dark circles and puffiness
Soliel Soft-Touch Anti Wrinkle Sun cream SPF 15	Antiwrinkle Sunscreen	LANCOME	It contains vitamin nanocapsules which help to preserve skin's youth effectively. SPF 15 offers optimal protection against the sun. It contains exclusive ingredients to guarantee a long-lasting effect.
Nano Gold Firming Treatment	Antiaging	CHANTECAILLE	Infinitely small nanoparticles of pure gold are bound to silk microfibers to firm and tone skin, while delivering incredible anti-inflammatory, healing, and age defying power.
Nanosphere plus	Antiaging	DERMASWISS	A stem cells revolutionary antiaging therapy Nanosphere Plus serum has been specially formulated to allow natural stem cells to preserve and protect skin cells. Using the cells from a rare Swiss apple (Uttwiler Spatlauber), Nanosphere Plus protects longevity and combats chronological aging.
Zelens fullerene C 60 Night cream	Antiaging	ZELENS	Fullerene C-60 is a naturally occurring microscopic form carbon which was found to have remarkable antioxidant property
Clearly it! Complexion mist	Antiacne	Kara vita	This nanosphere technology-based product tackles acne Conditions and balance sebum production. Nanosphere time-released bioactivities stimulate capillary activity for all-day detoxifying results.
DiorSnow pure UV Base SPF50	Sunscreen	Dior	Contains nano-UV filters for ultraprotection against the damaging effects of UVA and UVB rays.
Soliel instant cooling sun Spritz SPF15	Sun protection spray	Lancome	Contains vitamin nanocapsule. Instant cooling sun spray SPF15 immediately offers a sensation of freshness. SPF15 provides optimal protection against the sun.
Fresh as a daily body lotion	Body lotion	Kara vita	This lotion uses nanosphere to quickly penetrate, moisturize, and nourish all types of skin.
Cosilnano beauty soap	Cleanser	Natural Korea	Silver nanoparticles are highly effective as disinfectant and guarantee protection of skin.
Cosil whitening mask	Face mask	Natural Korea	Made with nanocolloidal silver used for the effect of getting rid of the germs from your face, compressing pores, soothing the skin condition, and keeping your skin radiant and soft.
Nano-rama Nano gold mask pack	Face mask	LEXON Nanotech	It contains pure nanosized gold that is highly effective in penetrating small pores and disinfecting skin, helps to reduce pore size, and prevents and treats acne. It is well known that nanogold is very effective disinfectants.
Primordial optimum Lip	Lip treatment	Lancome	Delivers 100% botanically pure vitamin E via nanocapsule technology to reduce lip bleeding and feathering due to fine lines and wrinkles.
Lip Tender	Lip moisturizer	Kara vita	Ten bioactive ingredients are precisely calculated to work within lyphazomes, delivering a 4-in-1 formula and bringing long-lasting hydration for fast and dramatic lip repair.
Nano cyclic cleanser silver	Cleanser	Nanocyclic	Cyclic cleanser is a scientifically balanced blend of nanosilver and natural ingredients. It kills harmful bacteria and fungi, treats can, exfoliates dead skin on all parts of the body, diminishes age spots, deodorizes the body. ³⁸

Recent Advances in Nano product regulation

Recently USFDA has published an Import Alert 66-38, for the skin care products labeled as antiaging creams. This is because there are numerous skin care products in the market which claims that the products counteract, retard, or control the aging process. According to the USFDA, a claim such as “molecules absorb and expand, exerting upward pressure to Lift wrinkles upward” is a claim for an inner structural change that would usually cause a product to be a drug. FDA has stated such claims are illegal on cosmetic labeling.³⁹

In the European Union (EU), the new Cosmetic Products Regulation 1223/2009 attempts to go some way in addressing concerns over the nanomaterials. According to this regulation all ingredients present as nanomaterials must be indicated on the package, from July 11, 2013, with the word “nano”. The format distinguishes a nanoparticle with the suffix “nano,” so TiO₂ becomes TiO₂-nano. The regulation also requires that all the marketed cosmetics and sunscreens using nanoparticles be individually tested for safety. Cosmetic products containing nanomaterials must be notified by electronic means to the commission, providing data on identification, specification, quantity, toxicological profile, safety data, and foreseeable exposure conditions. Such notification must occur six months before a cosmetic product containing nanomaterials is placed in the market.⁴⁰

Future Scope

Nanotechnology is becoming increasingly popular as a part of modern era cosmetics. Constantly more and more innovative application of materials resulting from the use nanotechnology is being recognized. An exceptionally unique nanomaterial, carbon nanobuds have been identified with combined properties of carbon nanotubes and fullerenes. They are prepared by combining two most common allotropes of carbon, fullerenes and carbon nanotubes. Carbon nanotubes are specifically covalently bounded to fullerene like “sprouts/ buds “. They possess remarkably good field emitting properties. This may be in particular used in lipsticks and mascaras.

Furthermore, new nano sized metal pigments, in addition to the most known titanium dioxide and zinc oxide should be continuously investigated and proposed for colored cosmetics. Specifically shaped nanoparticle to fill the uneven surfaces.

Especially after plastic surgery for aesthetic appearance of body parts may open new horizons. Another promising area could be triggered release of nanomaterials on skin facilitated by skin pH gradient. Enzymes conjugated with protein nanocarriers are also receiving attention due to their exceptional water binding capacity into the layers of skin.⁴¹

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. In view of all the scientific evidence it is suggested that nanoparticles in cosmetics offer large health benefits and applicability, nevertheless they need to be acutely characterized to ensure safe use and complete removal from body. Major limitation being the economical aspect which is the limiting factor for growth of nanomaterials in cosmetics. At the core, cosmetics must be safe and truthfullyeffective.⁴²

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