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Pioneering Applications of Nano Materials in Cosmetic Products

*[1]Sunil M Chore

*[1]Department of Chemistry, Shivramji Moghe Arts, Commerce and Science College, Kelapur, Maharashtra, India.

Abstract

Nanotechnology has the potential to create advanced material and formulations. Nanotechnology includes synthesis, characterization and applications of nanoscale material. Nanotechnology is the manipulation of matter at the nanoscale with one or more external dimensions of less than 100 nm. Nanotechnology has various applications in the field of medicine, agriculture, electronics, textile, energy consumption, cosmetics, water remediation and consumer products. Nanotechnology plays a crucial role in the formation of advanced new products and reframe new materials and chemicals with improved qualities, less harmful to the environment. Nanotechnology is appealing area for scientists and researcher working in the fields of nanocomposites, biocomposites, optical, biomedical, and electronic manufacturing.

The objective of review paper is to discuss the role nanomaterials in cosmetic products. Nanotechnology renders extraordinary properties in the cosmetic products. Nano based cosmetic products exhibits high performance, retention, appearance, and nontoxicity. Nanoparticles increase the efficiency of active ingredients, alter the appearance and feel of products. Nanomaterials used in cosmetics are nanoemulsions, nanosomes, nanopigments, nanocapsules, nanocrystals, dendrimers, hydrogels, fullerens etc.

Keywords: Nanotechnology, Nano applications, Cosmetics, Nanoliposomes, Nano capsules.

Introduction

Nano is a Greek word which means "Dwarf". Nanotechnology is deals with materials of small size, generally in the range of 1-100 nano meter. Nanotechnology is the combination of various scientific fields includes physics, chemistry, biology, engineering etc. Nanoscale size material provide high surface area with greater strength and stability. From last decade, nanomaterials have been used in a variety of products in modern society. Now a days nanotechnology is used in almost every field including electronics, diagnostics and medicine, agriculture, cosmetics, consumer products, paints and surface coatings. At present, various types of nanomaterial containing cosmetic products are available for consume all over the world. The raise in the use of nano cosmetic products shows the huge potential nanotechnology for the cosmetics industry and for consumers because of result oriented applicability. A nanomaterial that are already in use consist of nanoemulsions and nanoparticles of minerals occurring in nature such as titanium dioxide, zinc oxide, silicon dioxide, alumina, calcium fluoride, gold, silver, and copper. The reasonable use of nanomaterials inculcate superiority to the effects of cosmetic products. Nanopigments, nanocrystals, nanoemulsions, fullerenes and dendrimers are widely used in advanced cosmetic products. Nanopigments are insoluble compounds that provide colours to the materials they are used in. The most commonly used nanopigments in cosmetics are titanium oxide, zinc oxide. Fullerenes are unique antioxidants used to entrap active ingredients in cosmetics. Dendrimers are nanomaterials is used in cosmetics to provide active ingredients to the skin with unique characteristics and have been utilized in nanocosmetic products like shampoos, hair styling gel. Nanoemulsions are excellent carrier of lipophilic compounds and to protect sensitive active ingredients [1, 2, 3].

1. Nanoliposomes

In the cosmetic products, nanoliposomes are mainly used in moisturizing and antiaging products. Nanoliposomes are bilayer vesicles with an aqueous core surrounded by a hydrophobic lipid. Nanoliposomes are outstanding bioactive ingredients delivery systems for cosmetic. It provides active ingredients to specific target area. Nanoliposomes are present in various sizes, ranging from 15 nm up to several µm with either a single layer or multilayer structure. Nanoliposomes are used skin care products and shampoos due to its softening and conditioning properties. Nanoliposomes have also been used in the treatment of hair loss. The skin care products with empty or moisture loaded liposome minimizes the transdermal water loss and decrease the dehydration of skin. Nanoliposomes increase the hydration of skin due to its nano size. The role of Nanoliposomes in cosmetics is dermal carrier. Its unilayer nanosize with membrane flexibility is useful for dermal products. Nanoliposomes contain lipids which are fully hydrated make it excellent to protect dry skin. Nanoliposomes helps to penetrate active ingredients deeper in the skin layer and protect cells from UV light. The unique property of nanoliposomes is to enhance the stability and durability of cosmetics formulations [4, 5, 6, 17, 30, 31].

2. Nanoemulsions

Nanoemulsion is an isometric system of a colloidal dispersion of two immiscible liquids that are stabilized by emulsifying agents. The average droplet size of nanoemulsions ranges from 10-to 200 nm in diameters. Nanoemulsions are mostly found in two forms oil-in-water and water-in-oil colloidal

*Corresponding Author: Sunil M Chore

dispersions. Nanoemulsion is transparent due to the nanosize droplets and also remain stable for a longer period of time. Nanoemulsion have excellent properties like good transparency, low viscosity, good kinetic stability, large interfacial area, and the requirement of a little surfactant. In nanoemulsion, separation of oil and water is possible in course of time due to thermodynamics unstability. Nanoemulsions are kinetically stable on heterogeneous system. Processes of preparation of nanoemulesions are very costly. Nanoemulsions are prepared by various methods like buble bursting method, ultrasonication, high pressure homogenization, phase inversion temperature. The substances which have high melting point are moderately dissolve in nanoemulsions. Nanoemulsions are widely used in cosmetic products as distinguished carrier for the controlled delivery of cosmetics. They are extensively used in sunscreens, deodorants, shampoos, and skin and hair care products. The nanoemulsions are used proficiently in skin care products because of their excellent properties i.e. high surface area comes into contact with the skin, rapid penetration, merging textures and their biophysical properties especially, hydrating power [7, 8, 30, 31].

3. Nanocapsules

Nanocapsules are vesicular systems where active ingredients are restricted to cavity having an inner liquid core enclosed by a polymeric membrane. Nanocapsules are ranging from 10-1000 nm and used as a carrier of active ingredients. Surfactant-assisted, mini-emulsion polymerization techniques and chemical vapor condensation, solvent evaporation, salting out, super critical fluid technology are the methods to produce nano capsules. Nanocapsules can transport not only hydrophilic and hydrophobic substances but also used to increase the chemical activity of antioxidants, the water solubility of organic substances, and the volatility of aromatic compounds. Nanocapsules are widely used in cosmetic products because of their applicability to protect the degradation of sensitive compounds, reduce smells, and ensure high physical stability. Nanocapsules release active substances slowly, precisely and efficiently. Nanocapsules accelerate penetration of active ingredients into the skin. Nanocapsules have excellent bioavailability, biocompatibility and safe for the environment. In sunscreen, nanocapsules are used to reduce the effect of UV radiations by creating protective layer on suface of skin and restrict the penetration of active ingredients present in the sunscreen to the viable layer. Toxicity of nanoparticles present in nanocapsules is much more as compare to micronized particles because of permeation of particles deep into skin and at cellular level. Solubility, dimensions and surface properties decide the toxical effect of nanocapsules [9, 18, 30, 31].

4. Solid Lipid Nanoparticles

Solid lipid nanoparticles are excellent delivery system for cosmetics active ingredients. Solid lipid nanoparticles are the nanoscale droplets having lipids. Solid liquid nanoparticles are able to restrict the deterioration of active ingredients. They are prepared at high temperature by high pressure homogenization. In nano cosmetics, solid liquid nanoparticles control the penetration of actives with even distribution. Even spreading of active ingredients occurs after the formation of lipid coating on the surface of skin. Solid lipid nanoparticles are nanoscale dispersed system in which oily droplets of lipids are solid at body temperature and stabilized by surfactants containing active ingredients. Triglycerides, glycerides, fatty acids, steroids, and waxes belong to the group of lipid core which is solid at body temperature. They can protect the encapsulated ingredients from deterioration, used for the controlled distribution of cosmetic agents over a protracted period of time and improve the penetration of active compounds into the stratum corneum. Solid lipid nanoparticles have specific advantages like better skin hydration than a placebo from cosmetics and enhanced effectiveness of their sunscreen with UV radiation blockage properties. They are used as colloidal carriers such as emulsions, liposomes, and polymeric NPs. The capability of solid lipid nanoparticles mainly depends on the method of synthesis and lipophilicity of actives [10, 19, 30, 31],

5. Nanocrystals

Nanocrystals have the particle size ranging from 1 to 1000 nm. Nanocrystals are stabilized by surfactants or polymers to maintain their physico-chemical stability and drug bioavailability. Nanocrystals are composition of several hundred to tens of thousands of atoms that combine into a "cluster. Nanocrystals are prepared mainly by bottom-up and top-down technologies. Solubility of active ingredients is increased in water due to nanocrystals. Nanocrystals are used in cosmetic industry because of their excellent high penetration power through skin. Nanocrystals exhibit improved stability, increased bioavailability, and high dissolution. Their large surface area and increased size enhance the diffusion of active ingredients into tissues, improving retention time and adhesiveness at the site of action. The nanocrystals are mainly used in topical formulation e.g. creams, lotions and liposomal dispersions. Nanocrystals are specially used to deliver low soluble compounds and provide skin remediation without degrading the solubility of active ingredients [11, 20, 30, 31]

6. Nanosilver and Nanogold

Nanosilver and Nanogold particles are extensively use in cosmetics due to their effective antibacterial and antifungal property. Because of stability in formulations and less sedimentation effect, nanosilver particles are widely used in cosmetics as preservatives in personal care products, such as soaps, toothpaste, wet wipes, deodorants, shampoos, and acne treatment. Silver nanoparticles act as a antimicrobial action due to the release of silver ions. Silver nanoparticles exhibit growth inhibition to Staphylococcus epidermis, E. coli, Vibrio cholera, Staphylococcus aureus, and Syphilis typhus, Pseudomonas aeruginosa, making them promising anti-infective drugs. As the size of nanoparticles of silver decreases, its antibacterial impact increases because of availability of high surface contact.

Gold nanoparticles have variety in sizes and shapes, ranging from 5 to 400 nm, and including nanoshells, nanosphere, decahedral, tetrahedral, nanocluster, nanostar, nanorod, nanocube, nano triangles, and branched structures. Because of greater value of electrokinetic potential at the surface gold nanoparticles do not agglomerate after introduction to cream mixtures.

In cosmetic industry, gold nano particles are specifically used for skin whitening and antiaging purpose. The unique optical properties of gold nano particles including localized surface plasmon resonance (LSPR), make it promising material for cosmetic industry. LSPR enables the gold nanoparticles to enhance the skin brightness. Gold nanoparticles are also used in antiaging cream. Gold nanoparticles increase collagen formation. Collagen is the main structural protein which

maintain skin firmness and reduces wrinkles. Gold nanoparticles as an antioxidants protect skin from aging by reducing the oxidative stress and neutralizing free radicals. Apart from skin brightness and antiaging, gold nanoparticles are used for anti-inflammatory purpose, wound healing, and biomedical engineering [12, 13, 14, 30, 31].

7. Nano Dendrimers

Dendrimers are unique nanoparticles for modern cosmetics industry and an excellent delivery system for skin care products. Dendrimers are unimolecular, monodisperse, micellar nanostructures, around 20 nm in size, and a at their periphery. The amin structure of dendrimers is divided into three parts a central core, regularly interior with branched symmetrical structure and exterior with high density of functional end groups. Dendrimers are used in cosmetic specifically in hair care, skin care and nail care products. Dendrimers maintain the controlled release from the inner core. However, drugs are combined with both in the interior as well as attached on the surface. Due to versatile characteristics, both hydrophilic and hydrophobic drugs can be incorporated into dendrimers [21, 22, 23, 30].

8. Hydrogels

A hydrogel is soft, semisolid, elastic water-soluble polymeric networks of colloidal particles that fatten in water or biological fluids and retain water. Hydrogels held together chemical or physical cross-links. Hydrogels can be made by natural substances like gelatin, collagen or by synthetic material. Hydrogels can be prepared by applying chemical reactions, free radical polymerization, high energy radiation. Hydrogel is highly elastic so can take different shape. Hydrogels can alter their properties according to external response.

In cosmetics, hydrogel containing formulation is used for topical application on the skin and hair.

They are beneficial for the formulation of skin cleansers and as a carrier for nanoparticulate systems that are incongruous with the surfactants present in emulsions. Emulgels, in which an emulsion dispersed in a gel base, show versatile properties likewise pleasing appearance, easy spreadability, and greaseless texture, highly useful in incorporating and delivering hydrophobic active ingredients [24, 25, 30].

9. Niosomes

Niosomes are colloidal vesicular carrier comprised of nonionic surfactants, lipids and sometimes drugs and ion amphiphiles. Niosomes are self-assembled in water, biodegradable and safe. The composition of niosomes plays a vital role to decide its pharmacokinetic property, application and fabrication. The main content in niosomes is nonionic, amphipathic surfactants which decides the development of niosomes. Examples of nonionic surfactants are polysorbates, alkyl oxyethylene. Lipid like cholesterol or its derivatives are used to stabilize the formulation.

Hydrophilic and hydrophobic drugs are incorporated in niosomes. As compare to liposomes, niosomes are more advantageous with respect to higher chemically stability of surfactant, easy to synthesize and storage, no purity problems and the manufacturing cost is low. It is applied for controlled and precise drug administration in novel pharmacological formulations such as oral, topical, parental, and oral. The advantages of niosomes in cosmetic and skin care products include their ability to amplify the stability of entrapped drugs, improved bioavailability of poorly absorbed ingredients and improved skin penetration. Some examples of niosomes based products are Hair repairing shampoo and conditioner, Skin whitening cream, Antiwrinkle cream, Moisturizing cream [26, 27, 30].

10. Fullerenes

Fullerene is the allotropic form of carbon. Fullerenes have interconnected carbon atoms in hexagonal and pentagonal rings tropic form of carbon. Fullerene C60 and its derivatives exhibit unique applicability specially in cosmetic formulations as an active ingredient. Biological antioxidant, photoprotective, skin brightening, and antiaging properties, making fullerenes, particularly C60, unique material for skin rejuvenation cosmetic products. As an antioxidant, fullerenes not only reduce oxidative stress in the skin but also prevent and repair damage through different mechanism action. Fullerene derivatives can enhance the skin's antioxidant capacity and protect it from UV radiation damage. Fullerene have the potential to brighten the complexion by inhibiting free radical production and regulating melanin formation. Fullerene have a hydrophobic property and are insoluble in aqueous solutions due to their carbon-based structure, so it is quite difficult to prepare cosmetic formulations using fullerenes. Precise scientific and research study and advancement in formulation processes and biocompatibility is the urgent need to maximize the benefits of fullerenes in skincare [15, 16, 28, 29, 31].

4. Conclusion

Nanotechnology is a promising and advanced field and is applicable in various field including cosmetics. Various forms and types are used in cosmetics because of unique modified properties of nanomaterials. The introduction of nano based cosmetics formulations are now more popular and are unavoidable part of daily life. No doubt use of nanomaterials have drastically improved the properties and applicability of cosmetics. Nano carriers like liposomes, nano emulsions, niosomes are utilized profoundly in various cosmetic formulations. Nano delivery system carry the materials throughout the skin by various mechanisms. Nanomaterial in cosmetics are used for various functions such as UV protection, antiaging, antiwrinkle, moisturization. On the other side, nanoparticles used in cosmetics must first undergo a test related to toxicity, before being approved for use. Scientists and researchers should take efforts to find out possible adverse effect of nano cosmetics with respect to penetration of nanoparticles in the skin.

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