



NANOTECHNOLOGY IN COSMETICS AND COSMECEUTICALS

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ABSTRACT: IT HAS BEEN SHOWN TO BE SUCCESSFUL IN DELIVERING ACTIVE MEDICATIONS AND COSMETIC CHEMICALS IN A SAFE AND TARGETED MANNER. NANOTECHNOLOGY HAS BEEN INCREASINGLY EXPLORED AND UTILIZED IN THE COSMETIC INDUSTRY TO ENHANCE THE EFFICIENCY AND PERFORMANCE OF COSMETIC PRODUCTS. THE APPLICATION OF NANOTECHNOLOGY IN COSMETICS HAS BEEN SHOWN TO OVERCOME THE DRAWBACKS ASSOCIATED WITH CONVENTIONAL COSMETICS AND ALSO TO ADD MORE USEFUL FEATURES TO A FORMULATION. AS A RESULT, MANY CONVENTIONAL COSMECEUTICALS ARE BEING REPLACED BY NANOCOSMECEUTICALS. NANOPARTICLES ARE USED IN COSMETIC TO INCREASE THE DELIVERY OF ACTIVE INGREDIENTS, IMPROVE THE APPEARANCE AND FEEL OF PRODUCT AND SERVE AS UV FILTERS, DEMONSTRATING THE DIVERSE APPLICATIONS OF NANOTECHNOLOGY IN COSMETIC PRODUCTS. THIS REVIEW AIMS TO GIVE A GENERAL OVERVIEW OF NANOCOSMETICS AND NANOCOSMECEUTICALS AND THEIR APPLICATIONS IN THE COSMETIC INDUSTRIES. IT HELP CONSUMERS AND REGULATORS UNDERSTAND THE ADVANTAGES AND RISKS ASSOCIATED WITH PROLONGED AND CONTINUOUS USE OF THESE PRODUCTS.. THIS WILL ENCOURAGE THE PRUDENT USE OF THESE PRODUCTS.

INDEX TERMS

Cosmetics, Cosmeceuticals, Nanotechnology, Micellar Nanotechnology,

INTRODUCTION

Considered the most promising technology of the twenty-first century, nanotechnology is expected to have a significant positive impact on the cosmetics sector. The words "technology" and the Greek numeral "nano" which meaning dwarf, are combined to form the term "nanotechnology" [1,2].

Nanotechnology deals with manipulation of structures of matter in the size range of 1-100 nanometers. These sizes of particles are referred to as nanoparticles. Nanotechnology is a key technology leading to product innovation. About 40 years ago, liposome moisturizing creams marked the introduction of nanotechnology into the cosmetics and health product industries [3]. The particles' extremely small size increases their surface area, facilitating the active components' active transportation into the skin [4].

Raymond Reed, a founding member of the American Society of Cosmetic Chemists, first used the term "cosmetics" in 1961. Products that enhance the skin's appearance, deeper cleansing, and enhance its beauty are referred to as cosmetics [5]. Chemicals "designed to be applied to the human body for cleansing, beautifying, boosting beauty, or altering the look without harming the body's structure or functions" are known as cosmetics [6]. Cosmetic products include body lotions, shaving foams, lip balms, face creams, talcum powders, hair shampoos, soaps, conditioners, and makeup items including eye shadows, lipsticks, and skin foundations. Nano particles have been shown to be far more effective UV filters for the skin than any items now on the market [7].

The word "cosmeceuticals" describes products that contain substances with medicinal properties. Numerous ailments, such as damaged hair, wrinkles, photo aging, dry skin, light spots, and hyper pigmentation, are treated with these treatments. The gap between personal care items and medications is known as cosmeceuticals [8]. In conclusion, nanotechnology has become a useful instrument in the skincare sector, providing improved active ingredient delivery methods and the ability to raise the efficacy of cosmetics. To increase the effectiveness of cosmetic goods, the cosmetics sector has embraced nanotechnology.

HISTORY

The history of nanotechnology begins with Erwin Schrodinger, a physicist who received the noble prize in the year 1933 for discovering new forms of atomic energy. The technology was subsequently hypothesized in 1959, when Richard Feynman, the brilliant noble laureate physicist, delivered his now famous lecture, "There is plenty of room at the bottom" [9]. Nanotechnology is a term was delivered in 1974 by Norio Taniguchi. Eric Drexler elaborated on the terminology in 1986[10].

POSTIVE ASPECTS OF NANOCOSMECEUTICALS

- The goal of using nanotechnology in cosmetics is to extend the shelf life of fragrances, improve the effectiveness of sunscreens, and create anti-aging lotions.
- It is used to keep active substances like vitamins and antioxidants bright and transparent, as well as to prevent hair from becoming gray and to prevent hair loss [11].
- Active transport of active ingredient.
- Occlusive properties.
- Physical stability [12].

NEGATIVE ASPECTS OF NANOCOSMECEUTICALS

- Particles that are smaller are more reactive, more chemically reactive, and generate more reactive oxygen species.
- Clinical trials not required
- Photo-activated in cultivated human fibroblasts, titanium dioxide nanoparticles have been shown to oxidatively degrade DNA [13].
- No regulations for clinical safety.
- Toxicity [12].

NOVEL NANO CARRIERS FOR COSMECEUTICALS

Carrier technology, which provides an intelligent method for delivering active substances, is used for the delivery of nanocosmeceuticals. A variety of innovative nanocarriers for cosmeceutical delivery are shown [41].

A. LIPOSOMES:

A spherical vesicle with at least one lipid bilayer is called a liposome. Pharmaceutical medications and nutrients can be administered via the liposome [66]. The spherical shape of liposomes, which are made of a phospholipid and cholesterol bilayer, allows them to transport medications to specific locations. Liposomes are tiny, basic vesicles with a lipid-based membrane that entirely encloses an aqueous volume. [14]. In addition to increasing the occlusive effect (hydrating the skin), UV protection, and antioxidant properties, liposomes are utilized as medication carriers to treat psoriasis, hirsutism, alopecia, acne, hyperpigmentation, melasma, and cellulites. [15]. The most common applications for liposomes are in cosmeceutical formulations [42]. In skincreams, liposomes were initially used as a moisturizer in the 1960 [16].

Liposomes make up the product known as "cream capture," which was developed by the Dior firm in 1986 [17]. Liposomes are used in a variety of skincare products, including anti-aging lotions, moisturizers, sunscreens, and shampoos for hair loss [18]. They enhance skin hydration by employing nanoliposomes, which are made possible by the smaller size of the particles. used in cosmetics. Skin that is smooth and elastic [19]. Since liposomes contain the active ingredient, they are utilized in a range of cosmeceuticals because of their biodegradable, nontoxic, and biocompatible properties [48].

B. NIOSOMES

Niosomes are bilayer-shaped vesicles composed of hydrated nonionic surfactants that self-assemble, either with or without the addition of cholesterol or other lipids [20]. The main ingredients of niosomes include cholesterol and nonionic surfactants utilized in their synthesis, such as spans, tweens, brijs, alkyl amides, sorbitan ester, crown ester, polyoxyethylene alkyl ether, and steroid-linked surfactants [20]. Niosomes are a unique drug delivery method that can be utilized to transport poorly absorbed medications. It gives the medication encapsulation, which prolongs its time in the systemic circulation and improves its penetration into the target area. The stability issues, high cost, and oxidation susceptibility of liposomes are all resolved by niosomes [22]. L'Oreal initially created niosomes in 1970 through the study and creation of synthetic liposomes. In 1987, L'Oreal received a patent on niosomes, which were created under the Lancome brand. [23]. It gives the medication encapsulation, which prolongs its time in the systemic circulation and improves its penetration into the target area. The stability issues, high cost, and oxidation susceptibility of liposome's are all resolved by niosomes [32].

SOLID-LIPID NANOPARTICLES:

Dispersed systems with evenly distributed solid lipids in the aqueous phase are known as solid lipid nanoparticles. Fatty acids, glycerides, triglycerides, waxes, and steroids are all part of the lipid core group, which is solid at body temperature [30]. Because of their nanosize, biodegradability, and superior chemical stability brought about by surfactant stabilization, they are widely employed in the cosmetics industry. The hydration and UV resilience of solid lipid nanoparticles are further benefits [16]. Solid lipid nanoparticles (SLN) are a new way to deliver medicinal and cosmetic active substances. They are made up of generally regarded as safe (GRAS) stabilisers and biodegradable physiological lipids [60]. Another frequently used nanomaterial in cosmetic goods is solid lipid nanoparticles [33]. Precipitation and high pressure homogenization are the two main techniques for creating solid lipid nanoparticles. When paired with molecular sunscreen, solid lipid nanoparticles can provide better photoprotection with fewer adverse effects because they are UV resistant and function as physical sunscreens on their own [34].

NANO SILVER AND NANO GOLD PARTICLES:

Nanosilver which have a very good antimicrobial acts as preservative agents in cosmetics products.. Another well-known characteristic of nanosilver is its ability to heal wounds with little scarring. This characteristic helps explain why silver nanoparticles are used in scar removal cream [35]. Silver nanoparticles are used in the manufacturing of underarm deodorants, which improves the deodorant's capacity to function all day [36]. Nanoparticles are commonly used as preservatives in a range of personal care products, such as toothpaste, shampoos, and acne treatments [37]. AgNPs' antibacterial properties allow them to be used as preservatives in cosmetics. Silver nanoparticles have been demonstrated in studies to effectively protect cosmetic products from germs and fungi for prolonged periods of time without sedimenting, enhancing the stability and durability of skincare compositions. They are present in a variety of cosmetic items, including deodorants, lipsticks, wet wipes, and soap cleansers [38]

Because of their potent antifungal and antibacterial qualities, gold nanoparticles have been investigated as a beneficial material in the cosmeceutical sectors. Numerous cosmeceutical items, including face packs, lotions, creams, deodorants, antiaging creams, and more, include these nanoparticles. Gold nanoparticles are being used by major cosmetics brands like L'Oreal and L'Core Paris to create creams and lotions that are more effective. Gold nanoparticles are extremely stable, biocompatible, noncytotoxic, and inert in nature [39]. "In toothpastes, nanogold is used to increase the paste's disinfecting properties [36]. To promote good dental hygiene habits, nano gold is frequently added to toothpastes and other easily accessible personal care items [40].

Nano emulsions: Nanoemulsions are defined as liquid dispersions containing an oil phase, water phase, and surfactant that are kinetically or thermodynamically stable. Oil in water, water in oil, and bicontinuous nanoemulsion are the three different forms of nanoemulsions that depend on their composition [43]. Drug molecules are transported by colloidal particle systems called nanoemulsions. They are between 10 and 1,000 nm in size. The product's shelf life is extended by smaller particles because they are more stable and better suited to transport the active components [45]. The existence of tiny droplets of one liquid distributed throughout another liquid is what defines nano emulsions. These systems are regarded as meta stable, which means that preparation techniques can change their structure. The materials used to create nano emulsions are generally recognized as safe (GRAS) products, guaranteeing their usability [45]. Nanoemulsions are acceptable in cosmetics because there is no inherent creaming, sedimentation, flocculation or coalescence that are observed with macro emulsion. It would be beneficial for moisturizing, anti-aging, and sun care products. It

contributes to the positive skin feel of skin care formulations.[44] used in lotions, conditioners, and nail polish and hair serums [31].

MICELLAR NANOTECHNOLOGY

Micellar nanoparticle technology is regarded as one of the most effective and recent cosmeceuticals based on nanotechnology, and it has been widely used in the skin cleanser product categories [47]. Micellar nanotechnology promotes smaller nanoparticles, greater encapsulation efficiency, and lower production costs when compared to other nanocarriers like liposomes and niosomes [46]. One of the micellar nanoparticle creation processes that has been extensively studied and found to be the most appropriate system to be used in cosmetics formulation is the oil in water emulsion system. In order to create micelles, an oil-in-water emulsion needs two immiscible liquids: an oil phase and a water phase [49]. The emulsion is stabilized by the employment of a surfactant. Conventional emulsions, microemulsions, and nanoemulsions are all a part of this nanosystem [46]. A nanoemulsion system is a clear or translucent mixture of two immiscible liquids that contains a finely dispersed active ingredient organized in surfactant-stabilized nanolipid droplets called micelles or micellar nanoparticles [49]. Smaller micellar nanoparticle size that has excellent thermodynamic and kinetic stability of cosmetic formulation, against flocculation, sedimentation, and Ostwald ripening phenomenon, is the most significant function of nanoemulsion-based cosmeceuticals [50]. Because micellar nanotechnology is incorporated into the cleanser composition, Bioderma, L'Oréal, Avenue, Laroche-posay, Garnier, and other local and worldwide brands are asserting that their micellar facial cleanser is the most effective product. Micellar nanotechnology was employed in these brands to achieve their successful performance. There is a good chance that this method will be used for a larger market of cosmetics [49]. Using a nanoemulsion technology, the well-known cosmetics business L'Oreal S. A. has patented its micellar-based cosmetic formulations, which have numerous beneficial uses for the skin, hair, scalp, mucous membranes, and eyes. The "Micellar Series" product segments, which include micellar face cleanser and mist infused with different plants' bioactive components combined with micellar nanoparticles in a nanoemulsion system, are also introduced by the Malaysian cosmetic brand Naturel Kiss. Therefore, the purpose of this publication is to review the function of nanoemulsion systems in the development of cosmetics based on micellar nanotechnology [56,21].

HISTORY:

Historically, scientists at Novavax developed micellar nanoparticle technology in the mid-1990s, introducing the first topical estrogen replacement lotion product with nanoengineered ingredients, Estrasorb™, as an effective delivery system to improve the therapeutic effects of the lotion's active ingredient. Patients find this delivery method more aesthetically pleasing because it avoids the gastrointestinal tract and the hepatic firstpass effect. A nanoemulsion system comprising many components has been used to generate micellar nanoparticle-based lotion. This system has been claimed to be a delivery method with a potentially quick and affordable development strategy for producing more innovative proprietary formulations [49]

Properties and Advantageous of Micellar Nanoparticle Formation in Nanoemulsion:

Advantages over traditional emulsion, including improved solubility of bioactive compounds, high stability, and accelerated absorption rate, which led to a rise in bioavailability [64]. Because a nanoemulsion uses a small quantity of solvent to form micelles, it has a high loaded capacity, which is required by the performance of hydrophilic and hydrophobic segments by the surfactant operating on the oil-water interface [65].

Mechanism of Micellar Nanoparticle Formation

An emulsification mechanism is attributed to the reduction of interfacial tension between the oil and aqueous phase and the formation of charge over the micelle droplet surface, which is structured by an ionic or non-ionic surfactant, through the formation of micellar nanoparticles in a nanoemulsion system [51, 52]. In order to create micellar nanoparticles, this emulsification process is comparable to both conventional and microemulsion systems. Because of the production of huge micelle globule sizes, conventional emulsions are less stable than nanoemulsions [51]. The HLB of a nonionic surfactant is necessary for the formation of micellar nanoparticles in oil-in-water (o/w) nanoemulsion. A high HLB number indicates a more hydrophilic surfactant, whereas a low HLB value indicates a more hydrophobic one [53]. The HLB value determines how micelles are formed by surfactant self-aggregation; hydrophilic surfactants are more likely to concentrate in an aqueous environment, create stable oil-in-water nanoemulsions, and have smaller micelle particle sizes [54].

Micellar Nanoparticle Formulation Techniques In Nanoemulsion

To create micellar nanoparticles in a nanoemulsion system, a variety of emulsification techniques are available, which can be divided into two categories: high energy and low energy procedures. A high-pressure homogenizer, ultrasonication, and microfluidization are among the mechanical forces needed for the high-energy emulsification process. In addition, the low-energy approach uses spontaneous emulsification techniques and phase inversion temperature (PIC) and composition (PIT) [55]. The most widely used emulsification technology in the cosmetics industry for creating micellar nanoparticles using O/W nanoemulsion is the high energy method. Due to its energy-saving methodology and less harmful process for labile bioactive ingredients, the use of low energy emulsification techniques has increased significantly in recent years [56].

HIGH-ENERGY EMULSIFICATION TECHNIQUE: MECHANISM

Larger droplets are broken up into smaller ones by the high-energy method's mechanism, which also provides fluid stresses to successfully lower the interfacial tension between the aqueous and oil phases and produces a greater number of droplets per volume [57]. To create smaller micelles utilizing the high energy approach, two phases are often involved: (i) the ultimate production of tiny droplets from the deformation and disruption of macrosized molecules, and (ii) the adsorption of surfactants at their interface through an aqueous medium to promote steric stability [58]. The high-energy emulsification method is typically divided into three groups: (i) high-pressure homogenization, (ii) high-shear stirring with a rotor/stator system, and (iii) ultrasonication [59]. The two types of this high-pressure homogenizer (HPH) are the cold HPH technique (CHPH) and the hot HPH technique (HHPH). Depending on the temperature of the materials or emulsions before passing through the homogenizer's small slot, these two methods change [56]. It is better to use the cold HPH to process bioactive components that are extremely temperature-sensitive [60]. Both methods involve dispersing, dissolving, and solubilizing the bioactive molecule in the melting lipid phase. The hot HPH technique creates a hot pre-emulsion solution by dispersing this combination in a hot surfactant that is above the melting point and churning it at a high speed. In addition, the cold HPH approach creates a cold pre-suspension phase by cooling, grinding, and dispersing the mixture of bioactive ingredient and lipid phase into cold surfactant [56].

LOW-ENERGY EMULSIFICATION TECHNIQUE: MECHANISM

The low energy technique relies on the intrinsic physicochemical properties of the excipient formulations, cosurfactants, and surfactants. Additionally, compared to high-energy emulsification, this method of creating nanoemulsions uses less energy and a gentler mixing procedure [50]. In the past, high-energy technique methods are phase inversion techniques, such as spontaneous emulsification, phase inversion temperature (PIT), and phase inversion composition (PIC) [56]. However, while employing the spontaneous emulsification process, the system composition is crucial to optimizing the formation of smaller micelle particle sizes [56].

MAJOR CLASSES IN NANOCOSMECEUTICALS: _____

In the personal care market, cosmetics are thought to be the sector with the quickest rate of growth [61].

A) SKIN CARE:

Skin care products include: Moisturizer, Sunscreen, Anti-aging, Skin cleanser. By encouraging the production of collagen and preventing the harmful effects of free radicals, cosmetics for skin care products enhance the function and texture of the skin. By maintaining the structural integrity of the keratin, they promote skin health [62]. Because they create a thin film of humectants and hold onto moisture for an extended period of time, SLNs, nanoemulsions, liposomes, and niosomes are widely employed in moisturizing formulations [63].

SUNSCREEN:

The most effective minerals in sunscreen lotions are zinc oxide and titanium dioxide nanoparticles, which penetrate the skin's deep layers to protect the skin and reduce the product's oily, odorous, and transparent properties [28].

MOISTURIZERS:

Moisturizers are used to treat a number of skin conditions, including psoriasis, dryness, and atopic dermatitis. They are applied to the skin externally. In the production of moisturizers, liposomes, SLNs, and nanoemulsions are frequently used due to their long-lasting therapeutic effects [42].

B) HAIR CARE:

Hair care products include: Hair growth stimulators, Hair color, Hair styling gel, Hair serum, Shampoo, Hair conditioner [24]. Shampoos with nanoparticles in them lock moisture in the cuticles by building protective barriers to extend resident contact with the scalp and hair follicles film [8]. Agents for conditioning nanocosmeceuticals serve the purpose of improving hair disentangling and adding softness, shine, silkiness,

and gloss. s. Liposomes' primary job is to restore texture, heal damaged cuticles, and gloss, making hair less brittle, less oily, and lustrous [6]. Nanoparticle formulations are better than aqueous and alcohol based formulations in the treatment of hair disorders like alopecia

C) LIP CARE

Nanocosmeceuticals lip care products include lipstick, lip balm, lip gloss, and lip volumizer. Lip gloss and lipstick can contain a range of nanoparticles to lessen transepidermal water loss, which softens the colors leaving the lips. Leave the lips alone and they will remain colored for a longer period of time. Liposomes, which are present in Lip Splurge, plump up, moisturize, define, and fill the lips [12]. In Using pigments, oils, waxes, and emollients, lipstick is a cosmetic product that gives the lips color, texture, and protection [67].

D) NAIL CARE

For nail care, nano-based cosmeceuticals are being developed. Among thenair care items are nail polish. Benefits of nail polishes based onnanotechnology include increased toughness, rapid drying, durability, resistanceto chips, and ease of application because of their flexibility. novel methods suchas combining metal oxide and silver Nanoparticles have an antifungal effect innail paints used to cure toe nails [59]. Nanocosmeceuticals based nail careproducts have greater superiority over the conventional products [67].Additionally, it can be used therapeutically to treat onychomycosis.[67].

TABEL 1: COSMETIC FORMULATIONS CURRENTLY AVAILABLE IN THE MARKET

	Company	BRAND	PRODUCT	NANO SIZE INGREDIENT
Acne Treatment	Cealazome New Zealand Limited Wilma Schumann	Celazome	Target Acne Spot Treatment Acne Kit	Lyphazome Nanosphers Vitamin Nanopartical
After sun product	L' Oreal	Lancome	Colling sun spirtz	Vitamin Nanocapsulate
Anti -aging	Sircuit skin Cosmecuticals inc DS Laboratories inc	Sircuit skin DS Laboratories	Anti-Oxidant Serum Viterol.A(viatr oz ene Gel)16%	Fullerenes Nanosomes of Vitamin A
Body Wah/cleanser	DS Laboratories inc	DS Laboratories	DS Laboratories Hydroviton .C R Liquid Normalizing soap 80 mg	Nanosome of Vitamin A
Bronzer/Highlighter	Color Science relevon	Color Science relevon	Color Science Genie Sparkle Bottels (Flower Power) Revelon skin Light Colors Lightning for eyes & cheeks	Nano Vitamins Micronized Topaz Powder

Facial Cleanser	Fancl Laboratories,inc.	Boscia	Boscia Make up Break up Cool Cleansing oil	Nano Technology
Facial Moisturizer	Ferndale Laboratories ,inc	Ferndale Nouriva	Nouriva Repair Moisturizing Cream	Nano Particle
Lip Balm	DERMA doctor	DERMA doctor	DERMA doctor POUT Landis Hyper Moisturizing Lip paint	Nano Zinc Oxide
Moisturizer	Cealazome New Zealand Limited	Cealazome	Cealazome Spoil Me Body Lotion	Lyphazome
Nail Treatment	Cealazome New Zealand Limited	Cealazome	Cealazome Tip Treat Cuticle Exfoliator	Lyphazome
SunScreen	L' Oreal	Lancome	Lancome solely soft – Touch Moisturizing Sun Lotion SPF 15	Vitamin NanoCapsules
Hair Loss Treatment	DS Laboratories inc	DS Laboratories	DS Laboratories spectral Dnc Hair Loss Treatment	Nanosomes

ROUTE OF EXPOSURE

A) INHALATION

According to the National Institute of Occupational Health and Safety, the most common way that people are exposed to airborne nanoparticles is by inhalation. Customers may inhale the nanoparticles, and their respiratory systems may also be exposed. Scents, powders, and aerosols are examples of products that can expose workers to nanoparticles during production [8].

B) INGESTION

From hand to mouth, nanomaterials can inadvertently or intentionally enter the body. Nanoparticles may be present in cosmeceuticals such as lip balms, lip gloss, lipsticks, and other products applied to the mouth or lips [25]. Studies show that following consumption, nanomaterials quickly leave the body, however occasionally a small amount may be absorbed and go to the organs [26].

C) THROUGH SKIN/DERMAL ABSORPTION

The risk factor might essentially enter the dermal layer in three different ways [27]. The pathways that have been identified for penetration through the skin are intercellular, transfollicular, and transcellular [10]. If the skin is impaired, and the normal barrier disturbed, then the chances of the entry of particles may substantially gets increased [27]. Larger particles that penetrate deeper than 30 nm are less damaging to the skin than smaller ones that penetrate less than 10 nm (10).

D) EYE

It has been said that the human eye is the most intricate organ in the body. Although the eye only offers a tiny surface area for exposure, cosmetics meant to be applied near the eye or other kinds of cosmetic goods might expose people indirectly to nanomaterials [29].

CONCLUSION:

Nanotechnology is considered to be the most promising and revolutionizing field. Tiny nanomaterials that are designed to release medications at specific sites can readily permeate the skin. This characteristic of nanoparticles can improve the present goods' ability to filter UV rays and heal scars. The cosmetic industry uses a number of nanosystems as active cosmeceutical ingredients since they are simple to make. Liposomes,

niosomes, solid lipid nanoparticles, gold nanoparticles, nanoemulsions, and nanosomes are examples of novel nanocarriers that are now being utilized in a variety of cosmeceuticals. A number of goals, including site specificity, improved stability, biocompatibility, prolonged action, controlled and targeted drug administration, and increased drug-loading capacity, can be accomplished with these innovative delivery methods. In summary, the application of nanoparticles in cosmetics is a relatively new idea with a lot of promise, but further study is required to fully comprehend all the advantages and disadvantages.

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