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Advanced carrier systems in cosmetics and cosmeceuticals: A review

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Synopsis

Carrier systems refer to carrier vesicles such as liposomes, nano/microparticles, emulsions, etc., that are coupled with active agents and applied to products to achieve the promoted effects of the active ingredients. This article reviews the recent research on carrier systems, focusing on cosmetic and cosmeceutical applications; the pros and cons of each carrier system and products on the market utilizing the technologies are discussed.

INTRODUCTION

Cosmetic usage has a long history. The first evidence dates back to 3500 BC in ancient Egypt, where predominantly the royalty used makeup including unguent, kohl, and soot to beautify and enhance their skin's appearance (1). Since then, people's enthusiasm, especially women's, and demand for cosmetic products, has led to a prosperous growth in this industry (2). According to the Food and Drug Administration (FDA), cosmetics are defined as "articles intended to be rubbed, poured, sprinkled, or sprayed on, introduced into, or otherwise applied to the human body for cleansing, beautifying, promoting attractiveness, or altering the appearance; and articles intended for use as a component of any such articles except that such term shall not include soap" (3). However, many products exhibit functions surpassing that of solely covering and camouflaging defects in appearance and they often contain therapeutic or "active" ingredients to heal or repair skin tissue. They are in fact more than pure cosmetics and, with this in mind, the term "cosmeceutics" was coined (4). Cosmeceutical products are considered to be the hybrid of cosmetics and topical medication; applied topically, they contain ingredients and technology that influence the biological and physiological function of the skin. Due to both their skin-altering and skin-healing function, these products are considered to be futuristic (5).

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Though the effects of these products are fascinating, given the barrier function of the skin they are difficult to achieve merely by adding functional compounds to the products. The human skin is comprised of three tissue layers: the epidermis, the dermis, and the subcutaneous layer. The stratum corneum, the outermost layer of the epidermis, is the essential permeability barrier that limits the passage of most compounds. Normally, the penetrant that is applied to the skin surface may trespass the stratum corneum through three pathways: via appendages or through transcellular or intercellular routes (6). Although the pores of appendages bypass the stratum corneum, their openings onto the skin surface are very small (0.1% of total skin surface) (7), which renders this pathway negligible. With the transcellular route, a penetrant has to infiltrate into corneocytes, diffuse through keration, and then penetrate the next corneocyte. This route is not considered as a main pathway either and is merely suitable for highly hydrophilic compounds. The intercellular route is the principal pathway through which the compound goes through the continuous and tortuous domain formed by the intercellular lipid matrix (5). In fact, only small and lipophilic compounds are able to penetrate the stratum corneum; therefore, this poses a problem for cosmetic and cosmeceutical products: how to overcome the skin barrier and facilitate the active ingredients deep into skin where they can exhibit their functions. The use of carrier systems is one of the strategies investigated to enhance the penetration of compounds through the stratum corneum. Carrier technology, also referred to as nanotechnology if the vesicle or particle is under nanoscale, refers to the coupling of agents to carrier particles such as liposomes, niosomes, and solid lipid nanoparticles (SLN) (8) and is the main method of delivering ingredients into the skin. This is one reason why carrier systems are beneficial in skin and body care products.

Besides enhancing penetration (9,10), carrier systems may have other uses in cosmetic and cosmeceutical products such as improving agent stability (11), as targeting agents (12), and in modulating drug release (8).

APPLICATION OF CARRIER SYSTEMS IN COSMETICS AND COSMECEUTICALS

LIPOSOMES

Liposomes (Figure 1), first described by Bangham and Papahadjopoulos in the 1960s (13), are microscopic vesicles formed by phospholipid bilayers surrounding an aqueous medium. The ability of phospolipids to form a bilayer structure is attributed to their amphipathic character. The polar/hydrophilic head region assembles towards the aqueous phase, while the nonpolar/lipophilic tail part orientates towards the inside (13). Liposomes were investigated for the first time in 1980 as a topical delivery system for dermatological agents into the skin (14). Since then, studies on liposomes for dermal application have progressed.

The advantages of using liposomes for dermal application are summarized as follows:

1. Liposomes are biodegradable and nontoxic.
2. Due to the amphiphilic property of phospholipids, of which the bilayer is constituted, liposomes contain domains for both lipophilic and hydrophilic substances, meaning they can be used as carrier systems for active ingredients with different solubilities (8).
3. Liposomes provide controlled release profiles for many substances.

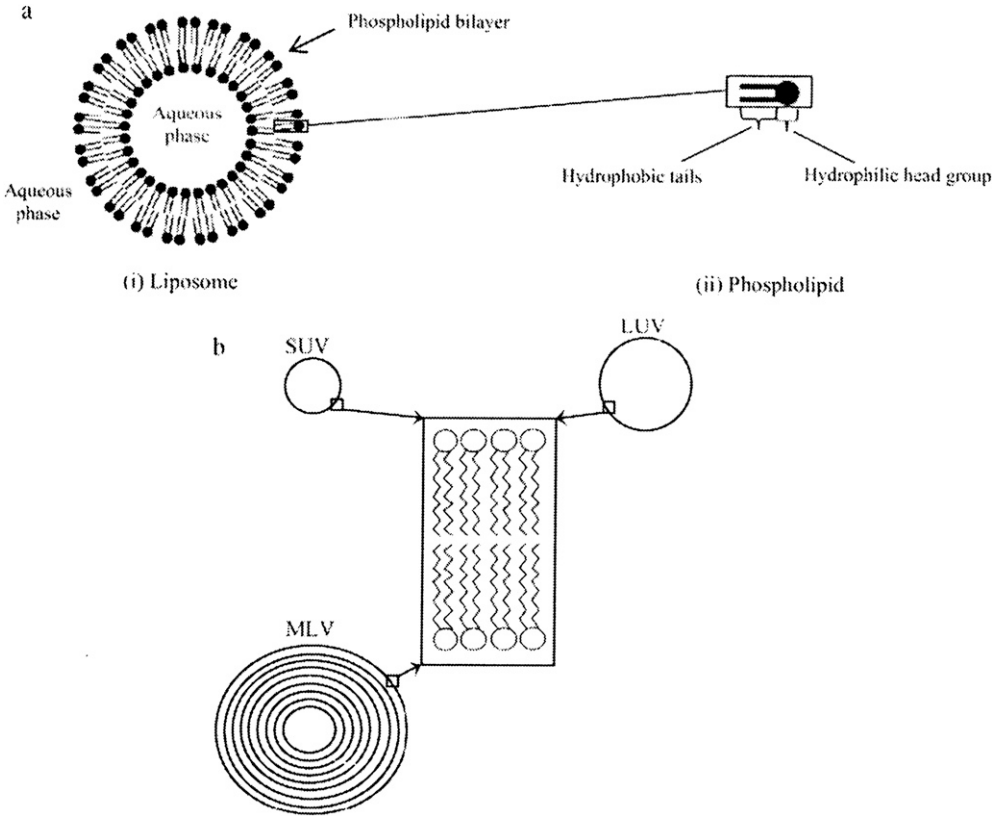

Figure 1. (a) Schematic representation of a liposome (i) and a phospholipid (ii). (b) Schematic representation of the structure of liposomes (SUV: small unilamellar vesicles; LUV: large unilamellar vesicles; MLV: multilamellar vesicles). (Adapted from Lesoin *et al*. (15).)

4. Liposomes enhance drug penetration through intact liposome skin penetration, vesicle adsorption and fusion onto the skin surface, and interaction of the lipid of liposomes and the stratum corneum. The mechanism by which intact liposomes with loaded drugs can penetrate into skin was first proposed by Mezei and Gulasekharam (14). Though this mechanism was disputed (16), reports indicated that intact liposomes, especially ultradeformable liposomes, may penetrate deeply into the skin (17). The second mechanism was proposed by Hofland *et al*. (18) and Abraham and Downing (19). They suggested that vesicles aggregate, fuse, and adhere to the skin surface and that this may lead to a high thermodynamic activity gradient of the drug, which serves as a driving force for drug penetration. The third mechanism stated that the similarity between the lipid composition of liposomes and the structure of epidermis enables liposomes to penetrate the epidermal barrier. It was suggested by Kirjavainen *et al.* (20) that the lipids of liposomes fuse and mix with the lipid of the intercellular matrix of the stratum corneum, altering its structure and promoting drug penetration through this impaired barrier.
5. Liposomes are considered to act not only as "drug transporters" but also as a "drug localizer." Liposomes have received considerable attention for delivering actives to the

target tissue, and with topical use liposomes may increase active absorption into the epidermis and dermis, decreasing systemic clearance from cutaneous tissue (21).

After Mezei and Gulasekharam (14) suggested that liposomes can be used on the skin, several studies followed, reporting that liposomes enhanced the skin deposition of certain drugs, e.g. corticosteroids (22), tetracaine (23), and ciclosporin (24). Except for the application of liposomes in treating skin diseases, there has been considerable interest in the use of liposomes as active ingredients in cosmetics and cosmeceutics (25). Researchers have studied the effects of liposomal systems on several compounds: tretinoin, for instance, is an anti-acne agent often used in pharmaceutical products. It was found that after the skin had been treated with negatively charged liposomal tretinoin, there was a higher accumulative amount of tretinoin in the epidermis. This may suggest that liposomes are efficient delivery carrier systems for tretinoin in acne treatment (26). Another hot topic in the cosmetic and cosmeceutical field is how to protect the skin from UV radiation. To maintain sodium ascorbyl phosphate (SAP), a photoprotective agent, in the skin, SAP-loaded liposomes were prepared for cutaneous use. This enabled greater SAP penetration through the epidermal membrane than did SAP in water solution (27). Similarly, anionic surfactants such as deoxycholic acid (DA) and dicetyl phosphate (DP) were incorporated in the liposomes in the presence of 15% ethanol. It was detected that this formulation increased the skin permeation and deposition level of (+)-catechin—a botanical ingredient in skin antioxidation and photoprotection—compared to catechin solution (28). Another example is Aloe vera leaf gel extract (AGE), which is widely used as a cosmetic and pharmaceutical ingredient because of its versatile skin care properties. It was found that liposomal AGE significantly improved proliferation and type I collagen synthesis in human fibroblast cell lines as well as the proliferation of human keratinocyte cell lines (23).

The ease of preparation of liposomes and the improvement in cosmetic and cosmeceutical effects by the carrier system make liposome use widespread, and there are now numerous products on the market claiming that they contain liposomal technology. However, several disadvantages were encountered by using liposomal products, such as hydrolysis, aggregation, fusion and oxidation of liposomes, as well as the leaching of actives, leading to a shorter shelf life of liposomal products. The cost of phospholipids may increase the price of liposomal cosmetics, which might deter a great number of consumers. Therefore, enhancing the effectiveness and efficacy of an ingredient-loaded liposome formulation, improving its stability, and lowering its production cost are still challenging topics for all formulation scientists globally.

NIOSOMES

Evolved from liposomes, niosomes (Figure 2) also have a closed bilayer structure, but they are formed from a self-assembly of nonionic surfactant(s) in an aqueous surrounding. In 1979, Handjani-Vila *et al*. (29) was the first to report the formation of a vesicular system on the hydration of a mixture of cholesterol and a single-alkyl chain nonionic surfactant. Since they exhibit similar behavior but possess distinct advantages over liposomes, this research led to further studies on niosomes as an alternative to liposomes (30).

Niosomes as carrier systems can also enhance the permeability of drug actives (32) and control the release of ingredients (33). Despite the similar bilayer structure and topical

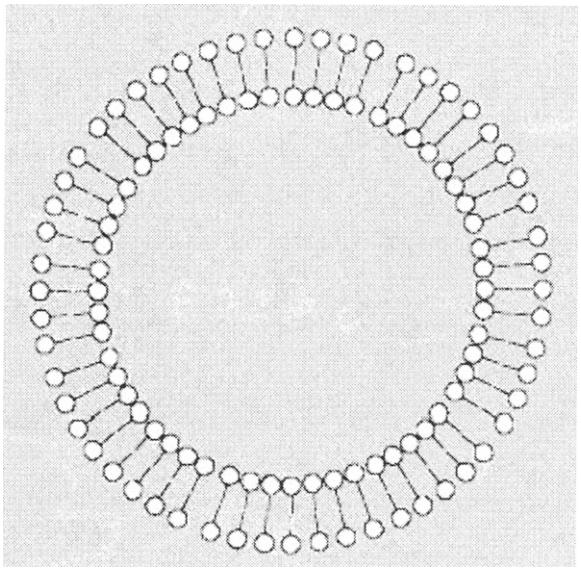

Figure 2. Schematic representation of a niosome. o: hydrophilic head group. --: hydrophobic tail. (Adapted from Uchegbu and Vyas (31).)

effects, niosomes are demonstrated to be the more promising drug carriers system as they possess greater stability than liposomes, and they overcome many of the disadvantages associated with liposomes including hydration, oxidation, aggregation, and fusion. Therefore, they have also been applied widely in cosmetics. It was found that small and negatively charged tretinoin-loaded niosomes showed higher cutaneous drug retention than both liposomes and a commercial formulation (RetinA®). Moreover, tretinoin entrapped in Brij® 30 or Triton® CG110 niosomes retarded the drug's photodegradation (34,35). Having further enhanced stability, proniosomes are nonionic-based surfactant vesicles, which may be hydrated immediately before being used to yield aqueous niosome dispersions (36). They are converted into niosomes upon simple hydration or by the hydration of skin itself after application. Proniosomal gel is generally present in a transparent, translucent, or white semisolid gel texture, which makes it more acceptable to consumers. More importantly, proniosomal gel is physically stable during storage and transport and, therefore, appears to be a potentially valuable carrier system in cosmetics.

Some problems with application of niosomes in cosmetics and cosmeceuticals lie in the components of the carriers. Unlike liposomes, which are formed by phospholipids and generally recognized as safe (GRAS), niosomes contain surfactants and are potentially more irritating to the skin. As a result, studies on how to utilize niosomes effectively and safely needs to be a priority.

MICROPARTICULATES AND NANOPARTICULATES

Microparticles are solid polymeric particles, including microcapsules and microspheres, ranging from 0.1 μm to 100 μm; nanoparticles include nanospheres and nanocapsules, have a similar polymer composition to microparticles, but have a smaller mean particle

diameter of 0.003 μm to 1 μm. For micro/nanospheres, the agents are either dissolved in the sphere matrix or absorbed onto the surface of the particles, while for micro/nanocapsules the actives are either attached to the surface or trapped within the capsules.

Incorporating agents into micro/nanoparticles has demonstrated to be advantageous in improved sustained drug release (37) and increased drug uptake (38), which has won these particles broad attention in the cosmetic industry. Specifically, nanoparticles have been used to encapsulate a wide range of ingredients that are intended to provide cosmetic benefits (39).

Many studies focusing on the topical use of microparticles and nanoparticles have been carried out, and actives encapsulated into particles include vitamin A and some precious metal elements: vitamin A has skin-softening and anti-wrinkle functions. One comparison experiment of *in vitro* and *in vivo* drug release of a microencapsulated vitamin A cream with a non-microencapsulated formulation showed that microspheres were able to remain on the skin for a longer period of time, and as a consequence were able to prolong the release of vitamin A (40). Free radicals including reactive oxygen species (ROS) are considered to be one of the main hazards to the skin. A decrease in ROS production was observed in platinum-nonparticle-treated HaCaT kertinocytes. Pretreatment of the cells with nano-platinum also caused a significant inhibition of UVB- and UVC-induced apoptosis. These results suggested that nano-platinum effectively protected against UV-induced inflammation by decreasing ROS production and inhibiting apoptosis in keratinocytes (41). Gold nanoparticles enhanced the proliferation of keratinocytes (42), while silver nanoparticles demonstrated preservative effects against mixed bacteria and mixed fungi, and did not penetrate normal human skin, suggesting that silver nanoparticles may have a potential for use as a preservative in cosmetics (43).

The use of nanomaterials gives rise to controversy: While cosmetologists claim that nanoparticles are able to penetrate the skin, which is attributed to their size, some academics question the potential dangers of the contact of nanoparticles with human skin. Recently, Friends of the Earth, an international environmental organization, warned against the use of nanoparticles in cosmetic and sunscreen products due to a possible uptake of particles by the human skin into the circulation: "If nanoparticles penetrate the skin, they can join the bloodstream and circulate around the body with uptake by cells, tissues and organs." (44). The safety of nanoparticles in cosmetic products needs to be addressed.

SOLID LIPID NANOPARTICLES (SLN) AND NANOSTRUCTURED LIPID CARRIERS (NLC)

Solid lipid nanoparticles (SLN) were developed at the beginning of the 1990s as an alternative carrier system to emulsions, liposomes, and polymeric nanoparticles (45). With SLN, a solid lipid or a blend of solid lipids is used to substitute the oil phase of an oil-in-water space (o/w) emulsion. Nanostructured lipid carriers (NLC) were developed to overcome the low loading capacity of SLN. Both SLN and NLC can be loaded with actives as carriers in cosmetic and cosmeceutical products.

It is reported that SLN and NLC are advantageous in dermal application in the following ways: (a) SLN and NLC are composed of biocompatible and biodegradable lipids exhibiting low toxicity (46); (b) SLN and NLC are reported to be able to enhance dermal penetration (47); (c) SLN and NLC provide controlled release profiles for many substances

(48); and (d) lipid nanoparticles are able enhance the chemical stability of compounds sensitive to light, oxidation, and hydrolysis (49).

Researchers successfully incorporated active ingredients, e.g., vitamin A (55), Coenzyme Q10 (57), ascorbyl palmitate (58), etc., into SLN and NLC. The outcome of the study in vitamin A-loaded glyceryl behenate SLN has shown a sustained release of vitamin A from SLN compared to a vitamin A nanoemulsion (50,51). Experiments comparing SLN and conventional o/w emulsions as carrier systems for the molecular sunscreen oxybenzone found that release rates could be decreased by up to 50% with the SLN formulation. SLN was also able to improve UV protection when applied together with organic sunscreens such as 2-hydroxy-4-methoxy benzophenone (52). Coenzyme Q10 is a potent antioxidation enzyme and is a popular component in many cosmetic and cosmeceutical products. It was reported that in contrast to the Coenzyme Q10-loaded nanoemulsion, Coenzyme Q_{10}-loaded NLC possessed a favorable biphasic release pattern. The NLC release patterns were defined by an initial fast release followed by a prolonged release, while the nanoemulsion showed a nearly constant release (53). Ascorbyl palmitate (AP), a cosmetically effective ingredient in skin-whitening, is unstable under normal conditions, but was proven to be more stable in both the NLC and SLN stored at 4°C (54). The mechanism is explained as the occlusion effect of the film formed by lipid nanoparticles on the skin. Film formation on the skin may increase stratum corneum hydration, resulting in reduced corneocyte packing and an open intercellular gap for drug penetration.

Although SLN and NLC are promising carrier systems in cosmetics and cosmeceutics, they suffer drawbacks. Low loading capacity and instability during storage are two problems concerning SLNs. To overcome these issues, NLCs were developed with their high-loading capacity and long-term stability, making them favorable in many cosmetic applications. However, NLCs are not suitable for purposes that may require a high level of crystallinity, such as in UV protection (55). These problems need to be addressed in the future.

MICROEMULSIONS AND NANOEMULSIONS

The concept of microemulsions (Figure 3) was introduced for the first time in the 1940s by Hoar and Schulman (56), who produced a transparent single-phase solution by titrating a milky emulsion with hexanol. The term "microemulsion" was coined in 1959 (57). Microemulsions consist of an aqueous phase, an oil phase, a surfactant, and a cosurfactant. They are colloidal, thermodynamically stable dispersion systems with a droplet diameter usually in the range of 10–100 nm (58). Compared to microemulsions, nanoemulsions have a droplet diameter smaller than 100 nm, are in a metastable state, and are easily valued in skin care because of their sensorial and biophysical properties (59). Stability studies of nanoemulsions indicate that they are stable for 15 years, which is an advantageous property for carriers in cosmetic and cosmeceutical products (60). In addition, they exhibit several advantages in topical drug delivery, i.e., control of drug release (61), protection of labile agents, increase of bioavailability, and enhancement of actives penetration (62). They are considered as potentially good carriers for cosmetic and cosmeceutical use.

Drugs incorporated into microemulsions and nanoemulsions range from antioxidants, such as hesperetin and quercetin, to moisturizing compounds, like ceramides. Hesperetin

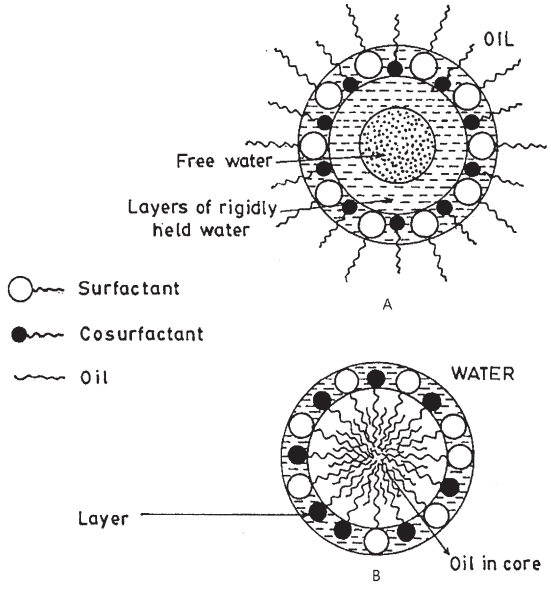

Figure 3. Schematic representation of a water-in-oil microemulsion (A) and an oil-in-water microemulsion (B). (Adapted from Moulik and Paul (63).)

is also a flavonoidal active ingredient possessing anti-inflammatory and UV-protecting effects. A hesperetin-loaded microemulsion was reported to enhance *in vitro* skin permeation compared to the aqueous and isopropyl myristate (IPM) suspension dosage form of hesperetin. In an *in vivo* study, a hesperetin-loaded microemulsion showed a significant topical whitening effect and diminished skin irritation when compared to the non-treatment group (64).

Quercetin is an antioxidant, known to be able to diminish UV radiation-mediated oxidative damage to the skin. The evaluation of the potential of a w/o microemulsion as a topical carrier system indicated that it increased the penetration of quercetin into the stratum corneum, epidermis, and dermis without transdermal delivery. Caffeine is widely used in cosmetics as an active substance because of its slimming effect. Investigation of the transport of caffeine to the hypodermis by an alcohol-free o/w microemulsion suggests that it allowed delivery of a larger fraction of the caffeine to the hypodermis than the emulsion and gel dosage forms (65). Ascorbyl palmitate, a skin-whitening ingredient, has better stability and skin penetration than ascorbic acid (vitamin C). A microemulsion of ascorbic acid decreased the level of formation of free radicals, and an o/w microemulsion delivered ascorbyl palmitate to the skin significantly better than a w/o microemulsion (66). Though the mechanism of penetration enhancement still needs to be eluciadated, some theories are proposed: the surfactant and cosurfactant in the microemulsions and nanoemulsions may act as penetration enhancers; the small droplets give the drug a chance of close adherence to the skin cells. Moreover, the occlusive effect after the emulsion is applied to the skin will increase the hydration of corneocytes so that drug penetration is facilitated. Except for penetration enhancement, the effects of micro- and nanoemulsions have been demonstrated: UVB irradiation induces the depletion of glutathione (GSH), an antioxidative enzyme and at the same time increases the secretion and

the activity of metalloproteinase, which is a kind of proteolytic enzyme contributing to skin photoaging and skin carcinoma. A w/o microemulsion containing quercetin significantly prevented the depletion of GSH and also the increase in the level of metalloproteinase (67). Ceramides, though enhancing the water content and smoothness of human skin, are applied limitedly because of their low solubility. This was overcome by using a positively charged nanoemulsion that successfully accommodates sufficient ceramides (68).

Microemulsions and nanoemulsions are highly convenient and acceptable formulations in cosmetics and cosmeceuticals. Their transparent and clear properties make them more appealing than other formulations with opaque or cloudy appearances. The cosmetic use of microemulsions has drawn substantial interest, and there are many *in vitro* and *in vivo* studies on microemulsion application in cosmetics and cosmeceuticals. However, due to the fact that a large amount of surfactant is required for microemulsion formation, it is important to select the surfactants judiciously. More research is paramount to developing safe and efficient products (69). The shelf life of emulsions is another problem that needs to be addressed since even nanoemulsions, which are relatively thermodynamically stable, undergo phase separation and droplet aggregation. How to enhance the stability of microemulsions and nanoemulsions needs to be addressed.

ON-MARKET PRODUCTS WITH CARRIER TECHNOLOGY

Cosmetics manufacturers have turned some outcomes of experimental research into practical production. The first liposomal cosmetic product to appear on the market was Capture®, an anti-aging cream launched by Christian Dior® in 1986. The Capture® line utilizes liposomes in gel and is claimed to be revolutionary in the prevention of wrinkles (70). The liposome delivery system in Advanced Night Repair Protective Recovery Complex Serum®, by Estee Lauder targets free radicals in the skin and promotes the skin's own natural repair rate (8). According to the Urban Sense® eye gel advertisement, "the liposome-enriched hydrating treatment gel will deeply penetrate and nourish the delicate skin around the eyes and soften fine lines around the face." Vitamins and botanical extracts are incorporated into this liposomal gel and delivered into skin to nourish skin cells and soften fine lines (71). Liposomes are applied in Kara vita's Clean It® products (mist, lotion, spot treatment) for deep penetration and controlled release of botanical actives, including tea tree oil, to fulfill an all-day detoxifying effect (72). Currently niosomes have also been applied in some products. Lancome brought the first cosmetic product containing niosome vesicles, called Niosomes®, into the market in 1987. The product also had its successors like Niosome Plus® anti-aging cream by Lancome, which reached the market in the early 1990s (73).

Microparticles and nanoparticles are probably the most widely used carrier systems in cosmetic and cosmeceutical products. Shisheido first launched its nanoparticles product, Elixir Skin Up®, in Japan in 2001, including titanium oxide nanoparticles (8). L' Oreal, the world's biggest cosmetics company, is also the biggest nanotechnology patent holder in the United States and the champion of nanotechnology use in beauty products (74). L'Oreal's anti-wrinke products, Revitalift® Double Lifting Serum and Intense Lift® Treatment Mask, contain nanosomes of Pro-Retinol to "lift and tighten skin." Lancome also uses a nanoparticles system in its anti-aging products. The anti-aging moisturizer Renergie

Microlift® incorporates nanoparticles of silica and proteins to help lift and tighten the skin's surface. Other Lancome products, Primordiale Nanolotion® cream and Hydrazen® cream both use vitamin A-containing nanocapsules to moisturize the skin (75). Helena Ruberstein another top cosmetics brand, develops colloidal gold in its Gold Future® cream, and it is claimed by the manufacturer that particles of gold are able to enhance the bioavailability of epidermis cells.

Currently there are many products containing SLN or NLC on the market. German cosmetics manufacturer Dr. Rimpler GmbH introduced Cutanova Cream NanoRepair Q10® into the market in 2005. It is the first lipid nanoparticle-based cosmetic product. This NLC-containing cream is superior to conventional o/w emulsion creams with regard to skin hydration (50). Chanel's Allure® perfume is incorporated into SLN and nanoemulsions. SLN yields a prolonged release of the perfume (76). It is also found in a prolonged release of Kenzo® perfume from NLC (77).

Products involving an emulsion as a carrier system include an oil-in-water emulsion patented by L' Oreal. It contains fillers such as Radiesse® and Restylane® that can be used in numerous cosmetic and dermatological applications and that are suitable for all skin types (8). Korres's Red Vine Hair® sunscreen utilizes a microemulsion with water-resistant UV filters to protect hair from UV radiation (78). L' Oreal owns several patents based on nanoemulsions. Coco Mademoiselle Fresh Moisture Mist® from Chanel has a nanoemulsion that prolongs the fragrance (79). Certain products in the market using carrier systems are tabulated below (Table I; also see ref. 80).

Table I
Summary of the Cosmetic and Cosmeceutical Products That Use Carrier Systems to Improve Performance

Trade name	Ingredient	Use	Name of brand	Type of carrier system used
Capture®		Anti-aging	Dior	Liposome (70)
Advanced Night Repair Protective Recovery Complex Serum®		Anti-aging	Estee Lauder	Liposome (82)
Clean It® Complexion Mist		Acne-controlling	Kara vita	Liposome
Royal Jelly Lift Concentrate		Anti-wrinkle	Royal Jelly	Liposome
Niosome Plus® Daily Treatment			Lancome	Niosome
Rénergie® line roducts (Flash Lifting Serum, Microlift Serum, Microlift Cream, Microlift Eye Cream	Nanoparticles of silica and proteins	Skin-tightening, anti-wrinkles	Lancome	Nanoparticles (83)
Nano Gold® Energizing Cream	24-karat gold, a natural protein	Anti-aging, anti-inflammation	Neiman Marcus	Nanoparticles
Nanorama™—Nano Gold® Mask Pack	Nano-gold, amino acid, collagen, coenzyme Q10,	Skin-tightening, anti-wrinkles	Lexon Nanotech, Inc™.	Nanoparticles
Oleogel®	Coenzyme Q10, primrose, Vitamin A,E	Antioxidation, anti-aging	Dermaviduals	Nanoparticles

Table I
Continued

Trade name	Ingredient	Use	Name of brand	Type of carrier system used
Platinum Silver Nanocolloid® line products (Platinum Silver Nanocolloid Milky Essence, Platinum Silver Nanocolloid Cream)	Botanicals and coenzyme Q10	Anti-wrinkles, anti-aging	DHC Skincare	Nanoparticles
RevitaLift® line (RevitaLift Double Lifting Serum, Intense Lift Treament Mask)	Pro-Retinol A, vitamin A	Skin-tightening, anti-wrinkles	L'Oreal	Nanosomes, nanoparticles (84)
Rutína® Nano-force Moisturizer	Hyaluronic acid derivative	Skin-moisturizing	KOSÉ	Nanotechnology
Rutína® Nano-white Serum		Skin-whitening	KOSÉ	Nanotechnology
The Makeup Dual Balancing Foundation SPF 17		Makeup	Shiseido	Nanoparticles (85)
Skin Forever®—Extreme Wear Flawless Makeup SPF 25		Makeup	Dior	Nanotechnology (86)
Snow Pure® UV Base SPF 50		Makeup	Dior	Nano UV filters
Hydra flash® Bronzer Daily Face Moisturizer	Vitamin E	Self-tanning, skin-moisturizing	Lancome	Nanocapsules
Hydrazen® Cream	Triceramides	Skin-moisturizing	Lancome	Nanosphere (87)
Elixir Skin Up® Cream	Titanium dioxide	Makeup foundation	Shiseido	Nanoparticles
Bioperformance Crème Super Régénérante Absolue®	Gamma linolenic acid		Lancome	Nanocapsules
Platinéum®	Hydroxyapatite	Anti-aging	Lancome	Nanoparticles
Gold Future®	Gold	Anti-free radical	Helena Rubinstein	Colloidal (88)
Happylogy® Glowing Skin Essence	Pro-endorphins complex	Anti-wrinkle	Guerlain	Nanoemulsion (89)
Precisone® Calming Emulsion			Chanel	Nanoemulsion (90)
Coco Mademoiselle Fresh Moisture Mist®		Skin-moisturizing	Chanel	Nanoemulsion (91)

SUMMARY

With people's increasing vanity of youthful appearance and flawless complexion, presumably carrier systems will continue to establish a leading role in the cosmetics industry. Liposomes and niosomes posses a similar structure and are both nontoxic and biocompatible. They are reported to exert favorable effects when applied with active ingredients on the skin, including facilitating ingredients into deep skin layers, improving ingredients' biomedical functions, and reducing application time. Liposome stability is one significant problem; however, the leakage of contents, oxidation of lipids, and change in particle

size may influence product quality (81). Another concern is the cost and variable purity of phospholipids, which may cause trouble in massive production (12). In comparison, niosomes are more stable and the low cost of materials makes them suitable for industry manufacture. Stability is also a concern when SLN and micro-/nanoemulsions are applied to cosmetic and cosmeceutical products.

In conclusion, a desired carrier system for cosmetic and cosmeceutical use requires release-control effects on active ingredients so that they remain at a constant level in the skin in order to preserve function for a period of time without repeated application of the product. The carrier system should also facilitate the ingredient penetration into certain layers of the skin, i.e., into vital epidermis and dermis but not into the blood circulation. The desired carrier system loading with the active ingredient should have a reasonably long shelf life, higher biocompatibility, and lower irritation properties. How to utilize carrier systems for each individual active ingredient and to overcome their limitations are concerns of further research.

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