

The Nanoparticle Controversy

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The skin care industry thrives on innovative ideas. These innovations may come in the form of raw materials, formulations, delivery systems, devices, or marketing ideas. Because marketing is an influential driving force behind cosmetics, the ability to claim a product's novelty leads to a competitive advantage. If consumers do not find a product that meets their expectations, they may welcome the opportunity to try something that is marketed as newer and more effective. Novelty also creates excitement in the press, which is always looking to increase readership by writing about new trends. No one wants to read about the old, thus encouraging the search for the new. Sometimes new is not completely new, but the old reinvented. This is the case with the "new" nanoparticles, which are finding their way into colored cosmetics, sunscreens, and cosmeceuticals. This article examines some of the issues regarding nanoparticles by first presenting a general background on the use of nanoparticles in the skin care industry and then presenting the controversy surrounding their use.

What Are Particles?

Particles are ground solids that form the powders used in skin care products. They are most frequently used in colored facial cosmetics that are applied to the face with a brush. These cosmetics include powders, eye shadows, blushes, and the new mineral facial foundations. These products are composed of particles of different sizes and ingredients in order to create a unique color or surface texture. For example, talc is a powder composed of particles that can camouflage imperfections, giving the skin a more even tone. If the talc is combined with iron oxide brown pigments, a facial powder is created. If the talc is combined with red pigments, a facial blush is created. The surface characteristics of the blush can be enhanced further by light-reflective particles, giving the skin an

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iridescent appearance. Particles form the basis for any facial cosmetic that is not a lotion or cream. However, colored facial cosmetics formulated as a lotion or cream are usually particles suspended in an emulsion.

How Do Particles Affect the Skin?

Particles can be applied to the skin with a brush or they can remain on the skin after the volatile vehicle evaporates. It is the architecture of the particle that will determine its interaction with the skin. If the particles are well constructed, like even spheres, they can create the illusion of smooth skin. Some of the newer moisturizing body lotions contain tiny polyethylene spheres, which are evenly distributed over the skin and left behind after the lotion dries. When the skin is massaged, the fingers rotate the spheres, reducing friction while creating the illusion of smooth skin. This is an illusion because the smoothness is not created by the intact stratum corneum barrier, but by the rotation of the spheres. Hence, the tactile effect is temporary.

On the other hand, rough-edged particles can create pruritus when the particles are massaged over the skin. The most commonly used rough-edged particles are ground nut and fruit materials, such as walnut shells or apricot pits. These particles are found in some natural exfoliating facial cleansers that are used to slough off desquamating corneocytes. However, rough-edged particles are sometimes found in iridescent materials used in mineral makeup. These particles are designed to create a glow and cosmetic interest. Because highly light-reflective mineral cosmetics contain rough-edged particles, individuals with sensitive skin cannot use them.

What Are the Cosmetic Benefits of Particles on the Skin?

Particles can provide many skin benefits. They form the basis for the currently popular mineral cosmetics. Mineral cosmetics are composed solely of particles that are dusted over the skin to add color and provide camouflage. The incidence of allergic reactions to these cosmetics is reduced because of the simple formulation, the absence of volatile vehicles, and the elimination of emulsifiers.

Mineral cosmetics do not remain on the skin as long as cream or lotion formulations, but they present a pleasant alternative.

Particles are also the basis for inorganic sunscreens, including zinc oxide and titanium dioxide. Zinc oxide and titanium dioxide are superb broad-spectrum sunscreens that are able to reflect both UVB and UVA radiation. They are available as micronized and microfine particles. Micronized particles are created by crushing a solid to yield particles of many different sizes. Particles of different sizes and shapes are more effective at reflecting light than smaller particles of the same size, also known as microfine particles. The problem with microfine and micronized particles is that they are visible on the skin. Although this is required in the realm of colored cosmetics, it is not a good quality for sunscreens, which are expected to be transparent. This desire for transparency has led to the design and production of particles of a smaller size, known as nanoparticles.

What Are Nanoparticles?

Nanoparticles are particles with a diameter of 1 to 100 nm and are commonly found in the environment as a by-product of fire or combustion. Nanoparticles are found in automobile exhaust, airplane exhaust, and general air pollution. We inhale nanoparticles every day in an urban environment and over time develop nanoparticle deposits on the walls of our alveoli. It is unknown if this is problematic.

What Are the Problems Associated With Nanoparticles?

There is a growing concern surrounding the presence of nanoparticles in the environment. These particles are invisible to the human eye and can penetrate the skin and lung tissues, gaining access to the lymphatics and entering blood circulation. From there, these particles can be widely distributed throughout the body. Once these particles enter the body, they cannot be removed. The medical community has voiced concern that nanoparticles found in metals may be responsible for neurologic diseases. Some scientists have wondered if chronic inflammation induced by nanoparticles causes other degenerative diseases.

At present, the main concern regarding nanoparticles is the use of nanoparticles of titanium dioxide and zinc oxide in sunscreens. Sunscreens are typically applied daily to exposed areas of the body, thus providing increased exposure opportunities. It is unclear exactly how titanium dioxide or zinc oxide nanoparticles might penetrate the skin. Some scientists believe

nanoparticles are able to penetrate through the pilosebaceous orifices, whereas others insist that the particles can enter between or through the corneocytes via passive diffusion. More studies need to be conducted using standardized methodologies to validate these conflicting opinions.

Nevertheless, the concern is over the effects of nanoparticles in titanium dioxide or zinc oxide once they penetrate the skin. Both titanium dioxide and zinc oxide are chemically inert. They are theorized to remain in the body indefinitely, either forming a reservoir within the dermis or spreading throughout the body via circulation. It appears that sunscreen particles are capable of absorbing and reflecting UV radiation within the skin, causing the generation of oxygen radicals within the dermis and initiating the inflammatory cascade. It is unknown whether the nanoparticle sunscreen reservoir might enhance the photoprotective abilities of the skin or prematurely age skin as a result of chronic low-grade inflammation characterized by unusually high levels of interleukins 8 and 12. This lack of understanding is the source of the controversy regarding nanoparticle use.

What Is the Industry Stance on Nanoparticle Use and Safety?

The cosmetic industry is responsible and has called for a halt in the widespread use of nanoparticles until more information can be obtained. No reputable manufacturer wants to put nanoparticles with long-term adverse health implications in the marketplace, even though there is no governmental organization forbidding their use. Nanoparticles offer tremendous opportunities for active and medication delivery that is substantial and long lasting. Nanoparticles could represent the most important discovery in skin disease prevention and treatment, or they could become a huge health menace.

What Are Some of the Uses for Nanoparticles in Skin Care Products?

As previously discussed, nanoparticles have primarily been investigated for use in sunscreens containing zinc oxide and titanium dioxide. However, nanodispersed organic sunscreen formulations containing benzophenone or octyl methoxycinnamate have also been created. All sunscreens containing nanoparticles carry the same health issues, such as unwanted penetration, since sunscreen actives are intended to stay on the skin.

For certain dermatologic conditions, enhanced penetration may be desirable. Consider the ability of nanodelivered salicylic acid or benzoyl peroxide to enter the

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pilosebaceous unit. This would allow very small concentrations of the active over-the-counter acne-fighting ingredients to reach the location of the *Propionibacterium acnes* organisms and more efficiently kill the bacteria, eliminating unwanted epidermal irritation. Topical antibiotics containing nanoparticles would create similar opportunities to improve the current treatment of acne. Very small quantities of targeted drug delivery would increase efficacy while reducing toxicity and side effects. The opportunities are tremendous.

Summary

Particles and their interactions with the skin are important issues of dermatology. The physical and chemical properties of particles create cosmetic and medical opportunities that are significant and unique. Particles are an indispensable component of all colored cosmetics and some sunscreen formulations; however, controversy arises when nanoparticles are applied to the skin. The safety of nanoparticles remains to be established, but the opportunities they create for novel formulations cannot be ignored. ■