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Review Article

Overview Of Nanotechnology

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ABSTRACT

Numerous advantages of nanotechnology depend on its capacity to modify materials at incredibly small scales to attain certain features that would significantly improve the materials science toolset. Considering the molecules and interacting groups of molecules in connection to the bulk macroscopic qualities of the material becomes necessary when controlling the underlying molecular structure, which provides control over the macroscopic chemical and physical properties. Physiological and medical applications necessitate both materials apparatus with a high degree of specificity to communicate with the body on a molecular (or subcellular) level. This may result in specialized clinical uses for cells and tissues that aim to acquire the most therapeutic results possible while limiting negative effects. The applications and main scientific and technological facets of nanotechnology are explained in this overview, along with some of its potential medical uses.

INTRODUCTION

Nanotechnology is merely the fundamental knowledge of how materials react or operate at the nanoscale (atomic, molecular, or subatomic level) in order to design and utilize structures, devices, and systems with special properties and capabilities. Nanotechnology focuses on manipulating matter structures that are between one and one hundred nano meters in size. When compared to the same material without nanoscale features, these particle size ranges are called nanoparticles because they may exhibit distinct properties and have an internal structure or one or more external dimensions on the nanoscale [1]. Nanotechnology has been used in skin preparations, cosmetics, and health goods for nearly 40 years. Nanotechnology has been used in several fields since 1959, including science, engineering, physics, chemistry, and biology. Around 4000 BC, the Egyptians, Greeks, and Romans recorded the use of nanotechnology, including the concept of creating hair dye with nanotechnology. [2] In order to produce nanostructured materials, some methods minimize

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raw ingredients. Based on their structure and function, these materials are categorized as dendrimers, carbon nanotubes, fullerenes, and quantum dots. Nano devices are tiny devices at the nanoscale, such as micro biviores and respirocytoses.

1. History of Nanotechnology:

Nanotechnology was founded by physicist Richard Feynman of the California Institute of Technology. He described nanotechnology as the miniaturization of maleria through the management and control of items on a small scale.

2. Method of Synthesis:

Nanostructured materials can be made in two basic ways: top-down and bottom-up [3]. The conversion of waste heat in nano machines into useful energy and improved power densities to maintain the storage charge utilized for various battery types with less flammable possibilities are both outcomes of nanotechnology. Additionally, solar film-based solar panels are being created by scientists that can be mounted on thin, light piezoelectric nanowires and machine casings to produce useful energy from wind, friction, and body heat to power mobile electronics [4-5]. Figure 1

3. Advantages of nanomaterials.

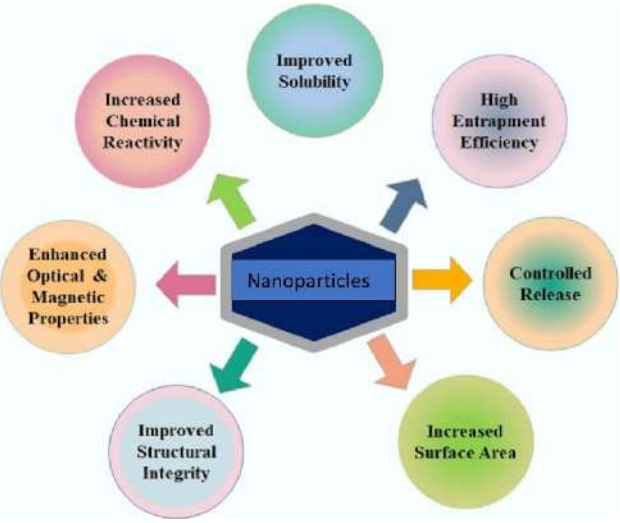

Fig 1. Advantages of nanomaterials.

4. Major Target areas where Nanotechnology Cosmetics are aimed at:

Cosmetics are considered to be the fastest-growing section of the personal care market. Skin, hair, nail, and lip care products contain a variety of nano cosmeceuticals. The primary classifications of nano cosmeceuticals are displayed in Figure 2[6] .

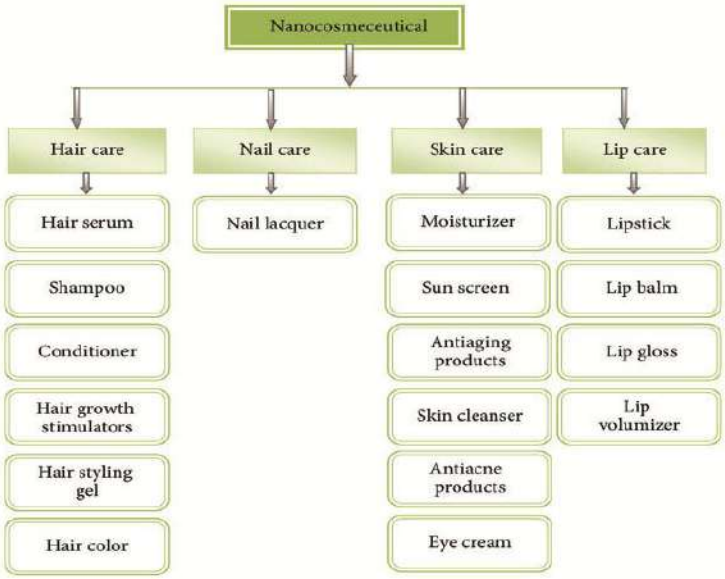

Fig 2 : Major Target areas where Nanotechnology Cosmetics are aimed

4.1. Skin Care:

Cosmetics for skin care products enhance the texture and functionality of the skin by

encouraging the creation of collagen and preventing the harmful effects of free radicals. By maintaining the structure of keratin, they enhance skin health. Zinc oxide and titanium dioxide nanoparticles are the most powerful minerals found in sunscreen creams; they protect the skin by penetrating its deep layers and also reduce the product's oiliness, odour, and transparency [7].SLNs, nano emulsions, liposomes, and niosomes are frequently used in moisturizing formulations due to their ability to build a thin layer of humectants and retain moisture for a long time. Commercially accessible antiaging nano cosmeceutical treatments that contain nano capsules, liposomes, nano somes, and nano spheres have shown benefits such as collagen renewal, skin rejuvenation, and skin firming and lifting [8].

4.2. Hair Care :

Hair nano cosmeceutical products include shampoos, conditioners, colouring, style treatments, and hair growth stimulants. Nanoparticles' unique size and inherent properties enable better active ingredient amount, hair follicle targeting, and shaft targeting. By creating a protective coating and maximizing resident contact time with the scalp and hair follicles, nanoparticles dissolved in shampoos retain moisture within the cuticles [9]. In addition to enhancing hair disentanglement, conditioning nano cosmeceutical chemicals also contribute gloss, softness, luster, and silkiness. Novel carriers such niosomes, liposomes, micro emulsion, nano emulsion, and nano spheres are primarily used to repair damaged cuticles, restore gloss and texture, and reduce oiliness, brittleness, and luster in hair [10].

4.3 Lip Care

The nano cosmeceuticals range includes lip balm, gloss, lipstick, and lip care products. A range of nanoparticles can be employed to make lipstick and lip gloss that soften and volumize lips by stopping transepidermal water loss [11]. They can help prolong the lips' color retention by preventing pigments from draining. In addition to moisturizing and contouring the lips, a lip volume sizer containing liposomes fills in the lip contour's wrinkles [12].

4.4. Nail Care :

Compared to traditional nail care products, nail care solutions based on nanocosmeceuticals are more superior. Improved toughness, quick drying, durability, chip resistance, and ease of application due to elasticity are some benefits of nail paints based on nanotechnology [13].

In order to cure toe nails caused by fungal infections, new techniques such amalgamating silver and metal oxide nanoparticles in nail paints offer antifungal qualities [14].

5. Applications of Nanotechnology in Medical and Healthcare :

The application of nanotechnology in physiology and medicine, according to Sahoo et al. [15], involves instruments and materials with a high degree of specificity for subcellular (i.e., molecular) interactions with the body. Nanotechnology is only one step away from nanomedicine, which can be defined as the molecular-level monitoring, maintenance, construction, and control of human biological systems using specially engineered nano devices and nanostructures, according to Bhattacharyya et al. [16]. It might be considered an additional use of nanotechnology in the field of medical sciences and diagnostics. One of the most important problems is getting drugs and other therapeutic substances into the patient's body in the right amounts. In the near future, one of the most important therapeutic uses of nanotechnology is expected to be the production of medications. In fact, there are already number of new applications [15,16].These applications are either developed for new techniques of controlled release, drug targeting, and recovery of medications with

restricted bioavailability, or they utilize the unique properties of nanoparticles as pharmaceuticals or drug-related substances on their own. To promote the absorption of a tumor rather than healthy cells, nanoscale polymer capsules, for example, can be designed to break down and release drugs by predefined charges and to allow for distinct releases under particular circumstances, such a corrosive environment." Medical tools, knowledge, and cures are currently being extended by the development of nanomedicine. Utilizing the inherent scale of biological phenomena, nanotechnology is being applied in medicine to provide precise solutions for disease prevention, diagnosis, and treatment. Improved imaging and diagnostic tools that boost treatment efficacy are just a few of the medical advancements made possible by nanotechnology. identifying the root cause of atherosclerosis, or the accumulation of plaque in arteries, treating it, and developing regenerative medicine—which entails growing new bone and brain tissue.

Drug delivery technique

Dendrimers are a specific class of nanostructure that may be carefully made and employed for a variety of applications, such as the treatment of cancer and other illnesses, according to Bhattacharyya et al. [16]. Multiple activities, such as identifying diseased cells, diagnosing disease stages, detecting cell death, delivering medications, reporting locations, and reporting therapy outcomes, can be carried out simultaneously by dendrimers carrying different materials on their branches. [17] Suri et al. describe how the use of nanoparticles in drug administration quantifies biodegradable materials, such as metals, lipids, natural or synthetic polymers, or both, that are smaller than 100 nm. Larger macromolecules may not be as well absorbed by cells as nanoparticles, which makes them potentially useful for effective administration and transportation. For medicinal applications, drugs might be incorporated into the particle matrix or attached to the particle surface. The destiny of a medication should be managed by a drug-targeting system once it has entered the biological environment. A great deal of research has been done on nano systems with different biological properties and compositions for use in gene delivery and medicine. The Park [18]. The application of nanotechnology in medication delivery has led to the possibility that the minuscule particles include unique characteristics that are equally present in vivo and in vitro when it comes to targeted drug administration to malignancies. There have been several formulations of nanoparticles developed and effectively tested in small animal models, however the results of these studies have not been properly transferred to human clinical settings. For translate on to be effective, it is essential to reevaluate the role of nanotechnology in drug delivery, understand the limitations of nanoparticles, recognize the pervasive myths in the field, and embrace difficult realities. Drug delivery can be greatly enhanced by focusing on pertinent issues, such as improving drug loading capacity, affinities for target cells, and spatiotemporal modulation of medication release, using nanoparticle approaches.[19]

6 Advances In Formulation Of Nanotechnology:

There are number of innovative cosmetic Delivery systems used in cosmetic products.

6.1 Nano emulsion :

Nano emulsions are particularly appealing for use in cosmetics because of their aesthetic qualities, which include low viscosity, transparent visual characteristics, droplet sizes below 200 nm, and a high surface area that facilitates the effective delivery of the active ingredient to the skin. Because nano emulsions don't naturally cream, sediment, flocculate, or coalesce like macro emulsions do, they are appropriate in cosmetics.

Using high energy equipment during manufacture can help prevent the incorporation of potentially irritating surfactants. Using nano gel technology to produce a tiny emulsion Figure 3:

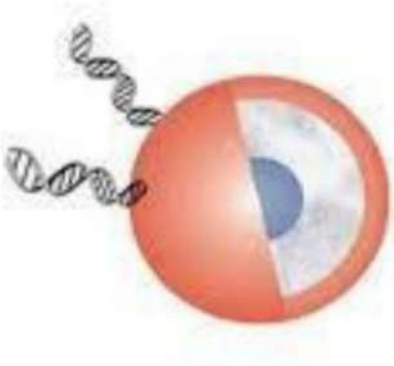

Fig 3 : Structure of Nano emulsion

Lipid Carrier Nanocrystals with Nanostructure Crystals smaller than 1 ?m are known as nanocrystals. They are collections of several hundred to tens of thousands of atoms that come together to form a "cluster." These aggregates typically have sizes in the range of 10–400 nm. Additionally, poorly soluble drug nanocrystals can be used in cosmetic products to give them a high penetration power through dermal application. The initial cosmetics were Juvena (rutin) in 2007 and La Prairie (oil-in-water concentrate) in 2008, which were designed to reduce trans-epidermal water loss and improve skin protection and active ingredient penetration. It would be helpful for moisturizing, anti-aging, and sun care products. It contributes to the pleasant skin feel of skin care formulations [20].

6.2 Nanoparticles:

Solid lipid nanoparticles (SLNs) are particles with a solid lipid matrix that are nano meters in size. They are lipid-based greasy droplets. whereby surfactants stabilize them and they are solid at body temperature. These days, silver nanoparticles can be found in toothpaste, face creams, soaps, food packaging, clothes, equipment, disinfectants, and bandages. Silver nanoparticles are highly effective at killing bacteria. Additional instances of nano cosmetic products that have been developed so far on Earth According to that research, nanoparticles are now present in almost all personal care products sold, including deodorant, body firming lotion, bronzer, exfoliating scrubs, eye liner, and styling gel. Shampoo, conditioner, foundation, moisturizer, anti-wrinkle cream, toothpaste, lipstick, blush, eye shadow, nail polish, perfume, and aftershave lotion[21].(hesperidin). Two plant glycoside antioxidants that were previously ineligible for topical application include rutin and hesperidin. As determined by the antioxidant action, they became dermally accessible after being formed as nanocrystals. The nanocrystals can be added to any topical cosmetic product, such as liposomal dispersions, lotions, and creams. Increased patient compliance, a sustained drug release, and a lower dose may all be possible using nanocrystals [22,23].

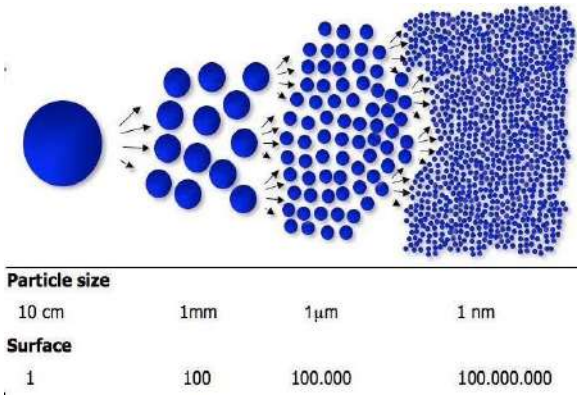

Fig 4 : Structure of Nanoparticles

6.3 Dendrimers :

Unimolecular, monodisperse, micellar nanostructures, dendrimers are around 20 nm in size. They have a high density of functional end groups at their periphery and a well-defined, regularly branched symmetrical structure. Usually, a dendrimer has a symmetrical core and a spherical three-dimensional morphology. The New Kome Dendrimer was synthesized in 1985 and was one of the first dendrimers. The usage of dendrimers in the cosmetics industry has also been contemplated [24]. Numerous patent applications

for the use of dendrimers in skin, hair, and nail care products have been submitted. There have been reports that dendrimers offer regulated.

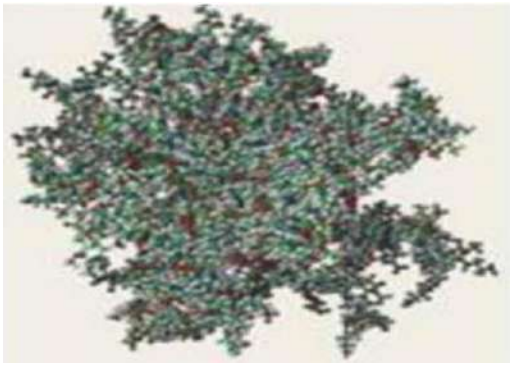

Fig 5 : Structure of Dendrimers

7. Advantages:

The goal of using nanotechnology in cosmetics is to boost the effectiveness of sunscreens, anti-aging treatments, and scents. A multi-component system is used to optimize manufacturing conditions for skin care formulations. To keep hair from going gray, to stop hair loss, and to keep active components like vitamins and antioxidants light and transparent. When used with organic sunscreens like 2-hydroxy-4-methoxy benzophenone, the concentration of the UV absorber can be decreased, improving UV protection. We discovered that nano zinc oxide is being utilized as a UV filter in sunscreen products, however this has not yet been thoroughly evaluated [25]. Nano materials used for this purpose must be evaluated separately. Another benefit is that the active ingredient is effectively transported to the skin by the tiny droplet's large surface area. In addition, nano emulsions are becoming more and more popular because of their unique bioactive properties. This could result in a decrease in trans epidermal water loss (TEWL), which would strengthen the skin's barrier function. Since there is no intrinsic creaming, sedimentation, flocculation, or coalescence that is seen with macro emulsions, nano emulsions are wipes for cosmetics and baby care is a relatively new but rapidly expanding application area remove [26].

8.Disadvantages:

The reactivity, chemical reactivity, and production of reactive oxygen species are all higher for smaller particles. It can cause inflammation, oxidative stress, and damage to proteins, membranes, and DNA. In human tissue and cell cultures, nanomaterials have been shown to be hazardous, leading to increased oxidative stress and cell death. Activated by photo Titanium dioxide nanoparticles have been shown to oxidatively damage DNA in human fibroblast cultures. Skin fibroblasts, nucleic acids, and human colon cancer cells were all poisoned by photo-activated titanium dioxide nanoparticles.

Pulmonary inflammation is caused by inhaled ultrafine particles, such as quartz, minerals, dust, coal, silicate, and asbestos. They can cause cytotoxicity, lung fibrosis, and possibly cancer [27, 28].

CONCLUSION:

Our nation's scientists and engineers are creating new uses for nanotechnology to improve our living conditions. These scientists envision a future where new materials with atomic and molecular precision provide useful, cost-effective means of using renewable energy sources and protecting the environment. Material characteristics can change significantly at the nanoscale. This has benefits that can produce positive outcomes, such as the growth of environmental compatibility. Given its benefits and range of uses, nanotechnology can be applied globally in a number of environmental domains, including waste management, water scarcity issues, air pollution control and reduction, and other situations as contemporary science

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