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# REVIEW:EMERGENCE OF NOVEL NANOPARTICLES AS UV ABSORBER IN SUNSCREEN AND THEIR APPLICATION

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***ABSTRACT***
*The sunscreen formulation safety is of high importance because of the diminishing ozone layer. Solid lipid nanoparticles (SLN) are introduced as the new generation of carriers for cosmetics, especially for UV blockers for the use on human skin and production thereof is described[1].Topical administration of drugs has advantages such as minimal systemic effects and targeting only the areas of disease (Ting et al. 2004). Nevertheless, the stratum corneum, is the non-viable upper layer of skin, is an resistance for the delivery of sufficient molecules at therapeutic levels. That's why the transport of drugs across the stratum corneum is complex processs (Kalia and Guy, 2001).*
*The dissolution and distribution extent of tropical agent through the skin depends on the ingredients chemical ingredents,on the encapsulation process ,on the size of nanoparticles and on the viscosity of the topical formulations. The polymeric nanoparticles show more effective properties like controlled drug release,drug adhesivity and time of its permanence in the skin. Briefly, the nanoparticles work as reservoirs of lipophilic drugs its delivery in the stratum corneum becoming an important scope to control their permeation into the skin.*

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## INTRODUCTION

Nanoparticles are particles that have one dimension that is 100 nanometers or less in size.The properties of many conventional materials change when formed from nanoparticles. This is typically because nanoparticles have a greater surface area per weight than larger particles; this causes them to be more reactive to certain other molecules.

**(Fig no.1)** Topically applied sunscreen

With the emergence of nanoparticles in pharmaceuticles,it's utilization in various field spread very widely.It influence drug penetration and transport across the membrane in cosmetics products.Use of nanoparticles in sunscreen formulations(work as protector against UV radiations) turned into a new era in sunscreen.These formulations have been researched to be meaningfull over broad spectrum UV protective having greater photostability.Various organic and inorganic component act as chemical or physical protective.Certain limits are found with organic components in their UV protection and photostability.New research such as solid lipid nanoparticles polymeric nanoencapsulation and cyclic compound highlight new ideals in UV protection.

Exposure to sunlight(UV radiation) prominently result into damage skin surface. UV radiations may be classified as on the basis of its effect on human health -

UV- A (long wave) - 400 nm–315 nm

UV-B (medium wave) - 315 nm–280 nm

UV C (short wave) - 280 nm–100 nm

The portion of the sunlight that is filtered or blocked is ultraviolet radiation. There are three regions of ultraviolet light.

UV-A penetrates deeply into the skin and can lead to cancer and premature skin aging.

UV-B is involved in tanning and burning of your skin.

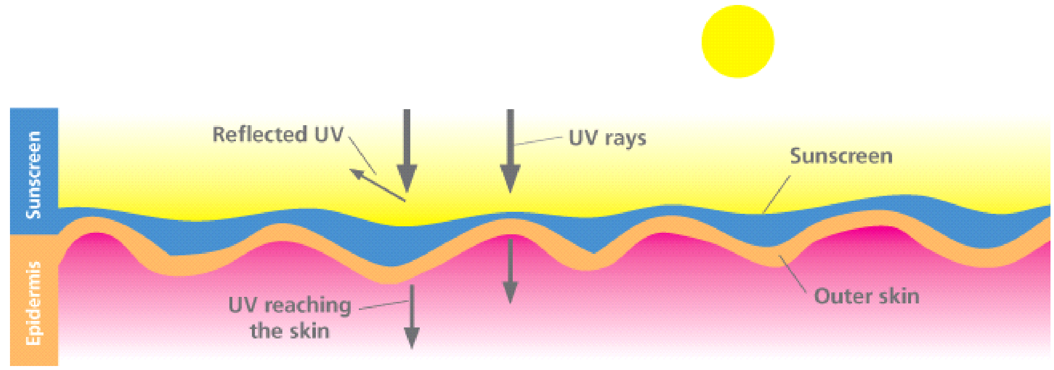
UV-C is completely absorbed by the earth's atmosphere

UV-A and UV-B that reach the earth contribute to the health risk that result due to over exposure to the sun. 99% of the ultraviolet radiation that reaches the earth is UV-A. Wavelength of sunlight are broadest spectrum of UV radition.Protection against above range of long,medium,short wave radaition may result in advancement in sunscreen formulation success.

In this review some of the commencement in UV protective nanoparticles,nanocapsules and nanocomplexation are examined that may provide novel pathway for future studies.

Factors affecting nature of sunscreens -

- Sunprotection factor
- Ability of sunscreen to protect skin
- Water resistance




Three things to look for in a sunscreen

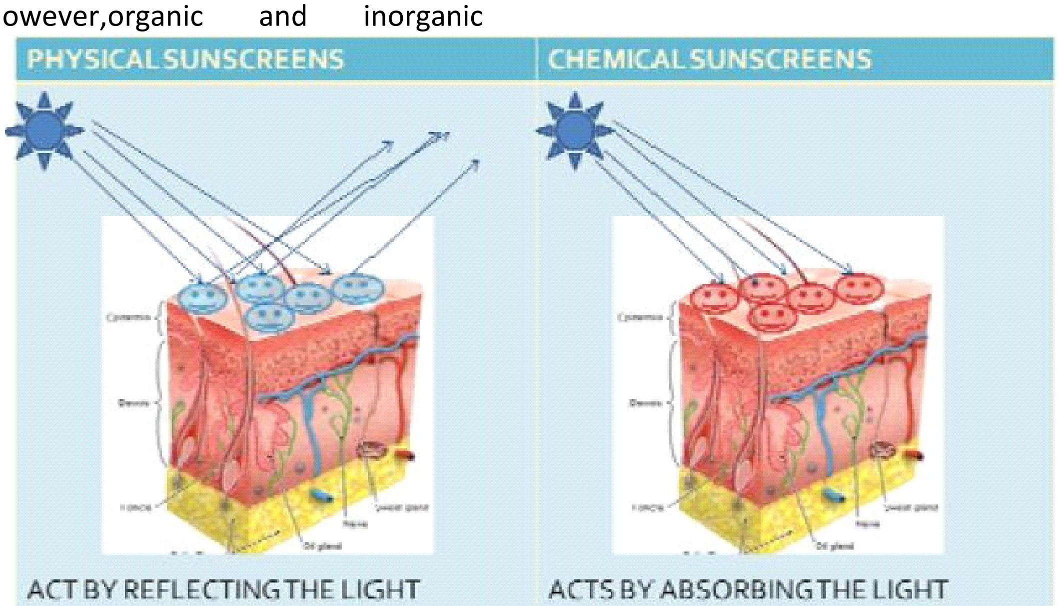
| | |
|---|---|
| SPF (Sun Protection Factor) 30 SPF Protection | • SPF is the ratio of UV radiation required to redden the skin with a sunscreen to that required without a sunscreen<br>• It is a standard laboratory method to measure SPF – not real time in the sun<br>• It is the number of times longer that you can be exposed to the sun when wearing a sunscreen before you experience the same effect as not wearing a sunscreen<br>• Eg. SPF 30+ gives you > 30 times your skin's natural sunburn protection |
| Broad Spectrum UVA Broad Spectrum | • Broad spectrum refers to the ability of a sunscreen to protect against the sun's UVA rays<br>• It is a Yes/No rating – the product is either broad spectrum or it is not<br>• Where the SPF measures the amplitude of protection, broad spectrum measures the breadth of protection |
| Water Resistance 4 HOURS Water Resistance | • Water resistance is the time for which a person can be immersed (eg. swimming pool) while maintaining the labelled SPF when evaluated immediately after immersion<br>• Eg. If the water resistance claim is 4 hours, then SPF tested after immersion will still meet the claimed SPF factor required |

**(Fig.no 2)** Factors that affect sunscreen working are sun protection factor,wide capability to provide protection from UV rays and resistance towards water

## DISCUSSION

Sunscreen lotions and sunscreen foundations are some commonly use formulations as UV protective.These formulations mainly comprises of organic and inorganic components.However,organic and inorganic components differ in mechanism as UV protector.

- ❖ Organic component – work as chemical sunscreen – absorb UV radiation
- ❖ Inorganic component – work as physical sunscreen – reflecting and scattering UV radiation




**(Fig no.3)** Basic mechanism of working of inorganic and organic sunscreens.

Sunsceen cover the stratum corneum covering(upper epiderml layer of skin) and provide shielding to layers of skin.Whereas the direct cause of skin carcinoma is still a cause of discusstion.[3-5]Sunsceen works by-

- refleting and scattering UV rays
- absorbe UV wavelengths
- posses stabilizing process .

Organic sunscreen component -

Organic sunscreens are conjugated systems that absorb UV light and release the absorbed energy in the form of heat. The following compounds are examples of common organic sunscreens.

FDA approved Sun protection compound and formula %

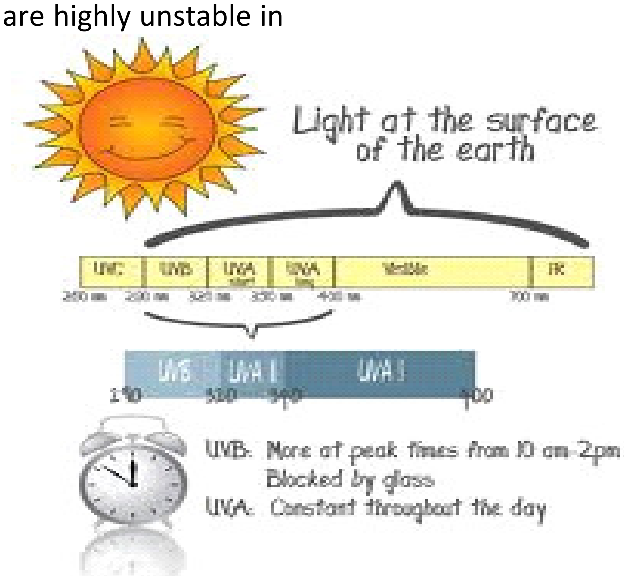
- Synthetic Benzene –based Sunscreens
  p-aminobenzoic acid (15%)
  avobenzone (3%)
  cinoxate(3%)
  dioxybenzone(3%)
  ensulizole(3%)
  oxybenzone(6%)
- Mineral pigment sunscreen
  Zinc oxide

Titanium dioxide

- Avobenzone - Oil-soluble and used as broad spectrum of UVA rays absorber.However as avobenzone molecules are highly unstable in the presence of sunlight it is often used in combination with a photo stabilizer in sunscreen formulations [4, 5]
- Oxybenzone - Absorbs UVA radiation. Partially harmful and photocarcinogen. Derivative of benzophenone, a well known photo-carcinogen [3].
- Ensulizole - More effective against UVB less to UVA radition. Aqueous-soluble and use for inhancing non-greasy,shoft feeling. [8].
- Octinoxate - Absorbs UVB radiation. Minimise scars apperance. Water-insoluble property, make it beneficial in waterproof formulations [9].
- Octisalate - Product of condensation of salicylic acid with 2-ethylhexanol. The salicylate portion of the molecule show function of absorbing UV radiation, whereas the ethylhexanol portion adds water proof property.[10]

Advantage-

Abundant organic components are used in sunscreen formulatons.Organic components show major category of excipient in comparison with inorganic components.This provide manufacturers good options towards formulation of sunscreen.Various SPF available in market such as SPF 45,70 are product of diversity in organic components use for sunsceen formulation.




**(Fig no.4)** UVB and UVA shows variation in wavelength in day and night time.

Disadvantage -

However,because they absorb UV radiation rather than reflecting and scattering radition result in its failure.The only indicatior of sunscreen efficacy is the SPF(sun protection factor).This represent a major problem because sunsceens are unable to reflect the degree of UVA protection as offered by the manufacturer.[11]

Avebenzone marked as promenant UVA protector in sunscreen formulation for some time.With new orgnic ingredients development new UV filters developed,examples,

- UV filter - Other name
- Oxybenzone - Benzophenone-3, Eusolex 4360, Escalol 567
- Homosalate - Homoethyl salicylate,HMS
- p-Aminobenzoic acid - PABA
- Cinoxate - 2-Ethoxyethyl p-methoxycinnamate

That act more effectively as UV protector and photostabilizer along with avobenzone than lonely avobenzone.Creating a synergistic effect for superior quality of UVA protection[11-12]

Inorganic nanoparticles

Use of nanoparticle as sunscreen ingredient over bulk form of sunscreen show certain advancement.Such as nanoparticles applied on stratum corneum reflect/scatter most incoming UV radition.Commonly used inorganic nanoparticles are Titanium dioxide and zinc oxide.

Titanium dioxide obtain from nature as well-known minerals rutile, anatase and brookite.It's ultra-fine naoparticles use in preparation of sunsceen particle size range from 10-60nm.[13] The TiO2 nanoparticles had penetrated the outermost layers of skin through mechanical action and no diffusive transport had taken place. Deep penetration had occurred into the hair follicles, but this would be cleared through the natural excretion of sebum.Particles form aggregates that increase their reflection and scattering nature.

In sunscreens formulation,$TiO_2$ is coated with silicon oils,$SiO_2$ or $Al_20_3$ to make it more effecient and improve disperstion.[13,14]

Zinc oxide is another well known mineral use to prepare ultrafine nanoparticles.Particle size range from 20-80nm.[15] ZnO is also coated with silicon oils,$SiO_2$ or $Al_20_3$ in sunsceens.

Depending upon sunsreen user requirement ZnO or $TiO_2$ formulation can be given priority.ZnO is more transparent and covers almost complete UVA spectrum.[16]

Alternatively, $TiO_2$ provide much greater SPF than ZnO.

Advantage-

Inorganic components used in sunsceen are found to be more effective than organic because they absorb,reflect or scatter UVR rather than absorption as in organic.Inorganic components provide broad spectrum of protection,that simplify the sunscreen formulation by minimizing organic ingredients.Transparaency property of inorganic sunscreen formulation make it 1st choice.[5]

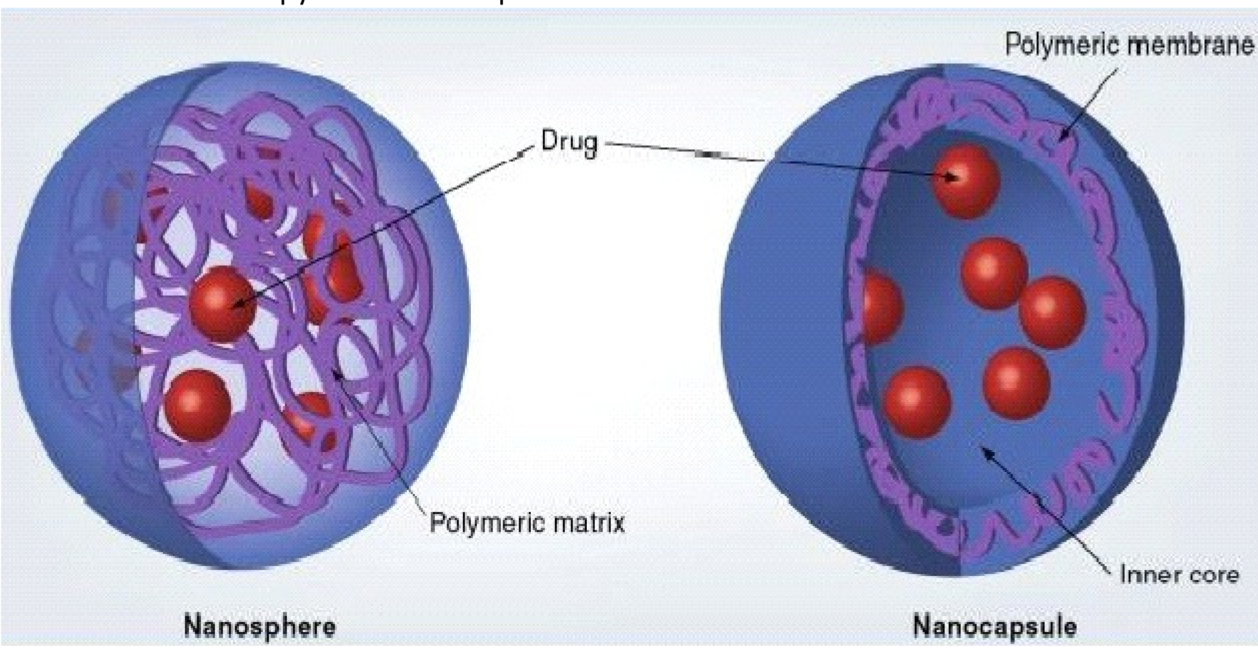

**(Fig no.5)** Various sunscreen formulations

Disadvantage-

Inorganic components requires additional material for coating to show better disperstion.[16] Direct exposure of inorganic component with UV radiation can leads to oxidation and result in release of free radicals,that can produce harmfull effect (photorective nature).Thus coating is essential need for inorganic component.[3-5,17] DNA,RNA and their bases pyrimidine and purine posses damage on exposure to UVA and UVB radition in contact with inorganic sunscreen agents.[18]

Nanoencasule -

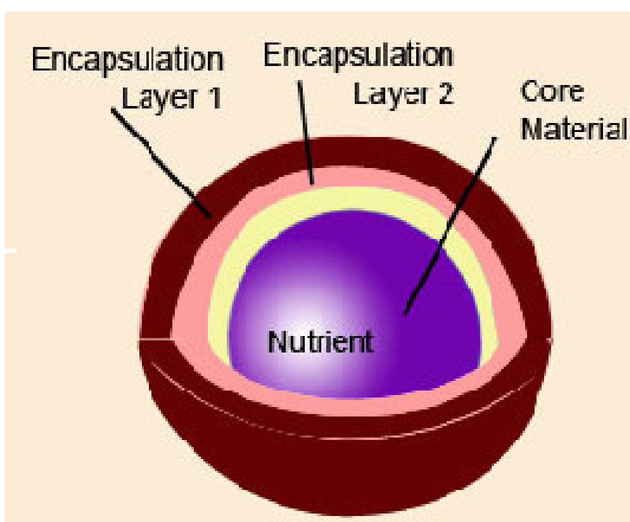
SLN(solid lipid nanoparticles) is a spherical lipid monolayer that encapasulate a solid lipid core.SLNs were developed in early 1990s.Introduced as a novel carrier system for drugs and cosmetics .[19]




(Fig no.6) Nanosphere and nanocapsules particles

SLN are well known in field of pharmaceuticals and drug delivery.[19,20] Additional characters of nanoencapsules that make them more beneficial.

- pre-determine doses
- disperstion
- high loading capability
- and biocompatibility
- structure stability [20]




**(Fig no.7)** Nanoencapsules various layers

Nanoencapsule promient sunscreen concern following jobs -

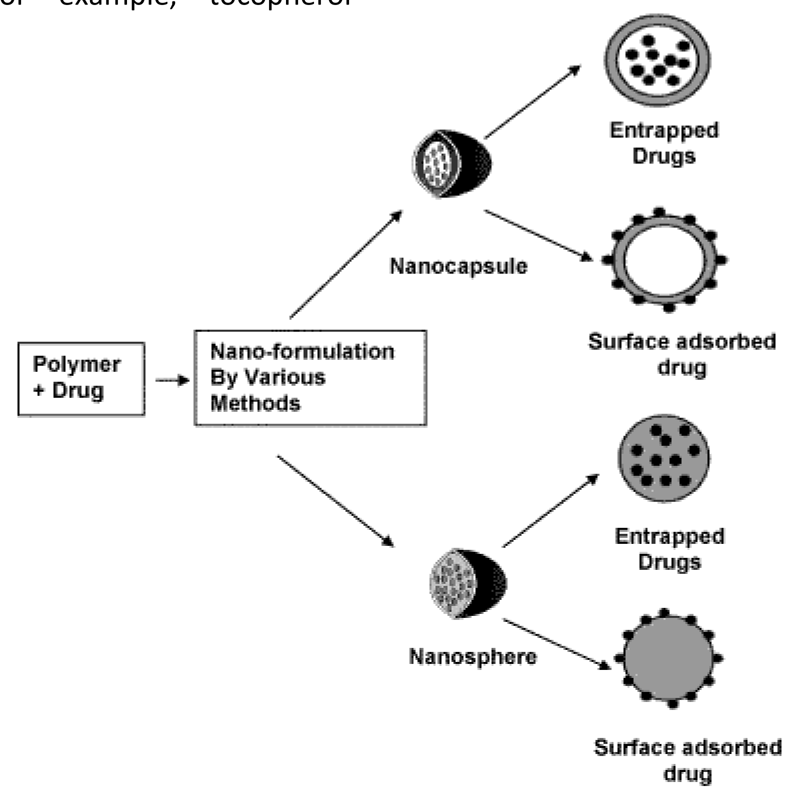
- skin hydration
- skin softing
- skin whiting effect
- chemical stabilety
- UV shielding[19,21,22]

SLN follow zero order reaction(control drug release system) thus release less sunscreen formulation in given time,i.e a advantage beside o/w emulstion.A long lasting effect is produce by solid lipid nanoparticles.The crystalline cetylpalmitate SLN particles represent property of physical blocker of its own without any help of molecular sunscreens.[23]

Althrough SLN found to produce synergistic effect as UV protector and photostability along with chemical sunscreen for example, tocopherol acetate.But merely commercially no product found in market.This advantage leads to decrease in photo-carcinogenic ingredients in sunscreen without ignoring SPF.[24] Crystalline property of SLN block UV radition by reflecting and scattering UV rays.Thus more crystalline SLNs have greater capability to reflect or scatter radition.[25]

Polymeric nanoprticles -

Polymeric nanoparticles intended for cutaneous delivery are prepared with biocompatible. Polymers generally presenting particle diameter around 200 to 300nm.The penetration and transport extent of these system through the skin seem to be mainly depending on the chemical composition of ingredients,on encapsulation mechanism,which by consequence,infleunce the drug release mechanism, on the size of nanoparticles and as much as on the viscosity of formulation.




**(Fig no.8)** Method of nanocapsule and nanosphere prepration.

Polymeric nanoparticles provide cutaneous delivery are embeded with biocompatibile polymer.Factors affecting performance of nanoparticle :

a)encapsulation mechanism
b)chemical composition of ingredients
c)drug release mechanism
d)viscocity of formulation
e)size of polynanoparticle

Nanoencapsulation of octinoxate using PLA show better result of photostability.[26]Further studies that encapsulate by octinoxate along with poly-d,l-

lactide-co-glycoside(PLGA) show better photostability than octinoxate alone[27]
Lee et al. show avobenzone when encapsulate by poly (methyl methacrylate) have greater UV protection and very stable sunscreen[28]
Cyclodextrin complexation -
Cyclodextrin cyclin oligosaccharides consist of five or more α-d-glucopyranoside units.They are found in three natural forms α,β and γ and consist of hydrophobic lumen in their ringed structure[29] Cyclodextrin help in protecting from oxidation and improving photostability [30,31] Cyclodextrins when complexed with ibuprofen has been proved in reducing the damage caused by UV rays,also reduce epidermal lipid damage.
Complex of ibuprofen and ecthydroxy propyl beta cyclodextrin enhance UV protection.[32]
Mycosporin like amino acids
Corals and other tropical symbioses are often induced under condition of UV exposure and have been implicated in the prevention of UV damage and oxidative stress in marin algal
invertebrates endosymbiosis.Marine algae synthesize mycosporin like aminoacids
that efficiently absorb UV radition between 310 and 360 nm.[ 33,34 ]

**(Fig no.9)** Coral reef

MMAs are a likely natural sunscreen additive because of their ability to absorb UV radition and strong photostability.MMAs require sunlight,oxygen and strong strenght photostability agent like sea water for photodegration to take place.[35-37]

**CONCLUSION**

Althrough nanoparticles sunscreen are most commonly used these days and are found quite effective.Some researchers view are against its use. Researchers Cyndee Gruden and Olga Mileyeva-Biebesheimer from the University of Toledo added large amounts of nanoparticles in water containing enoromous bacteria. The bacteria were grown in lab and treated with green fluorescent give raise to titanium dioxide(use in sunscreen).Titanium dioxide frequently reduced biological roles(metabolism) of bacteria within less than an hour of exposure.These effect blow an alarm towards elimination of microbes that play vital roles in ecosystem. [38]
Nanotechnology is a example of human playing with fire: It needs excessive care and restraint, whereas on the other side, playing with fire is perhaps one of the very special quality that defines us as humans.
Some cosmetics companies are found to say no to nanoparticles,examples
Lavera
Alba Botanica
Black Opal
Allergan[39]
Biochemical defence towards photochemical damage resulted by UVB and UVA radition mediate by reactive oxygen species are essential

requirement of human nowdays.That make humans to ignore harms caused by nanoparticles.

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