

Nanotechnology & Sunscreens



a consumer guide for avoiding nano-sunscreens

August 2007



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Friends of the Earth would like to thank the following individuals and institutions that make our work possible: Anonymous, Appleton Foundation, Changing Horizons Fund at Rockefeller Family Fund, C.S. Fund, and Newman's Own.

Design and layout by Natalie Lowrey.

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nanotechnology & sunscreens

A Consumer Guide for Avoiding Nano-Sunscreens

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Applying sunscreen at the beach. Photo: Inkastudio, www.yu4you.com.

Sun worshippers beware. While slathering up with sunscreens to block dangerous ultra-violet (UV) rays you may be exposing yourself to a new danger. Sunscreen manufacturers are adding nanoparticles to sunscreens to make sun-blocking ingredients like titanium dioxide and zinc oxide rub on clear instead of white. These nanoparticles are being added without appropriate labeling or reliable safety information. To cut through the confusion Friends of the Earth asked more than 120 sunscreen manufacturers to describe their companies policies regarding nanotechnology and whether their products contain nanoparticles. Only nine manufacturers said they were selling products that are nanoparticle free, 24 were found to have sunscreen products that contained nanoparticles and 95 brands have policies and ingredients that were unclear or chose to not respond to our survey. This underscores the need for labeling requirements and regulation, and for consumers to pay attention to which sunscreens they wear.

introduction

Summer is supposed to be a time for fun—for getting out of the house and going to the beach or pool or enjoying a sunny day in the park. Yet, while the sun's rays can put a smile on your face, without protection, overexposure to the sun can also lead to skin cancer and other diseases. Naturally people turn to sunscreens to protect themselves from sun exposure. Unfortunately in recent years, some of these sunscreens have begun to present problems of their own, created by a new form of technology called nanotechnology.

Many sunscreen manufacturers are now including potentially dangerous manufactured nanoparticles in their sun care products. Nanoparticles are manufactured through nanotechnology, a radical new platform technology that involves the manipulation of materials at the tiny scale of atoms and molecules. "Nano" is considered anything measuring less than 100 nanometers (nm); one nanometer is one billionth of a meter. For example, a human DNA strand measures about 2 nm in width. A human hair is huge by comparison, about 80,000 nm thick; the head of a pin is about 1 million nm across.

While nanoparticles are invisible to the human eye, their potential health impacts are huge. Materials engineered or manufactured to the nano-scale exhibit different fundamental physical, biological, and chemical properties than bulk materials. One reason for these fundamentally different properties is that a different realm of physics, quantum physics, governs at the nano-scale. But just as the size and chemical characteristics of manufactured nanoparticles can give them exciting properties for manufacturers, those same new properties—tiny size, vastly increased surface area to volume ratio, high reactivity—can also create unique



Father rubbing sunscreen into his sons shoulders. Photo: Jaimie Duplass.

and unpredictable human health and environmental risks. These potential hazards stem from nanomaterials' unprecedented mobility and enhanced toxicity.

Nanoparticles can potentially wreak havoc on our health if absorbed through the skin. Unlike larger particles, nanoparticles can enter vital organs, tissues and even our bodies' cells. While we still don't have a very good understanding about what levels of nano exposure might be unsafe, available scientific studies have shown that nanoparticles used in sunscreens can cause severe damage to our DNA¹, disrupt the function of our cells², and even lead to cell death³.

Despite these concerns, many sunscreen manufacturers still choose to "enhance" their products with nanoparticles even though these particles are not necessarily more effective at blocking radiation from the sun. In fact, Consumer Reports recently tested nanoparticle sunscreens and found no correlation between their presence and sun protection⁴. The reason manufacturers are lacing their sunscreens with these particles has more to do with marketing: the size-dependant optical properties of nanoparticles make the sunscreens transparent, or "cosmetically clear," and therefore presumably more desirable for consumers.

Even though nanoparticles might be dangerous, it's not wise to just stop using sunscreen. Skin cancer is the most common type of cancer in the United States. According to the National Human Genome Research Institute, an estimated 40 to 50 percent of Americans who live to age 65 will have skin cancer at least once⁵, so there are plenty of reasons to use sunscreen. The key is to know what's in your sunscreen—to ensure that it's nanoparticle-free.

Friends of the Earth's nano-free sunscreens guide

Friends of the Earth's consumer guide to nano-sunscreens surveyed more than 120 sunscreen manufacturers to ask them whether their products contain nanoparticles and what safety testing they have carried out.

Our guide ranks brands along a color-coded scale, from Green (Nano-Free) to Yellow (May Contain Manufactured Nanoparticles) to Red (Contains Manufactured Nanoparticles), depending on manufacturers' policies and the information we received. Companies were generally hesitant to share information about their products and only a few brands that use nanoparticles responded to our survey. Information about companies in the Red part of our guide was mostly gathered from the Woodrow Wilson Center's Project on Emerging Nanotechnologies' Inventory of Nanotechnology Consumer Products⁶. The Red list highlights specific sunscreens within brands that are certain to contain nanoparticles. However, carefully note the brand name next to the specific sunscreen name, because although the

nano content of other products in a brand line remains unknown, there is a good chance that more than one product in a brand line uses nano ingredients.

The government doesn't currently have any standards for which nanoparticles can or can't be used in cosmetics and sunscreens. Nor is the government funneling much money toward relevant risk research. In the absence of adequate government oversight, safety testing and comprehensive product labeling, this guide can help you make smart choices based on which products you can trust to be nanoparticle-free.

Sunscreen manufacturers are increasingly using this unregulated nanotechnology to reduce the size of titanium dioxide (TiO₂) and zinc oxide (ZO) (sun-blocking minerals widely used in sunscreens), which makes them clear instead of solid. While perhaps aesthetically preferable, the mostly cosmetic benefits of nanoparticle sunscreen do not outweigh the potential health risks involved in their use.



Woman rubbing sunscreen into her face. Photo: Carme Balcells

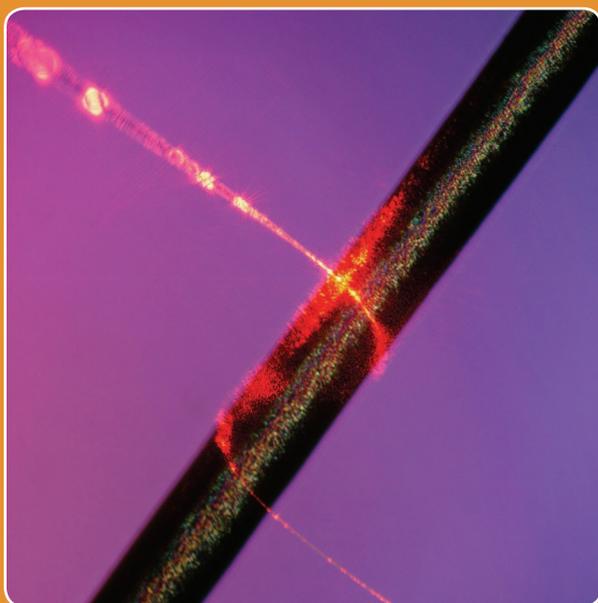
defining nanotechnology

Nanotechnology is a new science involving the manipulation of materials at the scale of atoms and molecules. The unit of measurement for the nanoscale is a nanometer (nm), which is one billionth of a meter – extremely tiny stuff. By way of comparison, a human hair cell is a whopping 80,000 nm wide.

However, “nano” does not simply mean tiny; rather, it is best understood to mean fundamentally different: materials engineered or manufactured to the nano-scale exhibit different essential physical, biological and chemical properties than their bulk material counterparts. For example, when a material is engineered to the nanometer-level it becomes much more reactive due to its exponentially increased relative surface area. Nanomaterials can also have very different and unpredictable optical, magnetic and electric properties, in part because quantum physics effects come into play at the nano-scale.

Sunscreens and cosmetics are only the tip of the experimental iceberg for this new science. Nanotechnology is increasingly used in a wide variety of applications including food production and food packaging. And the technology could potentially further affect our lives – from crippling our security and privacy with the creation of never-before-seen weapons and surveillance systems to altering the fabric of the clothes we wear and creating batteries from viruses constructed at the nano-scale. For more information on Nanotechnology visit:

<http://www.foe.org>
<http://nano.foe.org.au/>

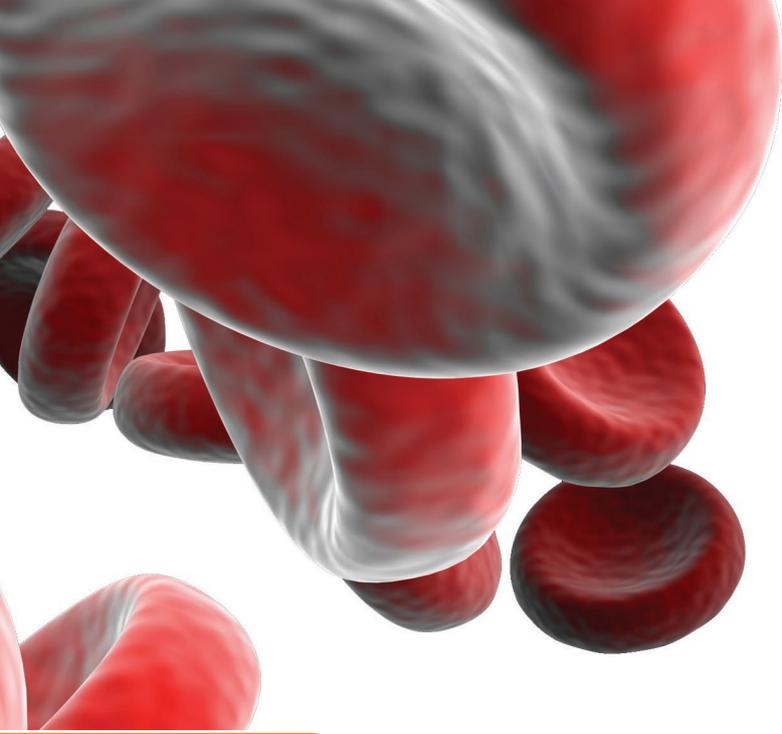


A light-conducting silica nanowire wraps a beam of light around a strand of human hair. The nanowires are flexible and can be as slender as 50 nanometers in width, about one-thousandth the width of a hair.
Photo: Limin Tong/Harvard University.

risks to human health

Manufactured nanoparticles present novel health and environmental risks that cannot be predicted from conventional materials. First, nanoparticles have unprecedented access to the human body. Unlike larger particles, once in the blood stream, nanoparticles have the ability to enter vital organs including the brain, heart, and liver, where they may disrupt normal cell activity⁷. When ingested, some nanomaterials may pass through the gut wall and circulate through our blood⁸.

Crucially for the use of nano-sunscreens, the jury is still out on how readily and how deeply nanoparticles penetrate skin. The ability of nanoparticles to be taken up through the skin and to access the blood stream remains poorly understood, although there is growing evidence that some nanoparticles may penetrate intact skin⁹. Studies have also shown that particles 1,000 nm in size can cross human skin and gain access to the dermis (the lower or inner layer of the two main layers of tissue that make up the skin),



Blood cells. Photo: James Steidl.

from where they can access the blood stream¹⁰. Skin uptake of these larger particles is increased with flexing and massage¹¹. Furthermore, broken skin is an ineffective barrier and enables particles up to 7,000 nm in size to reach living tissue¹² (keep in mind that nano TiO₂ and ZO are under 100nm). This suggests that the presence of acne, eczema or shaving wounds is likely to enable the uptake of nanoparticles. Additional research into the influence of skin condition, including sun burn, on the uptake of nanoparticles found in sunscreens is needed.

Once inside cells, laboratory studies have reported that many types of nanoparticles interfere with normal cellular function, and cause oxidative damage and even cell death¹³. These studies have found that other consequences of the use of nanoparticles can include increased oxidative stress, inflammatory cytokine production, and DNA mutation and even cell death¹⁴ – a full out attack on our bodies. Unlike larger particles used in conventional sunscreens, evidence from laboratory studies shows that some nanoparticle types may also be transported within cells and be taken

up by cell mitochondria¹⁵ (the principal energy source for cells) and cell nuclei¹⁶, where they can induce major structural damage to mitochondria¹⁷, cause DNA mutation¹⁸ and even result in cell death¹⁹.

Consumers need be aware that just because their skin is not burning thanks to nano-sunscreen, does not necessarily mean they are avoiding skin cancer. In fact, the International Agency for Research on Cancer (IARC) has classified titanium dioxide as a possible carcinogen for humans, based on rodent data²⁰. Nanoparticles are much more likely than larger particles to form free radicals²¹. Free radicals cause damage to DNA and can harm our delicate skin in many ways²². Titanium dioxide nanoparticles used in sunscreen can form free radicals in skin cells²³, especially when skin is exposed to UV radiation²⁴. This means that the process of skin-damaging free radical formation is further propelled when we wear nanoparticle titanium dioxide while in the sun²⁵. While these ingredients can save us from short-term sunburn they could at the same time have other damaging long-term effects on our skin.

Nanoparticles can also become toxic vehicles by binding to other foreign materials and “piggy-backing” on them into organs and sensitive areas that cannot normally be accessed²⁶. This means that even if titanium dioxide nanoparticles are unable to penetrate skin, they could still be hazardous when ingested in other ways, such as through the mouth when sunscreen is rubbed on child’s face. Personal care products may also be inhaled and are often ingested. Some figures show that over a trillion particles of titanium dioxide are ingested per person per day²⁷; because these are mainly either untested or unsafe materials, consumers will want to think twice before smearing them onto their skin and their children’s skin.

(For more reading on nanotoxicity and skin penetration check out <http://nano.foe.org.au/node/154> on the web)

worker safety and environmental health

It's often an afterthought that a consumer product potentially harmful to our bodies can also have equal or even greater negative consequences for the environment and those who actually create the product, such as workers who manufacture, research, package, handle, transport, use and dispose of nanomaterials.

The limited amount of peer-reviewed scientific studies on the health and environmental impacts of nanoparticles on the public, workers and ecosystems impedes our understanding of the full scope of consequences involved in the release and use of nanoparticles. However, there is scientific evidence that shows nano-ingredients in sunscreens could possibly harm both the environment and workers.

Substantial concerns have been raised regarding worker exposure to possibly toxic titanium dioxide nanoparticles while manufacturing sunscreens and other products that require the use of these ingredients. The International Agency for Research on Cancer (IARC) has classified titanium dioxide as a possible carcinogen for humans²⁸. The IARC's classification is based on specific evidence including a study showing that titanium dioxide dust caused respiratory tract cancer in rats²⁹, based primarily on inhalation and intratracheal installation studies. Major worker safety agencies in Canada have already alerted manufacturers to take action to protect workers from possible titanium dioxide toxicity based on the IARC conclusions.

While the U.S. National Science Foundation estimates that by 2015

nanotechnology industries will employ two million workers globally³⁰, there are still no existing occupational safety and health standards that specifically address nanotechnologies and nanomaterials, and there are no methods for limiting, controlling, or even measuring human exposure to nanomaterials in the workplace.

Studies have also raised red flags about the environmental impacts involved in the release of nanomaterials. Once loose in nature, nanomaterials constitute a completely new class of manufactured non-biodegradable pollutants. Similar mobility, durability, and toxicity concerns from nanomaterials apply to the environment. For example, a recent study demonstrated that some forms of titanium dioxide nanoparticles (popular ingredients in nano-sunscreens) are toxic to algae and water fleas, especially after exposure to UV light³¹.

The United Kingdom's Royal Society has recommended that:

Until more is known about their environmental impact we are keen that the release of nanoparticles and nanotubes in the environment be avoided as far as possible. Specifically we recommend as a precautionary measure that factories and research laboratories treat manufactured nanoparticles and nanotubes as hazardous, and seek to reduce or remove them from waste streams⁵².

However, despite the widespread commercial use and disposal of nanomaterials, we still lack the capacity for detecting, monitoring, measuring, or removing or filtering nanomaterials in the environment. When we consider the frequency with which sunscreens are washed off while swimming or in the shower, it becomes quite clear that choosing to use nano-sunscreens could compromise the health of the ecosystems we live in.



Fun in a swimming pool on a summers day. Photo: Studio One.

don't depend on your government because governments have yet to regulate nanotechnology

The Royal Society and the Academy of Engineering (UK) have warned governments that nanoparticles should be treated as new chemicals, and sunscreens and cosmetics containing nanoparticles should be subject to rigorous safety testing prior to commercial release. However, to date, sunscreen and cosmetics manufacturers in the United States are still not required to identify nanoparticle ingredients on product labels or to conduct new nano-specific safety tests on these ingredients. No government has yet established regulation to protect consumers from nanotechnology's risks or even allow the public to make informed choices through proper labeling. Until governments act, consumers should be wary and should inform themselves as best as they can.

With regard to sunscreens, choosing between protecting your skin from cancer and protecting your body from potential harm from nanoparticles shouldn't be a choice you have to make for yourself or your family. And thankfully it isn't—as long as you stay informed about what's in your sunscreen. Until government safeguards are in place to monitor nanotech's risks, you can, for the time being rely on this guide to avoid nano sunscreens.

A recent report from the Woodrow Wilson International Center for Scholars Project on Emerging Nanotechnologies, entitled *EPA and Nanotechnology: Oversight for the 21st Century*, explains how the U.S. Government is currently incapable of providing necessary oversight regulation for nanotechnology. According to the

report, authorities within the Environmental Protection Agency (EPA) and the Food and Drug Administration (FDA) with potential for regulating nanotechnology are deficient and incapable of doing so. The report outlines numerous steps that Government has yet to take in order to protect the public, workers, and the environment from potentially hazardous nanotechnology³³.

But we aren't just standing by and letting those agencies charged with protecting public health and the environment continue to ignore these potential risks. In May 2006, a coalition of public interest organizations including Friends of the Earth and led by the International Center for Technology Assessment (ICTA) filed the first-ever U.S. legal action on the potential human health and environmental risks of nanotechnology³⁴. The legal petition filed with the Food and Drug Administration (FDA) demanded that the FDA comprehensively amend its regulations to address the unique human health and environmental risks of nanomaterials in consumer products, including requiring mandatory nano-ingredient product labeling and premarket nano-specific toxicity testing. The petition also calls for the recall of nano-sunscreens currently on the market with manufactured nanoparticles of titanium dioxide and zinc oxide.

The early warning signs surrounding nanotoxicity in sunscreens and cosmetics are serious and warrant a precautionary approach to the commercialization of all products containing nanomaterials. Friends of the Earth believes there should be a moratorium on the further commercial release of sunscreens, cosmetics and personal care products that contain engineered nanomaterials, and the withdrawal of such products currently on the market, until adequate public, peer-reviewed safety studies have been completed, and adequate regulations have been put in place to protect the general public, the workers manufacturing

these products and the environmental systems in which waste products will be released. Specifically, Friends of the Earth is calling for an immediate moratorium on the commercial release of all nanotechnological materials and products until such time as:

- nanomaterials and products are subjected to rigorous health and environmental impact assessment, including evidence-based testing, prior to commercial production and/or environmental release;
- nanomaterials are assessed as new substances, even where the properties of larger scale counterparts are well-known, because of the radically altered characteristics of nanomaterials compared to larger sized-particles;
- a regulatory framework is established that protects the health of workers and the general public from the risks associated with exposure to nanomaterials, and the environmental systems into which waste nanoproducts will be released;
- safety assessments are based on the precautionary principle and the onus is on proponents to prove safety, rather than relying on an assumption of safety;
- risk assessment includes the entire life cycle of the products in question, from 'cradle to grave';
- all relevant data related to safety assessments, and the methodologies used to obtain them, are placed in the public domain;
- skin uptake of nanomaterials is assessed based on whole product and 'real life' conditions, given that flexing, massage and penetration enhancing ingredients have been demonstrated to increase skin uptake of larger particles, drugs and dyes;
- products that contain nanoparticle ingredients or are made with processes that use nanomaterials are clearly indicated on product labels to allow consumers to make an informed choice about product use.

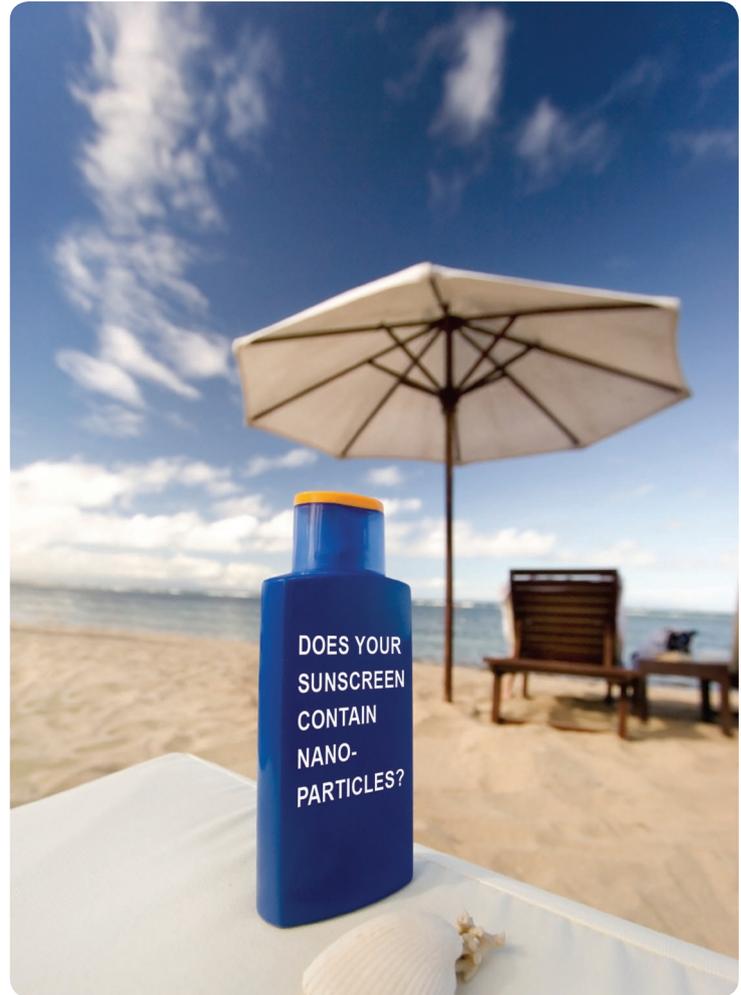
what you can do: cultivate consumer power

Contact the sunscreen companies yellow-listed in our guide as well as those not listed at all and demand that they inform you of whether or not they use nanoparticles and what safety precautions and testing they are performing. You can also tell the FDA to stop ignoring the new health and environmental dangers posed by nanoparticles and send a letter via our website at http://action.foe.org/campaign.jsp?campaign_KEY=5389.

You might also want to check out Friends of the Earth's recent report entitled *Nanomaterials, sunscreens and cosmetics: Small Ingredients, Big Risks*, which you can download on our website at <http://www.FOE.org/pdf/nanocosmeticsreport.pdf>. This report explains in larger breadth concerns regarding the risks posed to human health and the environment by engineered nanoparticles in cosmetics and sunscreens and lists a variety of other beauty products containing nanotechnology. And to make sure you're avoiding sunscreens and other personal care products that may use other risky and unhealthy ingredients, visit the Skin Deep project developed by the Environmental Working Group at <http://www.cosmeticsdatabase.com>. Also check out the Woodrow Wilson Center's Project on Emerging Nanotechnologies *Inventory of Nanotechnology Consumer Products* at <http://www.nanotechproject.org/44> and explore a list of more than 500 nanotechnology products on the market worldwide.

alternatives to chemical protection

This guide can help you choose sunscreen brands to avoid the use of possibly risky nanoparticles. However, remember that protection against the sun's rays cannot be guaranteed by sunscreen alone. There are many non-chemical alternatives to staying safe in the sun, which include:



Sunscreen lotion. Photo: Kazina, www.kazina.pl.

- staying in the shade, especially between the sun's peak hours (10 a.m.- 4 p.m.).
- covering up with clothing, a brimmed hat and UV-blocking sunglasses.
- avoiding tanning and UV tanning booths.
- examining your skin head to toe every month.
- seeing your physician every year for a professional skin exam.

Start a new trend on your block and cover up in the sun! Encourage others to change the culture of "tanning is sexy." The new "cool" is staying healthy in the sun. Healthy skin, even if less tan, is far sexier than fatal skin cancer. It might be time to reevaluate the need to be tanned and start better protecting what is sometimes known as our third lung: the skin.

appendix: sunscreens guide

To check out up-dates to Friends of the Earth's No-Nano Sunscreens list, please visit www.foe.org



(GREEN) PRODUCTS ARE NANO FREE

BRAND	NANO CONTENT CLAIM	BRAND	NANO CONTENT CLAIM
Alba Botanica	Retailer claims no nano content	Bull Frog	Retailer claims no nano content
Aubrey Organics	Retailer claims no nano content	M.D. Forte (Allergan)	Retailer claims no nano content
Avalon	Retailer claims no nano content	Schwarzkopf & Henkel	Retailer claims no nano content
Black Opal	Retailer claims no nano content	Tattoo Goo	Retailer claims no nano content
Blistex	Retailer claims no nano content		



(YELLOW) PRODUCTS MAY CONTAIN MANUFACTURED NANOPARTICLES - RETAILER WILL NOT PROVIDE INFORMATION

Ahava	Aveeno	California Baby	Dr. Haushka	Got2B
All Terrain	Avon	Cellex-C	DuWop	Hawaiian Tropic
Almay	Awake	Cetaphil	Elizabeth Arden	Iman Cosmetics
Alpha Hydrox	Baby Blanket	Clarins	Estee Lauder	Jack Black
Ambi Skincare	Bain De Soleil	Clinique	Eucerin	Jason Natural
Andrea Abbott	Beauty Without Cruelty	CVS	Fake Bake	Kinerase
Annemarie Borlind	B. Kamins	DDF	Fresh	Kiss My Face Corp
Aramis	Body Drench	Dermalogica	Fruit of the Earth	LaRoche-Posay
Aveda	Cactus Juice	Desert Essence	Glycolix Elite	Lavera



(YELLOW) PRODUCTS MAY CONTAIN MANUFACTURED NANOPARTICLES - RETAILER WILL NOT PROVIDE INFORMATION

Lancome	Nivea	Peter Thomas Roth	Rodan and Fields	Tanning Research Laboratories
L'Oreal	No-Ad	Philosophy	RoC	Ti-Silc
Lubriderm	Obagi	Physical Formula	Sea & Ski	TOPIX
Maybelline	Ocean Potion	Prescriptives	Shen Min	Total Skin Care
Md formulations	Olay	PreSun Ultra	Shiseido	Ultima II
Murad	Osmotics	Rachel Perry	Solar Sense	Unilever
National Allergy Supply	Palmer's	Ramy	Solbar PF	UV Natural
Nature's Gate	Panama Jack	Reviva	Somme	Walgreens
NeoStrata	Paula Dorf	Revlon	South Beach Sun	Zhen
Neutrogena	PCA	Rite Aid	Suave	Zia Natural



(RED) PRODUCTS CONTAIN MANUFACTURED NANOPARTICLES

PRODUCT	MANUFACTURER	NANO CONTENT CLAIM
Applied Therapeutics™	Applied Therapeutics™	Others claim nano content
Bebe/Enfant High Protection SPF 50	Mustela	Others claim nano content
Blue Lizard® BABY	Crown Laboratories, Inc.	Manufacturers claim nano content
Blue Lizard® Regular	Crown Laboratories, Inc.	Others claim nano content
Blue Lizard® Sensitive	Crown Laboratories, Inc.	Manufacturers claim nano content
Chemical-Free Sunscreen SPF 15	Burt's Bees® Inc.	Manufacturers claim nano content
Cotz SPF 58	Fallene	Others claim nano content



**(RED) PRODUCTS CONTAIN
MANUFACTURED NANOPARTICLES**

BRAND	MANUFACTURER	NANO CONTENT CLAIM
Daily Sun Defense SPF 20	SkinCeuticals®	Others claim nano content
IS Clinical SPF 20 Moisturizing Treatment Sunscreen	nnovative® Skincare	Others claim nano content
Kids Tear Free SPF 30	Banana Boat®	Others claim nano content
Lips 'n Face Protection Creme and Sunblock Creme	Dermatone® Laboratories	Others claim nano content
Physical UV Defense SPF 30	SkinCeuticals®	Others claim nano content
Rosacea Care Sunscreen "30"	Rosacea Care.	Manufacturers claim nano content
Solar Rx SPF 30+ Nano-Zinc Oxide Sunblock	Keys Soap	Others claim nano content
Soltan® Facial Sun Defence Cream - Optisol®	Boots® and Oxonica® Ltd.	Others claim nano content
Spectra3 SPF 50	Coppertone®	Others claim nano content
SPF 20 Sunscreen Powder	Innovative® Skincare	Others claim nano content
Sport UV Defense SPF 45	SkinCeuticals®	Others claim nano content
Sunscreen Plus Clear Zinc SPF30+	Cancer Council Australia	Manufacturers claim nano content
SunSense™ SPF 30+ Sunscreen	NuCelle® Inc.	Manufacturers claim nano content
TiO2 Automotive Sunscreen*	Nano Chemical Systems Holdings, Inc.	Manufacturers claim nano content
Ultimate UV Defense SPF 30	SkinCeuticals®	Others claim nano content
UV Pearls	Sol-Gel Technologies	Manufacturers claim nano content
ZinClear™ Nano Zinc Oxide	Advanced Nanotechnology Limited	Manufacturers claim nano content

*Note: this is a sunscreen product that protects cars.

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“Sun worshippers beware. While slathering up with sunscreens to block dangerous ultra-violet (UV) rays you may be exposing yourself to a new danger. Sunscreen manufacturers are adding nanoparticles to sunscreens to make sun-blocking ingredients like titanium dioxide and zinc oxide rub on clear instead of white. These nanoparticles are being added without labeling and reliable safety information.”