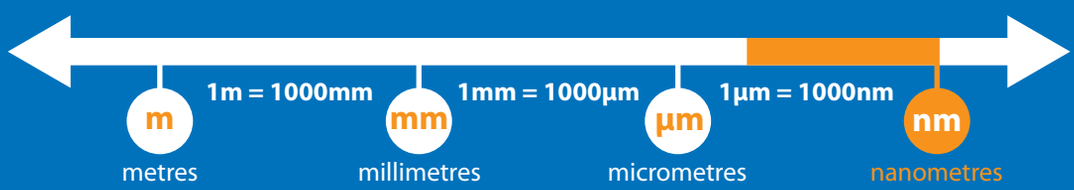
Factsheet
Nano-ingredients and sunscreen

Friends of the Earth Australia

What are nanomaterials?

The word nanomaterial is an umbrella term for objects of all different shapes and sizes with one or more dimensions (length, width or height) or surface structures on the nano-scale. The nano-scale is the range from 1 - 100 nanometres, with one nanometre being one millionth of a millimetre. The term nanomaterial includes nanoparticles, as well as aggregates and agglomerates (clumps) of nanoparticles.

The properties of matter change at the nano-scale, as the laws of classical physics give way to quantum effects. The properties of nanomaterials can therefore be quite different from those of larger particles of the same substance. Altered properties can include colour, solubility, material strength, electrical conductivity and magnetic behaviour. Nanomaterials also have a greater surface area relative to volume. This makes them much more chemically reactive than larger particles.

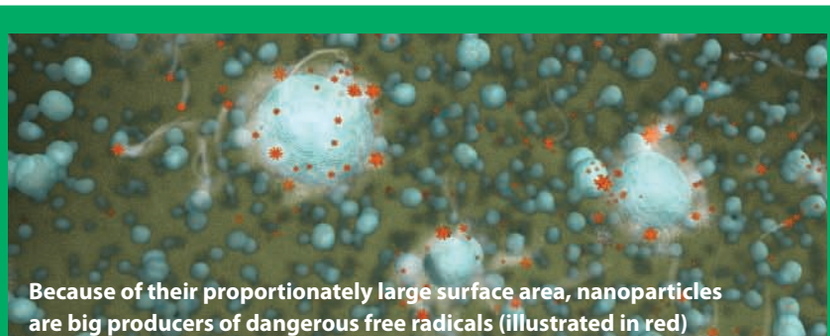


Why are nano-ingredients used in sunscreen?

Two increasingly popular sunscreen ingredients are the metal oxides – zinc oxide (ZnO) and titanium dioxide (TiO_2). The traditional larger bulk forms of these chemicals leave a white residue on the skin, but once the particles are reduced down towards the nano-scale they start to become transparent. Clumps of nanoparticles (agglomerates or aggregates) can also be transparent.

What are the health concerns?

There are growing concerns around the health and environmental risks of using nano-ingredients in sunscreen. Alarmingly little research has been conducted into the potential health risks. However, from the research that has been performed, we know that surface area plays a key role in the toxicity of nanomaterials. As we reduce the size of particles, the larger relative surface area increases the potential for free radical production which can damage proteins and DNA. Accordingly, the leader of CSIRO's Nanosafety group warned in 2008[1] that in a worst-case scenario, nano-ingredients in sunscreens could cause skin cancer. Dermatologists have also called for labelling so that people can choose nano-free sunscreens[2].



Because of their proportionately large surface area, nanoparticles are big producers of dangerous free radicals (illustrated in red)

Do nano-ingredients penetrate the skin?

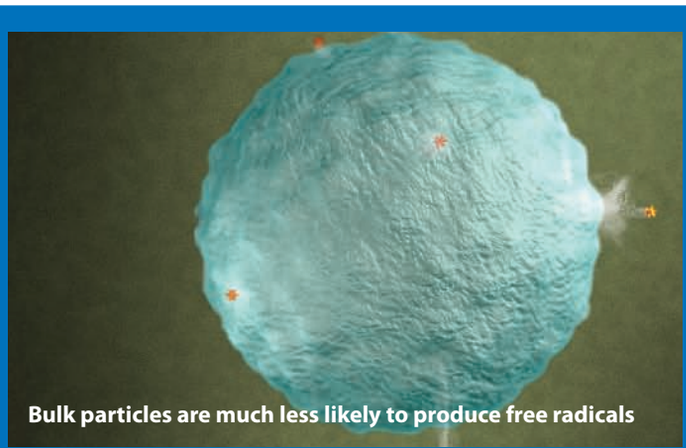
Our Australian sunscreen regulator, the Therapeutic Goods Administration (TGA) has refused to regulate the use of nano-ingredients in sunscreens. They argue that the hazards of nanomaterials are irrelevant because they don't penetrate the skin. However, the majority of the skin penetration studies the TGA refers to do not reflect realistic conditions[3]. Most of the studies are short-term, use excised skin and do not assess the role of penetration enhancers (used in some sunscreens). The European Union's high-level Scientific Committee on Consumer Products[4] and some dermatologists[2,5] have warned that further studies need to take into account abnormal skin conditions (such as eczema, acne or sunburn) and the possible impact of skin flexion on the penetration of nano-ingredients. It has also been scientifically demonstrated that particles up to a micrometre in size can potentially penetrate the skin[6].

Nano-ingredients can corrode paint - what does this mean for human skin?

Researchers at Blue Scope Steel found that nano-ingredients in sunscreens worn by workers installing roofs was corroding the paint on the roofs as they were installing them[7]. When researchers looked deeper into the problem, they found that nano-ingredients in sunscreens were able to speed up the sun damage to roof surfaces by 100 times. They described the process as "An aggressive, photocatalytically initiated, free-radical degradation mechanism...". While this study did not examine the interaction of nano-sunscreens with human skin, it did suggest a possible mechanism for toxicity that was of great concern to the scientific community. Despite these concerns, the TGA have failed to ban the use of these nano-ingredients in Australian sunscreens.

Sunscreen manufacturers & misleading claims

Surveys show there is growing demand for nano-free sunscreens in Australia[8]. As a result, there is a growing market for nano-free sunscreens, with many brands choosing to market only nano-free options. Accordingly, sunscreen ingredient suppliers have been marketing ingredients to sunscreen brands as nano-free. Unfortunately, it seems that the claims of some sunscreen manufacturers have been nothing more than spin.



Bulk particles are much less likely to produce free radicals

Misleading claims

When sunscreen brands buy ingredients, they want to know the ingredients don't contain nanomaterials and any of the associated risks. However, some sunscreen and ingredient manufacturers have been selling clumps (agglomerates and aggregates) of zinc oxide nanoparticles and marketing them as 'nano-free' or 'non-nano'. Companies have gotten away with this by referring to the size of the clumps, rather than the size of the particles these clumps are composed of. That is, although the clumps of 1000 nm are composed of particles around 30-40 nm in size, companies have selectively only referred to the 1000 nm size of the clumps in claiming 'non-nano'.

What are agglomerates?

Agglomerates are loose clumps of nanoparticles. These may be as large as bulk particles, but are not the same thing. They have lots of surfaces (nooks and crannies) both inside and outside the clump. This means that their surface area, and hence capacity to produce dangerous free radicals, is nearly as large as an equivalent mass of individual nanoparticles. What's more, the loosely bound nanoparticles in agglomerates may break free from the larger clumps.

What are aggregates?

Aggregates are tightly-bound clumps of nanoparticles. Some companies have also figured out how to melt holes (at high temperatures) into large micrometre-sized aggregates of zinc oxide in order to achieve desirable transparency properties. However, these clumps again have a very high surface area compared to their bulk counterparts, due to the nano-sized nooks and crannies (nano-structures) running throughout the nanomaterial.

The importance of definitions

Most definitions around the world describe aggregates and agglomerates as nanomaterials. Importantly, the ISO (International Organization for Standardization) definition on nanomaterials – agreed by 32 member countries, including Australia – specifies agglomerates and aggregates as nanomaterials. By choosing not to use accepted definitions (i.e. inventing their own), companies are denying consumers and sunscreen brands the ability to choose nano-free products.

Like individual nanoparticles, aggregates and agglomerates are big producers of free radicals

Stay Sun Safe!

Use a nano-free zinc-based SPF 30+ broad spectrum sunscreen in conjunction with protective clothing, a broad brimmed hat, sunglasses and shade to stay sun safe.

For more information see our website:

nano.foe.org.au

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References

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