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Home (https://www.safecosmetics.org/) > Chemicals (https://www.safecosmetics.org/chemicals/) > Titanium Dioxide

Titanium Dioxide

Titanium dioxide (TiO₂) is used in a variety of personal care products, including sunscreens, pressed powders, and loose powders, as a UV filter or whitening agent.



Titanium dioxide (TiO₂) is used in a variety of personal care products, including sunscreens, pressed powders, and loose powders, as a UV filter or whitening agent. In lotions and creams (dermal exposure), it is not a risk for adverse health effects. However, when titanium dioxide is inhalable—as it may be when in powder form—it is considered a possible carcinogen by the International Agency for Research on Cancer.^[1] Titanium dioxide nanoparticles do not appear to confer any unique health hazards.

What is Titanium Dioxide?

Titanium dioxide (TiO₂) is a fine white powder or dust that occurs naturally. It was first intentionally produced for use as a white pigment in 1923.^[2]

It is naturally opaque and bright, which makes it useful for use in paper, ceramics, rubber, textiles, paints, inks and cosmetics.^[3] It is also resistant to ultraviolet (UV) light, and is used widely in sunscreens and pigments that are likely to be exposed to UV light. It is used in a wide variety of personal care products, including color cosmetics such as eye shadow and blush, loose and pressed powders and in sunscreens.

Titanium dioxide can form several different shapes, which have different properties. Some shapes can be converted to nanomaterials. Micronized TiO₂ (also called “nano” or “nanoparticles”) was introduced in the early 1990s.^[4] Nanotechnology and micronization both refer to the practice of creating very small particles sizes of a given material. “Nanoparticles” usually refers to particles smaller than 100 nanometers; a nanometer is 1/1 billionth of a meter. At these small sizes, and at low concentrations, titanium dioxide appears transparent, allowing for effective sunscreens that do not appear white.^[5]

Titanium dioxide, or TiO₂, will be listed on product labels, but companies are not required to list ingredient size or structure. When it is used in sunscreens to block UV light, titanium dioxide is considered an active ingredient, which means the concentration must also be listed.^[6]

Found In

- Sunscreen
- Pressed and loose powders

What to look for on the label

- Titanium dioxide

- TiO₂
- Pigment grade Titanium dioxide

Health Concerns

The International Agency for Research on Cancer designates titanium dioxide (TiO₂) as a carcinogen, largely due to studies that have found increased lung cancers due to inhalation exposure in animals.^[7]

Exposure

Titanium dioxide does not penetrate through healthy skin and poses no local or systemic risk to human health from skin exposure.^{[8],[9],[10],[11]} In response to concerns that nano TiO₂ might more readily penetrate damaged skin, researchers applied nano-based sunscreens to pigs ears that had been sunburnt. Titanium dioxide did not reach the deeper levels of the skin in the sunburnt tissue.^[12]

Most concerns for human health arise when titanium dioxide is inhalable or respirable. For TiO₂ to be inhaled, particles must be small enough to reach the alveoli (where oxygen exchange happens) of the lungs. Sampling methods have been developed to estimate the airborne mass concentration of respirable particles,^{[13],[14],[15],[16],[17]} and inhalable dust.^{[18],[19],[20],[21]}

Inhalation & Cancer. The data suggests nanoized titanium dioxide can be inhaled by some mammals, leading to concerns about adverse effects of human inhalation. Existing studies have suggested TiO₂ nanoparticles may be more toxic than traditional larger particles of TiO₂.^{[22],[24]}

Titanium dioxide is described as fine if it is 100–3,000 nm^{[25],[26],[27]} and ultrafine if it is smaller than 100 nm.^[28] Findings show that commercial pigments contain almost no particles smaller than 100 nm.^{[29],[30]} Scattering of light by titanium dioxide is maximized in particles that are 200–300 nm in diameter.^[31] Studies have shown that inhalation exposure of TiO₂ particles in cosmetics are predominately inhaled as clusters and do not reach the alveoli (the part of the lungs where oxygen is exchanged).^[32] The findings demonstrated that a user would be exposed to nanomaterials that are larger than 1–100 nanometers.^[33]

Studies have found that when exposed to nanoized titanium dioxide (normally smaller than 100 nanometers), rats and mice experience significant lung inflammation^{[34],[35],[36]} and cell mutations.^[37] Some inflammatory responses resolved a few weeks post-exposure.^[38] Other studies have not found increased lung tumor development in rats that inhaled TiO₂.^{[39],[40]}

An inhalation study of pigmentary titanium dioxide particles in rats, mice, and hamsters found that there were significant species differences in pulmonary responses to inhaled particles. Rats developed more severe symptoms of lung damage.^[41]

Toxicological testing of nanomaterials needs to take into account the effects on particle size on the ways that dose is estimated because smaller particles will have greater surface area by volume.^[42]

Work Related Exposure

Human health studies—mostly occupational studies regarding titanium dioxide inhalation—have demonstrated mixed findings regarding cancer.^[43]

Supporting evidence: The most relevant data for assessing the health risk to workers are results from a chronic animal inhalation study with ultrafine titanium dioxide in which a statistically significant increase in adenocarcinomas was observed.^{[44],[45]}

Conflicting evidence: Several studies have concluded that there is no increase in mortality,^[46] lung inflammatory response,^[47] or carcinogenic effect^{[48],[49]} associated with workplace exposure and TiO₂.

Vulnerable Populations

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Regulations

The US National Institute for Occupational Health and Safety has set dust exposure limits for workers due to concerns about lung cancer.^[50] The E.U. was the first scientific opinion on the safe use of titanium dioxide as a UV-filter at a maximum concentration of 25% in cosmetic products was adopted 24 October 2000 by the SCCNFP.^[51]

How to Avoid?

Avoid loose powders and blushes that contain titanium dioxide. Use caution as well with pressed powders, since they can become airborne when used.

Caveat: TiO₂ makes a very effective sunscreen in creams and lotions, and is one of the safest options available. Avoid it only in aerosolized (spray on) sunscreens.

FAQs

What is titanium dioxide dust?



What is pigment grade titanium dioxide?



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11/11