Titanium dioxide (TiO_2)

Figure 1: © Image by chezbeate from Pixabay.

1. What is Titanium dioxide?

Titanium dioxide is an oxide of the chemical element titanium and forms different crystal structures, such as rutile, anatase or brookite. Each individual crystal structure results in TiO_2 having different properties.

In nature, titanium dioxide is mostly found in minerals, from which it must then be extracted synthetically. Probably the best known mineral is the so-called ilmenite ($FeTiO_3$), as this ore is a major component in global titanium dioxide production. Most of the industrial production of TiO_2 is achieved by the so-called sulphate. In both processes ilmenite is often used as a starting material. [1]

2. (Commercial) Use of the Material and its Applications

Depending on the crystal structure, titanium dioxide has different properties and is therefore used in a variety of applications such as cosmetics, textiles, food, medicines, photocatalysts, etc.

Titanium dioxide is industrially mainly used as a pigment. In addition to the classic use in white wall paint, titanium dioxide is also applied in the food industry as a white colouring additive. Many food products also display titanium dioxide with its identification number E171. However, most of the titanium dioxide produced is utilised in technical applications.

Nanoscale titanium dioxide is used as a UV filter in sun protection creams with high sun protection factor. Sunlight is reflected by the TiO_2 nanoparticles, which prevents the penetration of too much sunlight into the skin. In addition, nanoparticulate titanium dioxide is also used in textile fibers or wood preservatives. For these applications titanium dioxide is mainly used in its crystal modification rutile. However, if the photocatalytic property of titanium dioxide is required for an application, the anatase structure of TiO_2 needs to be used.

3. How can I come into contact with this material?

There are many different ways of coming into contact with titanium dioxide in everyday life. For example, in white wall paint, in sunscreens, in medicines and food, to name just a few. In most cases, if at all, only a small amount of nanoscale titanium dioxide is present. For applications in which

titanium dioxide nanoparticles are used, such as wall paints and varnishes, the particles are usually not released during daily life, as they are firmly bound.

4. Relevance for risk governance

The European Commission followed the classification proposal of ECHA's Risk Assessment Committee (RAC) and classified titanium dioxide as "suspected carcinogen by inhalation" under the CLP Regulation. [2] However, this classification by ECHA was annulled by the Court of Justice of the European Union in November 2022 because the underlying studies were not considered reliable. [3]

Regarding the potential health risks that may arise from the oral intake of titanium dioxide, there is currently no evidence of health concerns for consumers, according to the European Food Safety Authority (EFSA). Nevertheless, TiO_2 has received media attention due to the proposal of the European Chemicals Agency (ECHA) to classify titanium dioxide as a hazardous substance on the basis of recent studies and the ban in France since 2020 on marketing food containing the additive E171.[4]

TiO_2 has also been included as a substance in CoRAP (Community Rolling Action Plan) by the EU in 2012 under Regulation (EC) No 1907/2006 (REACH). The re-evaluations is running since 2018.[5]

5. Experimental plan and goals within RiskGONE

Within WP5 TiO_2 is currently being used to critically evaluate the nano-specific applicability of a sub-set of existing *in vitro* methods required for hazard assessment to identify where adaptation is required to existing testing approaches. The experiments are being conducted in multiple partner laboratories simultaneously, to determine methodological adaptations are required to ensure the tests are appropriate for nanomaterial safety assessment. The *in vitro* methods to be focused upon during the first phase critical evaluation include the comet assay, the colony forming efficiency assay, the HPRT forward mutation assay and the micronucleus assay.

6. Reference Material in RiskGONE: Repository and ID

TiO_2 (#JRCNM01005a990582)

7. General Characterisation Data

The first results and characteristic data will be obtained after completion of the round robins.

8. Results

The first results and characteristic data will be obtained after completion of the round robins.

9. References

[1] https://www.nanopartikel.info/en/nanoinfo/materials/titanium-dioxide/overview

[2] https://www.echa.europa.eu/-/titanium-dioxide-proposed-to-be-classified-as-suspected-of-causing-cancer-when-inhaled

[3] https://curia.europa.eu/jcms/upload/docs/application/pdf/2022-11/cp220190en.pdf

[4] https://echa.europa.eu/de/substance-information/-/substanceinfo/100.033.327

[5] https://echa.europa.eu/information-on-chemicals/evaluation/community-rolling-action-plan/corap-table/-/dislist/details/0b0236e1807ebca5