

Titanium tetrachloride

sc-251251

Material Safety Data Sheet



The Power is Question

Hazard Alert Code Key:

EXTREME

HIGH

MODERATE

LOW

Section 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

PRODUCT NAME

Titanium tetrachloride

STATEMENT OF HAZARDOUS NATURE

CONSIDERED A HAZARDOUS SUBSTANCE ACCORDING TO OSHA 29 CFR 1910.1200.

NFPA



SUPPLIER

Santa Cruz Biotechnology, Inc.
2145 Delaware Avenue
Santa Cruz, California 95060
800.457.3801 or 831.457.3800

EMERGENCY

ChemWatch
Within the US & Canada: 877-715-9305
Outside the US & Canada: +800 2436 2255
(1-800-CHEMCALL) or call +613 9573 3112

SYNONYMS

Cl₄-Ti, TiCl₄, "titanium chloride", "titanic chloride"

Section 2 - HAZARDS IDENTIFICATION

CHEMWATCH HAZARD RATINGS

	Min	Max
Flammability:	0	
Toxicity:	4	
Body Contact:	3	
Reactivity:	2	
Chronic:	2	

Min/Nil=0
Low=1
Moderate=2
High=3
Extreme=4



CANADIAN WHMIS SYMBOLS



EMERGENCY OVERVIEW

RISK

Reacts violently with water.
Harmful if swallowed.
Causes burns.
Risk of serious damage to eyes.

POTENTIAL HEALTH EFFECTS

ACUTE HEALTH EFFECTS

SWALLOWED

- The material can produce chemical burns within the oral cavity and gastrointestinal tract following ingestion.
- Accidental ingestion of the material may be harmful; animal experiments indicate that ingestion of less than 150 gram may be fatal or may produce serious damage to the health of the individual.
- Ingestion of acidic corrosives may produce burns around and in the mouth.
the throat and esophagus.
- Dusts of titanium and titanium compounds are thought to exhibit little or no toxic effects.

EYE

- The material can produce chemical burns to the eye following direct contact. Vapors or mists may be extremely irritating.
- If applied to the eyes, this material causes severe eye damage.
- Direct eye contact with acid corrosives may produce pain, tears, sensitivity to light and burns.
Mild burns of the epithelia generally recover rapidly and completely.

SKIN

- The material can produce chemical burns following direct contact with the skin.
- Skin contact with acidic corrosives may result in pain and burns; these may be deep with distinct edges and may heal slowly with the formation of scar tissue.
- Skin contact with the material may damage the health of the individual; systemic effects may result following absorption.
- Open cuts, abraded or irritated skin should not be exposed to this material.
- Entry into the blood-stream, through, for example, cuts, abrasions or lesions, may produce systemic injury with harmful effects.
Examine the skin prior to the use of the material and ensure that any external damage is suitably protected.

INHALED

- The material can cause respiratory irritation in some persons.
The body's response to such irritation can cause further lung damage.
- Corrosive acids can cause irritation of the respiratory tract, with coughing, choking and mucous membrane damage.
There may be dizziness, headache, nausea and weakness.
- Inhalation of vapors or aerosols (mists, fumes), generated by the material during the course of normal handling, may produce severe damage to the health of the individual.
Relatively small amounts absorbed through the lungs may prove fatal.
- Inhalation of quantities of liquid mist may be extremely hazardous, even lethal due to spasm, extreme irritation of larynx and bronchi, chemical pneumonitis and pulmonary edema.
- Hydrogen chloride (HCl) vapour or fumes present a hazard from a single acute exposure.
Exposures of 1300 to 2000 ppm have been lethal to humans in a few minutes.

CHRONIC HEALTH EFFECTS

- Repeated or prolonged exposure to acids may result in the erosion of teeth, swelling and or ulceration of mouth lining. Irritation of airways to lung, with cough, and inflammation of lung tissue often occurs.
Long-term exposure to respiratory irritants may result in disease of the airways involving difficult breathing and related systemic problems.
Limited evidence suggests that repeated or long-term occupational exposure may produce cumulative health effects involving organs or biochemical systems.
Chronic minor exposure to hydrogen chloride (HCl) vapour or fume may cause discolouration or erosion of the teeth, bleeding of the nose and gums; and ulceration of the nasal mucous membranes.
Repeated exposures of animals to concentrations of about 34 ppm HCl produced no immediate toxic effects.
Workers exposed to hydrochloric acid suffered from gastritis and a number of cases of chronic bronchitis have also been reported.
Repeated or prolonged exposure to dilute solutions of HCl may cause dermatitis.
Long term exposure to titanium and several of its compounds produces lung scarring and chronic bronchitis. Breathing is impaired and cardiac changes with right heart enlargements occur.
Prolonged or periodic exposure causes disturbances to the upper respiratory and nervous system.

Section 3 - COMPOSITION / INFORMATION ON INGREDIENTS

NAME	CAS RN	%
titanium tetrachloride	7550-45-0	>98.5
NOTE: In moist air or in contact with water evolve		
hydrogen chloride	7647-01-0	
titanium dioxide	13463-67-7	

Section 4 - FIRST AID MEASURES

SWALLOWED

· For advice, contact a Poisons Information Center or a doctor at once. · Urgent hospital treatment is likely to be needed.

EYE

■ If this product comes in contact with the eyes: · Immediately hold eyelids apart and flush the eye continuously with running water. · Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids.

SKIN

■ If skin or hair contact occurs: · Immediately flush body and clothes with large amounts of water, using safety shower if available. · Quickly remove all contaminated clothing, including footwear.

INHALED

· If fumes or combustion products are inhaled remove from contaminated area. · Lay patient down. Keep warm and rested. Inhalation of vapors or aerosols (mists, fumes) may cause lung edema. Corrosive substances may cause lung damage (e.g.

NOTES TO PHYSICIAN

- For acute or short term repeated exposures to strong acids:
- Airway problems may arise from laryngeal edema and inhalation exposure. Treat with 100% oxygen initially.
- Respiratory distress may require cricothyroidotomy if endotracheal intubation is contraindicated by excessive swelling.

Section 5 - FIRE FIGHTING MEASURES

Vapor Pressure (mmHg):	9.976 @ 21.3C
Upper Explosive Limit (%):	Not available
Specific Gravity (water=1):	1.726 @ 20C
Lower Explosive Limit (%):	Not available

EXTINGUISHING MEDIA

· DO NOT use water.

FIRE FIGHTING

- Alert Emergency Responders and tell them location and nature of hazard.
- May be violently or explosively reactive.

When any large container (including road and rail tankers) is involved in a fire, consider evacuation by 800 metres in all directions.

GENERAL FIRE HAZARDS/HAZARDOUS COMBUSTIBLE PRODUCTS

- Non combustible.
 - Not considered to be a significant fire risk.
- Decomposition may produce toxic fumes of: hydrogen chloride, metal oxides.

FIRE INCOMPATIBILITY

- None known.
- Keep dry.
- NOTE: May develop pressure in containers; open carefully. Vent periodically.

PERSONAL PROTECTION

Glasses:

Safety Glasses.

Full face- shield.

Gloves:

1.SARANEX-

Respirator:

Type B-P Filter of sufficient capacity

Section 6 - ACCIDENTAL RELEASE MEASURES

MINOR SPILLS

- Drains for storage or use areas should have retention basins for pH adjustments and dilution of spills before discharge or disposal of material.
- Check regularly for spills and leaks.
- Clean up all spills immediately.
- Avoid breathing vapors and contact with skin and eyes.

MAJOR SPILLS

- Clear area of personnel and move upwind.
- Alert Emergency Responders and tell them location and nature of hazard.

Section 7 - HANDLING AND STORAGE

PROCEDURE FOR HANDLING

- DO NOT allow clothing wet with material to stay in contact with skin.
- Avoid all personal contact, including inhalation.
- Wear protective clothing when risk of exposure occurs.

RECOMMENDED STORAGE METHODS

■ DO NOT use aluminum or galvanized containers.

Check regularly for spills and leaks.

Glass container.

· Lined metal can, Lined metal pail/drum

· Plastic pail.

For low viscosity materials

· Drums and jerricans must be of the non-removable head type.

· Where a can is to be used as an inner package, the can must have a screwed enclosure.

STORAGE REQUIREMENTS

· Store in original containers.

· Keep containers securely sealed.

Section 8 - EXPOSURE CONTROLS / PERSONAL PROTECTION

EXPOSURE CONTROLS

Source	Material	TWA ppm	TWA mg/m³	STEL ppm	STEL mg/m³	Peak ppm	Peak mg/m³	TWA F/CC	Notes
US ATSDR Minimal Risk Levels for Hazardous Substances (MRLs)	titanium tetrachloride (TITANIUM TETRACHLORIDE)		0.0001						
US ATSDR Minimal Risk Levels for Hazardous Substances (MRLs)	titanium tetrachloride (TITANIUM TETRACHLORIDE)		0.01						
US AIHA Workplace Environmental Exposure Levels (WEELs)	titanium tetrachloride (Titanium Tetrachloride [a])		0.5						
Canada - Alberta Occupational Exposure Limits	titanium tetrachloride (Hydrogen chloride)					2	3		
Canada - British Columbia Occupational Exposure Limits	titanium tetrachloride (Hydrogen chloride Revised 2003)					2			
US - Minnesota Permissible Exposure Limits (PELs)	titanium tetrachloride (Hydrogen chloride)					5	7		
US ACGIH Threshold Limit Values (TLV)	titanium tetrachloride (Hydrogen chloride)					2			TLV Basis: upper respiratory tract irritation
US NIOSH Recommended Exposure Limits (RELs)	titanium tetrachloride (Hydrogen chloride)					5	7		
US - Tennessee Occupational Exposure Limits - Limits For Air Contaminants	titanium tetrachloride (Hydrogen chloride)					5	7		
US - Vermont Permissible Exposure Limits Table Z-1-A Transitional Limits for Air Contaminants	titanium tetrachloride (Hydrogen chloride)	(C)5	(C)7						

US - Vermont Permissible Exposure Limits Table Z-1-A Final Rule Limits for Air Contaminants	titanium tetrachloride (Hydrogen chloride)			5	7		
US - California Permissible Exposure Limits for Chemical Contaminants	titanium tetrachloride (Hydrogen chloride; muriatic acid)	5	7		C		
US - Idaho - Limits for Air Contaminants	titanium tetrachloride (Hydrogen chloride)			5	7		
US - Hawaii Air Contaminant Limits	titanium tetrachloride (Hydrogen chloride)			5	7		
US - Alaska Limits for Air Contaminants	titanium tetrachloride (Hydrogen chloride)			5	7		
US - Michigan Exposure Limits for Air Contaminants	titanium tetrachloride (Hydrogen chloride)			5	7		
Canada - Yukon Permissible Concentrations for Airborne Contaminant Substances	titanium tetrachloride (Hydrogen chloride)	5	7	-	-		
US - Washington Permissible exposure limits of air contaminants	titanium tetrachloride (Hydrogen chloride)			5.0			
Canada - Saskatchewan Occupational Health and Safety Regulations - Contamination Limits	titanium tetrachloride (Hydrogen chloride)			2			
US - Oregon Permissible Exposure Limits (Z-1)	titanium tetrachloride (Hydrogen chloride)			5	7		
US - Wyoming Toxic and Hazardous Substances Table Z1 Limits for Air Contaminants	titanium tetrachloride (Hydrogen chloride)			5	7		
Canada - Quebec Permissible Exposure Values for Airborne Contaminants (English)	titanium tetrachloride (Hydrogen chloride)			5	7,5		
US OSHA Permissible Exposure Levels (PELs) - Table Z1	titanium tetrachloride (Hydrogen chloride)			5	7		
Canada - Northwest Territories Occupational Exposure Limits	titanium tetrachloride (Hydrogen chloride)			5	7.5		

(English)

Canada - Nova Scotia Occupational Exposure Limits	titanium tetrachloride (Hydrogen chloride)	2	TLV Basis: upper respiratory tract irritation
Canada - Prince Edward Island Occupational Exposure Limits	titanium tetrachloride (Hydrogen chloride)	2	TLV Basis: upper respiratory tract irritation
US - Minnesota Permissible Exposure Limits (PELs)	titanium dioxide (Titanium dioxide - Total dust)	10	
US - Minnesota Permissible Exposure Limits (PELs)	titanium dioxide (Titanium dioxide - Respirable fraction)	5	
Canada - Alberta Occupational Exposure Limits	titanium dioxide (Titanium dioxide)	10	
Canada - British Columbia Occupational Exposure Limits	titanium dioxide (Titanium dioxide Revised 2006)	10 (N)	2B
US - Vermont Permissible Exposure Limits Table Z-1-A Transitional Limits for Air Contaminants	titanium dioxide (Titanium dioxide - Respirable fraction)	5	
US - Vermont Permissible Exposure Limits Table Z-1-A Final Rule Limits for Air Contaminants	titanium dioxide (Titanium dioxide - Total dust)	10	
US - Vermont Permissible Exposure Limits Table Z-1-A Final Rule Limits for Air Contaminants	titanium dioxide (Titanium dioxide - Respirable fraction)	5	
US - Idaho - Limits for Air Contaminants	titanium dioxide (Titanium dioxide - Total dust)	15	
US - Tennessee Occupational Exposure Limits - Limits For Air Contaminants	titanium dioxide (Titanium dioxide Total dust)	10	
US - Vermont Permissible Exposure Limits Table Z-1-A Transitional Limits for Air Contaminants	titanium dioxide (Titanium dioxide - Total dust)	15	
US ACGIH Threshold Limit Values (TLV)	titanium dioxide (Titanium dioxide)	10	TLV Basis: lower respiratory tract irritation
US - Alaska Limits for Air Contaminants	titanium dioxide (Titanium dioxide - Total dust)	10	

US - Alaska Limits for Air Contaminants	titanium dioxide (Titanium dioxide - Respirable fraction)	5		
US - Michigan Exposure Limits for Air Contaminants	titanium dioxide (Titanium dioxides Total dust)	10		
US - Washington Permissible exposure limits of air contaminants	titanium dioxide (Titanium dioxide - Total particulate)	10	20	
Canada - Saskatchewan Occupational Health and Safety Regulations - Contamination Limits	titanium dioxide (Titanium dioxide)	10	20	
US - Hawaii Air Contaminant Limits	titanium dioxide (Titanium dioxide Total dust)	10	20	
US - Wyoming Toxic and Hazardous Substances Table Z1 Limits for Air Contaminants	titanium dioxide (Titanium dioxide-Total dust)	15		
Canada - Quebec Permissible Exposure Values for Airborne Contaminants (English)	titanium dioxide (Titanium dioxide)	10		
US OSHA Permissible Exposure Levels (PELs) - Table Z1	titanium dioxide (Titanium dioxide - Total dust)	15		
US - Oregon Permissible Exposure Limits (Z-1)	titanium dioxide (Titanium dioxide)	-	10	Bold print identifies substances for which the Oregon Permissible Exposure Limits (PELs) are different than the federal Limits.
Canada - Nova Scotia Occupational Exposure Limits	titanium dioxide (Titanium dioxide)	10		TLV Basis: lower respiratory tract irritation
Canada - Prince Edward Island Occupational Exposure Limits	titanium dioxide (Titanium dioxide)	10		TLV Basis: lower respiratory tract irritation

ENDOELTABLE

PERSONAL PROTECTION



RESPIRATOR

- type b-p filter of sufficient capacity.
- Consult your EHS staff for recommendations

EYE

- Chemical goggles.
- Full face shield.

HANDS/FEET

- Elbow length PVC gloves.
 - When handling corrosive liquids, wear trousers or overalls outside of boots, to avoid spills entering boots.
- Suitability and durability of glove type is dependent on usage. Important factors in the selection of gloves include: such as:
- frequency and duration of contact,
 - chemical resistance of glove material,
 - glove thickness and
 - dexterity

Select gloves tested to a relevant standard (e.g. Europe EN 374, US F739).

- When prolonged or frequently repeated contact may occur, a glove with a protection class of 5 or higher (breakthrough time greater than 240 minutes according to EN 374) is recommended.
- When only brief contact is expected, a glove with a protection class of 3 or higher (breakthrough time greater than 60 minutes according to EN 374) is recommended.
- Contaminated gloves should be replaced.

Gloves must only be worn on clean hands. After using gloves, hands should be washed and dried thoroughly. Application of a non-perfumed moisturiser is recommended.

OTHER

- Overalls.
- PVC Apron.

ENGINEERING CONTROLS

- Local exhaust ventilation usually required. If risk of overexposure exists, wear an approved respirator.

Section 9 - PHYSICAL AND CHEMICAL PROPERTIES

PHYSICAL PROPERTIES

Liquid.
Corrosive.
Acid.
Toxic or noxious vapours/gas.
Reacts violently with water.

State	Liquid	Molecular Weight	189.7
Melting Range (°F)	-13	Viscosity	Not Applicable
Boiling Range (°F)	278	Solubility in water (g/L)	Reacts violently
Flash Point (°F)	Not Applicable	pH (1% solution)	Not available
Decomposition Temp (°F)	Not Available	pH (as supplied)	Not applicable
Autoignition Temp (°F)	Not available	Vapor Pressure (mmHg)	9.976 @ 21.3C
Upper Explosive Limit (%)	Not available	Specific Gravity (water=1)	1.726 @ 20C
Lower Explosive Limit (%)	Not available	Relative Vapor Density (air=1)	>1
Volatile Component (%vol)	Not available	Evaporation Rate	Not available

APPEARANCE

Colourless to light yellow liquid with an irritating odour. Reacts violently with water to form hydrogen chloride. Reacts with moisture in air producing dense white fumes. Miscible with cold water, dilute hydrochloric acid and alcohol. Decomposes in hot water.

Section 10 - CHEMICAL STABILITY

CONDITIONS CONTRIBUTING TO INSTABILITY

- Contact with alkaline material liberates heat.

STORAGE INCOMPATIBILITY

- Inorganic acids are generally soluble in water with the release of hydrogen ions. The resulting solutions have pH's of less than 7.0.

- Inorganic acids neutralize chemical bases (for example: amines and inorganic hydroxides) to form salts.

Hydrogen chloride:

- reacts strongly with strong oxidisers (releasing chlorine gas), acetic anhydride, caesium cyanotridecahydrodecaborate(2-), ethylidene difluoride, hexalithium disilicide, metal acetylides, sodium, silicon dioxide, tetraselenium tetranitride, and many organic materials
- is incompatible with aliphatic amines, alkanolamines, alkylene oxides, aluminium, aluminium-titanium alloys, aromatic amines, amides, 2-aminoethanol, ammonia, ammonium hydroxide, calcium phosphide, chlorosulfonic acid, ethylenediamine, ethyleneimine, epichlorohydrin, isocyanates, metal acetylides, metal carbides, oleum, organic anhydrides, perchloric acid, 3-propiolactone, sulfuric acid, uranium phosphide, vinyl acetate, vinylidene fluoride
- attacks most metals forming flammable hydrogen gas, and some plastics, rubbers and coatings.
- **WARNING:** Avoid or control reaction with peroxides. All transition metal peroxides should be considered as potentially explosive. For example transition metal complexes of alkyl hydroperoxides may decompose explosively.
- The pi-complexes formed between chromium(0), vanadium(0) and other transition metals (haloarene-metal complexes) and mono- or poly-fluorobenzene show extreme sensitivity to heat and are explosive.
- Avoid reaction with borohydrides or cyanoborohydrides.

Segregate from alcohol, water.

- **NOTE:** May develop pressure in containers; open carefully. Vent periodically.

Titanium tetrachloride and titanium trichloride:

- produces hydrogen chloride fumes on contact with air
- reacts violently with water, producing heat, hydrogen chloride and dense white cloud of titanium oxide; a similar reaction occurs with alcohols
- is a strong reducing agent
- reacts violently with oxidisers, potassium, hydrogen fluoride
- reacts with tetrahydrofuran causing a violent exotherm
- forms complex with urea which decomposes violently above 90 deg C.
- forms complexes with disulfur dinitride and tetrasulfur tetranitride which may explode violently
- attacks metals in the presence of moisture

Dusts of titanium alloys ignite and then explode in a carbon dioxide atmosphere.

For incompatible materials - refer to Section 7 - Handling and Storage.

Section 11 - TOXICOLOGICAL INFORMATION

titanium tetrachloride

TOXICITY AND IRRITATION

■ unless otherwise specified data extracted from RTECS - Register of Toxic Effects of Chemical Substances.

TITANIUM DIOXIDE:

TITANIUM TETRACHLORIDE:

■ The material may produce moderate eye irritation leading to inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.

HYDROGEN CHLORIDE:

TITANIUM TETRACHLORIDE:

■ Asthma-like symptoms may continue for months or even years after exposure to the material ceases. This may be due to a non-allergenic condition known as reactive airways dysfunction syndrome (RADS). which can occur following exposure to high levels of highly irritating compound. Key criteria for the diagnosis of RADS include the absence of preceding respiratory disease, in a non-atopic individual, with abrupt onset of persistent asthma-like symptoms within minutes to hours of a documented exposure to the irritant. A reversible airflow pattern, on spirometry, with the presence of moderate to severe bronchial hyperreactivity on methacholine challenge testing and the lack of minimal lymphocytic inflammation, without eosinophilia, have also been included in the criteria for diagnosis of RADS. RADS (or asthma) following an irritating inhalation is an infrequent disorder with rates related to the concentration of and duration of exposure to the irritating substance. Industrial bronchitis, on the other hand, is a disorder that occurs as result of exposure due to high concentrations of irritating substance (often particulate in nature) and is completely reversible after exposure ceases. The disorder is characterised by dyspnea, cough and mucus production.

TITANIUM TETRACHLORIDE:

TOXICITY	IRRITATION
Inhalation (rat) LC50: 400 mg/m ³	Nil Reported
Inhalation (mouse) LC50: 100 mg/m ³ /2h * [Sigma/Aldrich]	
Oral (rat) LD50: 464 mg/kg *	
Dermal (rabbit) LD50: 3160 mg/kg *	

■ The material may produce respiratory tract irritation, and result in damage to the lung including reduced lung function.

The material may cause skin irritation after prolonged or repeated exposure and may produce on contact skin redness, swelling, the production of vesicles, scaling and thickening of the skin.

TOXICITY	IRRITATION
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HYDROGEN CHLORIDE:

Inhalation (human) LCLo: 1300 ppm/30m

Eye
(rabbit):
5
mg/30s
- Mild

Inhalation (human) LCLo: 3000 ppm/5m

Inhalation (rat) LC50: 3124 ppm/60m

■ The material may be irritating to the eye, with prolonged contact causing inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.

4701 ppm/30m

TITANIUM DIOXIDE:

Oral (Rat) LD50: >20000 mg/kg *

Skin
(human):
0.3 mg
/3D
(int)-Mild
*

Oral (Mouse) LD50: 10000 mg/kg *

■ The material may cause skin irritation after prolonged or repeated exposure and may produce on contact skin redness, swelling, the production of vesicles, scaling and thickening of the skin.

For titanium dioxide:

Humans can be exposed to titanium dioxide via inhalation, ingestion or dermal contact. In human lungs, the clearance kinetics of titanium dioxide is poorly characterized relative to that in experimental animals. (General particle characteristics and host factors that are considered to affect deposition and retention patterns of inhaled, poorly soluble particles such as titanium dioxide are summarized in the monograph on carbon black.) With regard to inhaled titanium dioxide, human data are mainly available from case reports that showed deposits of titanium dioxide in lung tissue as well as in lymph nodes. A single clinical study of oral ingestion of fine titanium dioxide showed particle size-dependent absorption by the gastrointestinal tract and large interindividual variations in blood levels of titanium dioxide. Studies on the application of sunscreens containing ultrafine titanium dioxide to healthy skin of human volunteers revealed that titanium dioxide particles only penetrate into the outermost layers of the stratum corneum, suggesting that healthy skin is an effective barrier to titanium dioxide. There are no studies on penetration of titanium dioxide in compromised skin.

Respiratory effects that have been observed among groups of titanium dioxide-exposed workers include decline in lung function, pleural disease with plaques and pleural thickening, and mild fibrotic changes. However, the workers in these studies were also exposed to asbestos and/or silica.

No data were available on genotoxic effects in titanium dioxide-exposed humans.

Many data on deposition, retention and clearance of titanium dioxide in experimental animals are available for the inhalation route. Titanium dioxide inhalation studies showed differences — both for normalized pulmonary burden (deposited mass per dry lung, mass per body weight) and clearance kinetics — among rodent species including rats of different size, age and strain. Clearance of titanium dioxide is also affected by pre-exposure to gaseous pollutants or co-exposure to cytotoxic aerosols. Differences in dose rate or clearance kinetics and the appearance of focal areas of high particle burden have been implicated in the higher toxic and inflammatory lung responses to intratracheally instilled vs inhaled titanium dioxide particles. Experimental studies with titanium dioxide have demonstrated that rodents experience dose-dependent impairment of alveolar macrophage-mediated clearance. Hamsters have the most efficient clearance of inhaled titanium dioxide. Ultrafine primary particles of titanium dioxide are more slowly cleared than their fine counterparts.

Titanium dioxide causes varying degrees of inflammation and associated pulmonary effects including lung epithelial cell injury, cholesterol granulomas and fibrosis. Rodents experience stronger pulmonary effects after exposure to ultrafine titanium dioxide particles compared with fine particles on a mass basis. These differences are related to lung burden in terms of particle surface area, and are considered to result from impaired phagocytosis and sequestration of ultrafine particles into the interstitium.

Fine titanium dioxide particles show minimal cytotoxicity to and inflammatory/pro-fibrotic mediator release from primary human alveolar macrophages in vitro compared with other particles. Ultrafine titanium dioxide particles inhibit phagocytosis of alveolar macrophages in vitro at mass dose concentrations at which this effect does not occur with fine titanium dioxide. In-vitro studies with fine and ultrafine titanium dioxide and purified DNA show induction of DNA damage that is suggestive of the generation of reactive oxygen species by both particle types. This effect is stronger for ultrafine than for fine titanium oxide, and is markedly enhanced by exposure to simulated sunlight/ultraviolet light.

Animal carcinogenicity data

Pigmentary and ultrafine titanium dioxide were tested for carcinogenicity by oral administration in mice and rats, by inhalation in rats and female mice, by intratracheal administration in hamsters and female rats and mice, by subcutaneous injection in rats and by intraperitoneal administration in male mice and female rats.

In one inhalation study, the incidence of benign and malignant lung tumours was increased in female rats. In another inhalation study, the incidences of lung adenomas were increased in the high-dose groups of male and female rats. Cystic keratinizing lesions that were diagnosed as squamous-cell carcinomas but re-evaluated as non-neoplastic pulmonary keratinizing cysts were also observed in the high-dose groups of female rats. Two inhalation studies in rats and one in female mice were negative.

Intratracheally instilled female rats showed an increased incidence of both benign and malignant lung tumours following treatment with two types of titanium dioxide. Tumour incidence was not increased in intratracheally instilled hamsters and female mice.

In-vivo studies have shown enhanced micronucleus formation in bone marrow and peripheral blood lymphocytes of intraperitoneally instilled mice. Increased Hprt mutations were seen in lung epithelial cells isolated from titanium dioxide-instilled rats. In another study, no enhanced oxidative DNA damage was observed in lung tissues of rats that were intratracheally instilled with titanium dioxide. The results of most in-vitro genotoxicity studies with titanium dioxide were negative.

* IUCLID

CARCINOGEN

titanium tetrachloride	US - Rhode Island Hazardous Substance List	IARC	
hydrogen chloride	US - Rhode Island Hazardous Substance List	IARC	
titanium dioxide	US - Rhode Island Hazardous Substance List	IARC	
TITANIUM DIOXIDE	US Environmental Defense Scorecard Suspected Carcinogens	Reference(s)	P65-CAND

Section 12 - ECOLOGICAL INFORMATION

This material and its container must be disposed of as hazardous waste.

Ecotoxicity

Ingredient	Persistence: Water/Soil	Persistence: Air	Bioaccumulation	Mobility
titanium tetrachloride	No Data Available	No Data Available	LOW	
hydrogen chloride	LOW	No Data Available	LOW	HIGH
titanium dioxide	HIGH	No Data Available	LOW	HIGH

Section 13 - DISPOSAL CONSIDERATIONS

US EPA Waste Number & Descriptions

A. General Product Information

Corrosivity characteristic: use EPA hazardous waste number D002 (waste code C)

Disposal Instructions

All waste must be handled in accordance with local, state and federal regulations.

! Puncture containers to prevent re-use and bury at an authorized landfill.

Legislation addressing waste disposal requirements may differ by country, state and/ or territory. Each user must refer to laws operating in their area. In some areas, certain wastes must be tracked.

A Hierarchy of Controls seems to be common - the user should investigate:

- Reduction
- Reuse
- Recycling
- Disposal (if all else fails)

This material may be recycled if unused, or if it has not been contaminated so as to make it unsuitable for its intended use. If it has been contaminated, it may be possible to reclaim the product by filtration, distillation or some other means. Shelf life considerations should also be applied in making decisions of this type. Note that properties of a material may change in use, and recycling or reuse may not always be appropriate.

DO NOT allow wash water from cleaning equipment to enter drains. Collect all wash water for treatment before disposal.

For small quantities:

- Neutralize an aqueous solution of the material.
- Filter solids for disposal to approved land fill.
- Recycle wherever possible.
- Consult manufacturer for recycling options or consult Waste Management Authority for disposal if no suitable treatment or disposal facility can be identified.

Section 14 - TRANSPORTATION INFORMATION

DOT:

Symbols: + Hazard class or Division: 8

Identification Numbers: UN1838 PG: II

Label Codes: 8, 6.1 Special provisions: 2, B7, B9, B14, B32, B77, T20, TP2, TP13,

TP38, TP45
Packaging: Exceptions: None Packaging: Non- bulk: 227
Packaging: Exceptions: None Quantity limitations: Forbidden
Passenger aircraft/rail:
Quantity Limitations: Cargo Forbidden Vessel stowage: Location: C
aircraft only:
Vessel stowage: Other: 40
Hazardous materials descriptions and proper shipping names:
Titanium tetrachloride

Air Transport IATA:

ICAO/IATA Class: 6.1 (8) ICAO/IATA Subrisk: None
UN/ID Number: 1838 Packing Group: -
Special provisions: A2
Cargo Only
Packing Instructions: Forbidden Maximum Qty/Pack: Forbidden
Passenger and Cargo Passenger and Cargo
Packing Instructions: Forbidden Maximum Qty/Pack: Forbidden
Passenger and Cargo Limited Quantity Passenger and Cargo Limited Quantity
Packing Instructions: Forbidden Maximum Qty/Pack: Forbidden
Shipping Name: TITANIUM TETRACHLORIDE

Maritime Transport IMDG:

IMDG Class: 8 IMDG Subrisk: None
UN Number: 1838 Packing Group: II
EMS Number: F-A , S-B Special provisions: None
Limited Quantities: 0
Shipping Name: TITANIUM TETRACHLORIDE

Section 15 - REGULATORY INFORMATION

titanium tetrachloride (CAS: 7550-45-0) is found on the following regulatory lists;

"Canada - Saskatchewan Industrial Hazardous Substances", "Canada Ingredient Disclosure List (SOR/88-64)", "Canada National Pollutant Release Inventory (NPRI)", "Canada Toxicological Index Service - Workplace Hazardous Materials Information System - WHMIS (English)", "IMO MARPOL 73/78 (Annex II) - List of Noxious Liquid Substances Carried in Bulk", "OECD Representative List of High Production Volume (HPV) Chemicals", "US - California Air Toxics ""Hot Spots"" List (Assembly Bill 2588) Substances for which emissions must be quantified", "US - California Toxic Air Contaminant List Category IV", "US - Massachusetts Oil & Hazardous Material List", "US - New Jersey Right to Know Hazardous Substances", "US - Pennsylvania - Hazardous Substance List", "US - Rhode Island Hazardous Substance List", "US AIHA Workplace Environmental Exposure Levels (WHEELs)", "US ATSDR Minimal Risk Levels for Hazardous Substances (MRLs)", "US Clean Air Act - Hazardous Air Pollutants", "US Department of Homeland Security Chemical Facility Anti-Terrorism Standards - Chemicals of Interest", "US Department of Transportation (DOT) List of Hazardous Substances and Reportable Quantities - Hazardous Substances Other Than Radionuclides", "US DOE Temporary Emergency Exposure Limits (TEELs)", "US EPA Acute Exposure Guideline Levels (AEGs) - Interim", "US EPCRA Section 313 Chemical List", "US List of Lists - Consolidated List of Chemicals Subject to EPCRA, CERCLA and Section 112(r) of the Clean Air Act", "US SARA Section 302 Extremely Hazardous Substances", "US Toxic Substances Control Act (TSCA) - Inventory", "USA: Chemical Facility Anti-Terrorism Standards - List Appendix A - 6CFR 27"

Regulations for ingredients

hydrogen chloride (CAS: 7647-01-0) is found on the following regulatory lists;

"Canada - Alberta Ambient Air Quality Objectives", "Canada - Alberta Occupational Exposure Limits", "Canada - British Columbia Occupational Exposure Limits", "Canada - Northwest Territories Occupational Exposure Limits (English)", "Canada - Nova Scotia Occupational Exposure Limits", "Canada - Prince Edward Island Occupational Exposure Limits", "Canada - Prince Edward Island Occupational Exposure Limits - Carcinogens", "Canada - Quebec Permissible Exposure Values for Airborne Contaminants (English)", "Canada - Saskatchewan Industrial Hazardous Substances", "Canada - Saskatchewan Occupational Health and Safety Regulations - Contamination Limits", "Canada - Yukon Permissible Concentrations for Airborne Contaminant Substances", "Canada Controlled Drugs and Substances Act Schedule VI", "Canada Domestic Substances List (DSL)", "Canada Ingredient Disclosure List (SOR/88-64)", "Canada National Pollutant Release Inventory (NPRI)", "Canada Prohibited Toxic Substances, Schedule 2, Concentration Limits (English)", "Canada Toxicological Index Service - Workplace Hazardous Materials Information System - WHMIS (English)", "CODEX General Standard for Food Additives (GSFA) - Additives Permitted for Use in Food in General, Unless Otherwise Specified, in Accordance with GMP", "GESAMP/EHS Composite List - GESAMP Hazard Profiles", "IMO IBC Code Chapter 17: Summary of minimum requirements", "IMO MARPOL 73/78 (Annex II) - List of Noxious Liquid Substances Carried in Bulk", "International Agency for Research on Cancer (IARC) - Agents Reviewed by the IARC Monographs", "International Council of Chemical Associations (ICCA) - High Production Volume List", "International Maritime Dangerous Goods Requirements (IMDG Code) - Goods Forbidden for Transport", "OECD Representative List of High Production Volume (HPV) Chemicals", "United Nations Convention Against Illicit Traffic in Narcotic Drugs and Psychotropic Substances - Table II", "United Nations List of Precursors and Chemicals Frequently used in the Illicit Manufacture of Narcotic Drugs and Psychotropic Substances Under International Control (Red List) - Table II", "US - Alaska Limits for Air Contaminants", "US - California Air Toxics ""Hot Spots"" List (Assembly Bill 2588) Substances for which emissions must be quantified", "US - California Occupational Safety and Health Regulations (CAL/OSHA) - Hazardous Substances List", "US - California OEHHA/ARB - Acute Reference Exposure Levels and Target Organs (RELs)", "US - California OEHHA/ARB - Chronic Reference Exposure Levels and Target Organs (CRELs)", "US - California Permissible Exposure Limits for Chemical Contaminants", "US - California Toxic Air Contaminant List Category II", "US - Connecticut Hazardous Air Pollutants", "US - Florida Essential Chemicals", "US - Hawaii Air Contaminant Limits", "US - Idaho - Limits for Air Contaminants", "US - Massachusetts Oil & Hazardous Material List", "US - Michigan Exposure Limits for Air Contaminants", "US - Minnesota Hazardous Substance List", "US - Minnesota Permissible Exposure Limits (PELs)", "US - New Jersey Right to Know Hazardous Substances", "US - Oregon Hazardous Materials", "US -

Oregon Permissible Exposure Limits (Z-1)", "US - Pennsylvania - Hazardous Substance List", "US - Rhode Island Hazardous Substance List", "US - Tennessee Occupational Exposure Limits - Limits For Air Contaminants", "US - Vermont Permissible Exposure Limits Table Z-1-A Final Rule Limits for Air Contaminants", "US - Vermont Permissible Exposure Limits Table Z-1-A Transitional Limits for Air Contaminants", "US - Washington Permissible exposure limits of air contaminants", "US - Wyoming List of Highly Hazardous Chemicals, Toxics and Reactives", "US - Wyoming Toxic and Hazardous Substances Table Z1 Limits for Air Contaminants", "US ACGIH Threshold Limit Values (TLV)", "US ACGIH Threshold Limit Values (TLV) - Carcinogens", "US Clean Air Act - Hazardous Air Pollutants", "US CWA (Clean Water Act) - List of Hazardous Substances", "US CWA (Clean Water Act) - Reportable Quantities of Designated Hazardous Substances", "US Department of Homeland Security Chemical Facility Anti-Terrorism Standards - Chemicals of Interest", "US Department of Transportation (DOT) List of Hazardous Substances and Reportable Quantities - Hazardous Substances Other Than Radionuclides", "US DOE Temporary Emergency Exposure Limits (TEELs)", "US Drug Enforcement Administration (DEA) List I and II Regulated Chemicals", "US EPA Acute Exposure Guideline Levels (AEGLs) - Final", "US EPA High Production Volume Chemicals Additional List", "US EPA Master Testing List - Index I Chemicals Listed", "US EPCRA Section 313 Chemical List", "US Food Additive Database", "US List of Lists - Consolidated List of Chemicals Subject to EPCRA, CERCLA and Section 112(r) of the Clean Air Act", "US NFPA 45 Fire Protection for Laboratories Using Chemicals - Flammability Characteristics of Common Compressed and Liquefied Gases", "US NIOSH Recommended Exposure Limits (RELs)", "US OSHA List of Highly Hazardous Chemicals, Toxics and Reactives", "US OSHA Permissible Exposure Levels (PELs) - Table Z1", "US Postal Service (USPS) Hazardous Materials Table: Postal Service Mailability Guide", "US SARA Section 302 Extremely Hazardous Substances", "US Spacecraft Maximum Allowable Concentrations (SMACs) for Airborne Contaminants", "US Toxic Substances Control Act (TSCA) - Inventory"

titanium dioxide (CAS: 13463-67-7, 1317-70-0, 1317-80-2, 12188-41-9, 1309-63-3, 100292-32-8, 101239-53-6, 116788-85-3, 12000-59-8, 12701-76-7, 12767-65-6, 12789-63-8, 1344-29-2, 185323-71-1, 185828-91-5, 188357-76-8, 188357-79-1, 195740-11-5, 221548-98-7, 224963-00-2, 246178-32-5, 252962-41-7, 37230-92-5, 37230-94-7, 37230-95-8, 37230-96-9, 39320-58-6, 39360-64-0, 39379-02-7, 416845-43-7, 494848-07-6, 494848-23-6, 494851-77-3, 494851-98-8, 55068-84-3, 55068-85-4, 552316-51-5, 62338-64-1, 767341-00-4, 97929-50-5, 98084-96-9) is found on the following regulatory lists;

"Canada - Alberta Occupational Exposure Limits", "Canada - British Columbia Occupational Exposure Limits", "Canada - Nova Scotia Occupational Exposure Limits", "Canada - Prince Edward Island Occupational Exposure Limits", "Canada - Quebec Permissible Exposure Values for Airborne Contaminants (English)", "Canada - Saskatchewan Occupational Health and Safety Regulations - Contamination Limits", "Canada Domestic Substances List (DSL)", "Canada Toxicological Index Service - Workplace Hazardous Materials Information System - WHMIS (English)", "CODEX General Standard for Food Additives (GSFA) - Additives Permitted for Use in Food in General, Unless Otherwise Specified, in Accordance with GMP", "GESAMP/EHS Composite List - GESAMP Hazard Profiles", "IMO IBC Code Chapter 17: Summary of minimum requirements", "International Agency for Research on Cancer (IARC) - Agents Reviewed by the IARC Monographs", "International Fragrance Association (IFRA) Survey: Transparency List", "OECD Representative List of High Production Volume (HPV) Chemicals", "US - Alaska Limits for Air Contaminants", "US - California Permissible Exposure Limits for Chemical Contaminants", "US - Connecticut Hazardous Air Pollutants", "US - Hawaii Air Contaminant Limits", "US - Idaho - Limits for Air Contaminants", "US - Michigan Exposure Limits for Air Contaminants", "US - Minnesota Hazardous Substance List", "US - Minnesota Permissible Exposure Limits (PELs)", "US - New Jersey Right to Know Hazardous Substances", "US - Oregon Permissible Exposure Limits (Z-1)", "US - Pennsylvania - Hazardous Substance List", "US - Rhode Island Hazardous Substance List", "US - Tennessee Occupational Exposure Limits - Limits For Air Contaminants", "US - Vermont Permissible Exposure Limits Table Z-1-A Final Rule Limits for Air Contaminants", "US - Vermont Permissible Exposure Limits Table Z-1-A Transitional Limits for Air Contaminants", "US - Washington Permissible exposure limits of air contaminants", "US - Wyoming Toxic and Hazardous Substances Table Z1 Limits for Air Contaminants", "US ACGIH Threshold Limit Values (TLV)", "US DOE Temporary Emergency Exposure Limits (TEELs)", "US FDA CFSAN Color Additive Status List 4", "US FDA CFSAN Color Additive Status List 5", "US FDA CFSAN Color Additive Status List 6", "US FDA CFSAN Color Additive Status List 7", "US FDA Indirect Food Additives: Adhesives and Components of Coatings - Substances for Use as Components of Coatings - Acrylate ester copolymer coating", "US FDA Indirect Food Additives: Adhesives and Components of Coatings - Substances for Use Only as Components of Adhesives - Adhesives", "US Food Additive Database", "US NFPA 30B Manufacture and Storage of Aerosol Products - Chemical Heat of Combustion", "US NIOSH Recommended Exposure Limits (RELs)", "US OSHA Permissible Exposure Levels (PELs) - Table Z1", "US Toxic Substances Control Act (TSCA) - Inventory"

Section 16 - OTHER INFORMATION

Ingredients with multiple CAS Nos

Ingredient Name CAS titanium dioxide 13463-67-7, 1317-70-0, 1317-80-2, 12188-41-9, 1309-63-3, 100292-32-8, 101239-53-6, 116788-85-3, 12000-59-8, 12701-76-7, 12767-65-6, 12789-63-8, 1344-29-2, 185323-71-1, 185828-91-5, 188357-76-8, 188357-79-1, 195740-11-5, 221548-98-7, 224963-00-2, 246178-32-5, 252962-41-7, 37230-92-5, 37230-94-7, 37230-95-8, 37230-96-9, 39320-58-6, 39360-64-0, 39379-02-7, 416845-43-7, 494848-07-6, 494848-23-6, 494851-77-3, 494851-98-8, 55068-84-3, 55068-85-4, 552316-51-5, 62338-64-1, 767341-00-4, 97929-50-5, 98084-96-9

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■ Classification of the preparation and its individual components has drawn on official and authoritative sources as well as independent review by the Chemwatch Classification committee using available literature references.

A list of reference resources used to assist the committee may be found at:

www.chemwatch.net/references.

- The (M)SDS is a Hazard Communication tool and should be used to assist in the Risk Assessment. Many factors determine whether the reported Hazards are Risks in the workplace or other settings. Risks may be determined by reference to Exposures Scenarios. Scale of use, frequency of use and current or available engineering controls must be considered.

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