



PRESIDENT TITANIUM CO., INC.

243 FRANKLIN STREET -- P.O BOX 36

HANSON, MA 02341-0036 U.S.A.

PHN: (781) 294-0000 ~ (800) 225-0304 ~ FAX: (781) 293-3753

WWW.PRESIDENTTITANIUM.COM



MATERIAL SAFETY DATA SHEET FOR TITANIUM

DATE OF PREPARATION: NOVEMBER 1st, 1985

PREPARED BY: GREGG HOFFMAN, ENVIROMENTAL AND

DATE OF REVISION: JANUARY 1st, 2009

SAFETY COORDINATOR FOR OREMET

PRODUCT NAME/NUMBER: TITANIUM & TITANIUM ALLOY

REVISED BY: JOHN TOLER, QC/QA (PRESIDENT TITANIUM)

I - COMPONENT DATA

<u>CHEMICAL COMPONENTS</u>	<u>C.A.S. NUMBER</u>	<u>% WEIGHT</u>	<u>CHEMICAL COMPONENTS</u>	<u>C.A.S. NUMBER</u>	<u>% WEIGHT</u>
ALUMINUM	7429-90-5	0-8	TANTALUM	7440-25-7	0-1
CHROMIUM	7440-47-3	0-11	TIN	7440-31-5	0-4.5
COLUMBIUM (NIOBIUM)	7440-03-1	0-2	TITANIUM	7440-32-6	73-99
IRON	7439-89-6	0-2	VANADIUM	7440-62-2	0-13
MOLYBDENUM	7439-98-7	0-11.5	ZIRCONIUM	7440-67-7	0-6
NICKEL	7440-02-0	0-0.8			

II - PHYSICAL DATA

BOILING POINT (°F): 5930°

SPECIFIC GRAVITY (H₂O = 1): 4.5

VAPOR PRESSURE (mmHg @ 20°C): N/A

MELTING POINT (°F): 3050°

VAPOR DENSITY (AIR = 1): N/A

EVAPORATIVE RATE (ETHYL ETHER = 1): N/A

SOLUBILITY IN WATER: INSOLUABLE

APPEARANCE & ODOR: ODORLESS GRAY METALLIC SOLID. AVAILABLE IN INGOTS, MILL PRODUCTS, CASTINGS, SPONGE, CHIPS, BRIQUETTES, AND OTHER IRREGULAR SHAPES.

III - FIRE & EXPLOSION HAZARD DATA

FLASH POINT (°F): N/A

METHOD USED: N/A

FLAMMABILITY LIMITS (%VOL): LEL: N/A - UEL: N/A

AUTO-IGNITION TEMP. (°F): 2200°F FOR METAL IN AIR - 480°F FOR POWDER IN AIR

EXTINGUISHING MEDIA: DRY TABLE SALT OR TYPE D FIRE EXTINGUISHER - *DO NOT USE WATER (SEE BELOW)!!!*

SPECIAL FIRE-FIGHTING INSTRUCTIONS: REMOVE UNINVOLVED MATERIAL; ALLOW FIRE TO BURN OUT. FIRE CAN BE CONTROLLED BY COVERING WITH DRY SALT OR POWDER FROM TYPE D EXTINGUISHER. CARBON DIOXIDE IS NOT EFFECTIVE.

UNUSUAL FIRE AND EXPLOSION HAZARDS: DRY TITANIUM BURNS SLOWLY WHILE RELEASING MUCH HEAT. WATER APPLIED TO BURNING TITANIUM MAY CAUSE AN EXPLOSION. PILED CHIPS MAY BURN VIGOROUSLY.

IV - REACTIVITY DATA

STABILITY (CONDITIONS TO AVOID): STABLE, AVOID OPEN FLAME AND HEAT.

INCOMPATIBILITY (MATERIALS TO AVOID): STRONG OXIDIZING OR REDUCING AGENTS.

HAZARDOUS DECOMPOSITION PRODUCTS: METALLIC OR METAL OXIDE FUMES AND/OR DUST MAY BE PRODUCED DURING THE FOLLOWING OPERATIONS: WELDING, GRINDING, AND/OR CUTTING. SEE SECTION V FOR FURTHER INFORMATION.

HAZARDOUS POLYMERIZATION: WILL NOT OCCUR.

V - HEALTH HAZARD DATA

PRIMARY ROUTE(S) OF ENTRY: INHALATION, SKIN CONTACT, EYE CONTACT.

EFFECTS OF EXPOSURE: NO TOXIC EFFECTS WOULD BE EXPECTED FROM ITS INERT SOLID FORM OR UNDER NORMAL USAGE SUCH AS FORGING AND/OR PROLONGED, REPEATED EXPOSURE TO FUMES AND/OR DUSTS GENERATED DURING CUTTING, GRINDING, AND/OR WELDING MAY CAUSE ADVERSE HEALTH EFFECTS ASSOCIATED WITH THE FOLLOWING CONSTITUENTS:

INHALATION OF METAL FUMES AND/OR DUST:

ALUMINUM - NOT GENERALLY REGARDED AS SERIOUS INDUSTRIAL HEALTH HAZARD.

CHROMIUM - THE DUSTS OF CHROMIUM METAL ARE USUALLY REPORTED TO BE RELATIVELY NONTOXIC, ALTHOUGH THERE ARE REPORTS OF SKIN ULCERS, USUALLY ON HANDS OR A PERFORATED NASAL SEPTUM. SOME INSOLUABLE CHROMIUM COMPOUNDS ARE SUSPECTED CARCINOGENS.

COLUMBIUM(NIOBIUM) - NO REPORTS OF HUMAN INTOXICATION.

IRON - SIDEROSIS, NO FIBROSIS.

MOLYBDENUM - IRRITATION TO THE NOSE AND THROAT, WEIGHT LOSS, AND DIGESTIVE DISTURBANCES IN ANIMALS. NO INDUSTRIAL POISONING HAS BEEN REPORTED.

NICKEL - RESPIRATORY IRRITATION AND PNEUMONITIS. SEVERAL NICKEL COMPOUNDS, INCLUDING NICKEL OXIDE, ARE SUSPECTED LUNG AND NASAL CARCINOGENS.

TANTALUM - NO SYSTEMIC EFFECTS FROM INDUSTRIAL EXPOSURE HAVE BEEN REPORTED IN HUMANS.

TIN - DUST OF TIN OXIDES HAS CAUSED A PNEUMONOCOINOSIS, WHICH IS RELATIVELY BENIGN.

TITANIUM - GENERALLY CONSIDERED TO BE IN THE NUISANCE DUST CATEGORY.

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VANADIUM - IRRITANT TO BE CONJUNCTIVAE AND RESPIRATORY TRACT. MAY LEAD TO PULMONARY INVOLVEMENT. SIGNS AND SYMPTOMS OF POISONING ARE PALLOR, GREENISH-BLACK DISCOLORATION OF THE TONGUE, COUGH, CONJUNCTIVITIS, PAIN IN THE CHEST, BRONCHITIS, RALES AND RHONCHI, BRONCHOSPASM, TREMOR OF THE FINGERS AND ARMS, AND RADIOGRAPHIC RETICULATION.

ZIRCONIUM - STUDIES OF SEVERAL ZIRCONIUM COMPOUNDS CONCLUDE THAT ZIRCONIUM IS AN ELEMENT OF LOW TOXICITY.

NOTE: SOME FUME CONSTITUENTS POSE MORE POTENTIAL HAZARDS THAN OTHERS, DEPENDING UPON THEIR INHERENT TOXICITY AND CONCENTRATION. OF SPECIAL CONCERN ARE CHROMIUM, VANADIUM, NICKEL, AND POSSIBLY TITANIUM. IT IS ADVISED THAT YOUR PARTICULAR OPERATION BE EVALUATED BY A COMPETENT HEALTH PROFESSIONAL TO DETERMINE WHETHER OR NOT THAT A HAZARD EXISTS.

SKIN CONTACT: DERMATITIS DUE TO SENSITIZATION MAY OCCUR IN SOME INDIVIDUALS FROM EXPOSURE TO CHROMIUM AND/OR NICKEL FUMES. COLUMBIUM (NIOBIUM) HAS BEEN REPORTED TO BE A SKIN IRRITANT.

EYE CONTACT: MAY CAUSE IRRITATION.

INGESTION: MAY CAUSE IRRITATION TO THE MOUTH AND THROAT.

EXPOSURE LIMITS: (OSHA NUISANCE DUST STANDARDS APPLY TO COMPONENTS SHOWN AS "NONE")

CHEMICAL COMPONENTS	OSHA PEL (mg/M³)	ACGIH TLV (mg/M³)	NTP LISTED	IARC LISTED
ALUMINIUM	NONE	5 (AS WELDING FUMES)	NO	NO
CHROMIUM	0.5 (SOLUBLE COMPOUNDS)	0.5	YES	YES
CHROMIUM (Cr + 6)	0.1	0.1	YES	YES
COLUMBIUM(NIOBIUM)	NONE	NONE	NO	NO
IRON	10 (AS FE ₂ O ₃ FUME)	5	NO	NO
MOLYBDENUM	5 (SOLUBLE COMPOUNDS)	5 (SOLUBLE COMPOUNDS)	NO	NO
NICKEL	1.0	0.1 (SOLUBLE Ni COMPOUNDS)	NO	YES
TANTALUM	5	10	NO	NO
TIN	2	2	NO	NO
TITANIUM	NONE	10 (AS TiO ₂)	NO	NO
VANADIUM	0.5 (DUST) / 0.1 (FUME)	0.05 (V ₂ O ₅)	NO	NO
ZIRCONIUM	5	5	NO	NO

VI - EMERGENCY & FIRST AID PROCEDURES

INHALATION: IN CASE OF OVEREXPOSURE, IMMEDIATELY REMOVE PERSON FROM CONTAMINATED AREA INTO FRESH AIR. GIVE OXYGEN IF NECESSARY OR IF BREATHING HAS STOPPED, PERFORM ARTIFICIAL RESPIRATION IMMEDIATELY. SEEK MEDICAL ATTENTION IF NECESSARY.

SKIN: IF IRRITATION DEVELOPS, REMOVE CONTAMINATED CLOTHING IMMEDIATELY AND WASH CONTAMINATED SKIN WITH SOAP OR MILD DETERGENT AND WATER FOR FIVE MINUTES. IF IRRITATION PERSISTS, SEEK MEDICAL ATTENTION.

EYES: IN CASE OF CONTACT, WASH EYES IMMEDIATELY WITH LARGE AMOUNTS OF WATER FOR 15 MINUTES, OCCASIONALLY LIFTING THE LOWER AND UPPER LIDS. SEEK MEDICAL ATTENTION IF NECESSARY.

INGESTION: SEEK MEDICAL ATTENTION IF NECESSARY.

VII - SPECIAL HANDLING INFORMATION

VENTILATION: VENTILATION, AS DESCRIBED IN THE *INDUSTRIAL VENTILATION MANUAL* PRODUCED BY THE AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGENISTS, IS THAT IT SHOULD MAINTAIN CONCENTRATIONS OF AIR CONTANIMENTS BELOW ESTABLISHED AIR CONTANIMENT STANDARDS.

RESPIRATORY PROTECTION: A PROPERLY FITTED, NIOSH APPROVED DUST FUME RESPIRATOR SHOULD BE WORN DURING WELDING OR BURNING WHEN AIR CONTANIMENTS EXCEED OSHA PERMISSABLE EXPOSURE LEVELS (PELs) OR ACGIH THRESHOLD LIMIT VALUES (TLVs). RESPIRATORY PROTECTION SHOULD BE SELECTED AND USED IN ACCORDANCE WITH OSHA RESPIRATORY PROTECTION STANDARD (29 CFR 1910.134 OR THE MOST CURRENT REVISION) AND/OR ANY OTHER APPLICABLE REGULATIONS.

PROTECTIVE CLOTHING: USE APPROPRIATE PROTECTIVE CLOTHING FOR PROTECTION OF EXPOSED AND/OR UNPROTECTED SKIN AREAS FROM HEAT, SPARKS, AND/OR ULTRAVIOLET RADIATION DURING FORGING, GRINDING, AND/OR WELDING.

EYE PROTECTION: USE FACE SHIELD (8" MINIMUM) OR GOGGLES WHEN BURNING AND/OR GRINDING. WHEN WELDING, USE A HOOD PROVIDING FULL FACE COVERAGE FOR PROTECTION FROM ULTRAVIOLET RADIATION.

VIII - SPECIAL PRECAUTIONS

DO NOT ALLOW METALLIC DUST TO ACCUMULATE. METALLIC DUST MAY PRESENT A SERIOUS FIRE HAZARD.

TITANIUM AND TITANIUM ALLOY SOLIDS ARE NOT CONSIDERED COMBUSTIBLE IN SOLID FORM. HOWEVER, SUBSEQUENT MACHINING OPERATIONS REQUIRE THE USE OF COPIOUS AMOUNTS OF CUTTING FLUIDS TO REDUCE THE TEMPERATURE OF THE WASTE MATERIAL WHICH COULD IGNITE WITHOUT COOLANT.

ARC AND SPARKS GENERATED WHEN WELDING AND/OR GRINDING COULD BE A SOURCE OF IGNITION FOR COMBUSTIONAL AND/OR FLAMMABLE MATERIALS. ACTION TO TAKE FOR SPILLS (USE APPROPRIATE SAFETY EQUIPMENT): KEEP MATERIAL SEPERATED FROM INCOMPATIBLE MATERIALS AND SOURCES OF IGNITION.

DISPOSAL INFORMATION: NON-RECYCLABLE SCRAP MAY BE LAND-FILLED IN ACCORDANCE WITH FEDERAL, STATE, AND LOCAL REGUALTIONS.

IX - ADDITIONAL INFORMATION

DOT INFORMATION

HAZARDOUS MATERIAL PROPER SHIPPING NAME: N/A

HAZARD CLASS: N/A

UN IDENTIFICATION NUMBER: N/A

EPA HAZARDOUS WASTE NUMBER: N/A

DISCLAIMER: WHILE THE INFORMATION CONTAINED IN THIS MATERIAL SAFETY DATA SHEET IS BELIEVED TO BE ACCURATE, PRESIDENT TITANIUM MAKES NO REPRESENTATIONS REGARDING THE ACCURACY AND/OR COMPLETENESS OF THE INFORMATION AND ASSUMES NO LIABILITY FOR ANY LOSS, DAMAGE, OR INJURY OF ANY KIND THAT MAY RESULT FROM OR ARISE OUT OF THE USE OF OR RELIANCE ON THIS INFORMATION. **THIS IS INTENDED AS A GUIDE AND A GUIDE ONLY.**