MATERIAL SAFETY DATA SHEET

I. PRODUCT IDENTIFICATION

Manufacturer/Supplier:
ESPI Metals
1050 Benson Way, Ashland, OR 97520
Toll Free (800) 638-2581 * Fax (541) 488-8313
E-Mail: sales@espimetals.com

Trade Name: Hafnium
Chemical Family: Metal
Formula: Hf
CAS#: 7440-58-6

Hazardous Component:	**%:**	**OSHA/PEL:**	**ACGIH/TLV:**
Hafnium	97-99.8	0.5 mg/m^3	0.5 mg/m^3
Zirconium	0.05-3	5 mg/m^3	10 mg/m^3

HMIS Hazard Rating (Solid): **Health**: 0 **Flammability**: 0 **Reactivity**: 0
HMIS Hazard Rating (Powder): **Health**: 2 **Flammability**: 3 **Reactivity**: 1

III. PHYSICAL DATA

Boiling Point: 4602 ^oC
Melting Point: 2227 ^oC + 20 ^oC
Vapor Density: N/A
Vapor Pressure: 0 @ 20 ^oC
Specific Gravity: 13.31 g/cc at 20 ^oC
% Volatile: N/A
Appearance and Odor: Silver metallic solid or gray powder, no odor.
Solubility in H_2O: Insoluble

IV. FIRE AND EXPLOSION HAZARDS DATA

Flash Point: N/A
Explosive Limits: **Lower**: N/E **Upper**: N/E
Ignition Point: Solid hafnium will not ignite. 10 micron powder may autoignite at room temperature.

Extinguishing Media: Use suitable media for metal fires, such as type D extinguisher or dry salt. DO NOT USE WATER.
Fire Fighting Procedures: Isolate burning material. It is advisable to allow large fires to burn out, keeping the fire from spreading. Firefighters must wear full face, self-contained breathing apparatus with full protective clothing to prevent contact with skin and eyes. Fumes from fire are hazardous. Isolate runoff to prevent environmental pollution.
Unusual Fire & Explosion Hazard: **Do not spray water on burning fines, chips, powder or sponge as a violent explosion may result**. This hazard increases with finer particles. If a fire starts in a mass of wet metal fines, such as a barrel of damp machining chips, the initial fire may be followed by an explosion and a very high temperature flash radiation. Therefore, when in doubt, personnel should retire and not attempt to extinguish the fire. The explosion characteristics of such material is caused by the hydrogen and steam generated by the burning mass. Carbon dioxide is not effective in extinguishing

burning hafnium. Powder may explode when heated with nitrogen, phosphorus, oxygen, sulfur, non-metals, oxidizing agents or halogens. May explode on contact with hot nitric acid and other oxidants.

V. HEALTH HAZARD INFORMATION

Effects of Exposure:

To the best of our knowledge the chemical, physical and toxicological properties of hafnium metal have not been thoroughly investigated and recorded. Hafnium is a poison by unspecified route. It is poorly soluble in water and thus is not absorbed efficiently by ingestion. Many hafnium compounds are poisons. (Sax, Dangerous Properties of Industrial Materials, eighth edition)

Acute Effects:

Inhalation: Toxic by inhalation. May cause irritation to the nose, throat and mucous membranes.
Ingestion: Considered to be non-toxic due to poor absorption in the alimentary tract of mammals.
Skin: May cause irritation.
Eye: May cause irritation.

Chronic Effects: May cause damage to the liver. No other chronic effects are recorded.

Routes of Entry: Inhalation, skin , eye

Target Organs: May affect the liver.
Medical Conditions Generally Aggravated by Exposure: Pre-existing respiratory disorders.
Carcinogenicity: **NTP**: No **IARC**: No **OSHA**: No

EMERGENCY AND FIRST AID PROCEDURES:

INHALATION: Remove victim to fresh air; keep warm and quiet; give oxygen if breathing is difficult and seek medical attention.
INGESTION: Seek medical advice.
SKIN: Remove contaminated clothing; brush material off skin; wash affected area with mild soap and water; seek medical attention if symptoms persist.
EYE: Flush eyes with lukewarm water, lifting upper and lower eyelids, for at least 15 minutes. Seek medical attention if symptoms persist.

VI. REACTIVITY DATA

Stability: Stable
Conditions to Avoid: None
Incompatibility (Material to Avoid): Hydrofluoric acid, hydrofluoric-nitric acid mixture, fluorine, chlorine, bromine, iodine, carbon tetrachloride, carbon tetrafluoride, freons, chlorates, chromates, nitrates, sulfates, molybdates, tungstate, borax, lead oxide and copper oxide.
Hazardous Decomposition Products: Hydrogen, fumes of nitrogen oxides and corrosive hafnium halide vapors.
Hazardous Polymerization: Will not occur

VII. SPILL OR LEAK PROCEDURES

Steps to be Taken in Case Material is Released or Spilled: For powder spills, wear appropriate respiratory and protective equipment specified in section VIII. Isolate spill area, provide ventilation and extinguish sources of ignition. Vacuum up spill using a high efficiency particulate absolute (HEPA) air filter and place in a closed container for proper disposal. Take care not to raise dust. Use non-sparking tools.

Waste Disposal Method: Dispose of in accordance with local, state, and federal regulations.

VIII. SPECIAL PROTECTION INFORMATION

Respiratory Protection: Wear appropriate NIOSH-approved dust-mist-vapor cartridge respirator while conducting operations such as surface grinding which will generate respirable dust.
Ventilation: Powder: Handle in an inert has such as argon, in a controlled atmosphere. Use local exhaust to maintain concentration at or below the PEL, TLV.

Protective Gloves: Rubber gloves
Eye Protection: Wear goggles or face mask while conducting operations such as surface grinding which will generate flying particles.
Protective Clothing: Protective gear suitable to prevent contamination.
Additional Protective Measures: Wear reflective heat resistant suit while burning fine scrap.

IX. SPECIAL PRECAUTIONS

Precautions to be Taken in Handling and Storage: Store in a cool, dry area. Store in tightly sealed container. Wash thoroughly after handling. Machining of hafnium may result in fine turnings, chips or dust. Any material with a dimension less than 0.0625 inch (1/16 in.) or a cross section less than 0.0078 in^2 (1/16 x 1/8), if present in any quantity, can be ignited and can sustain combustion. Keep away from any source of ignition. Keep fine turnings completely dry, or very wet. If wet, the water content should be more than 25% by weight for maximum safety in handling. **Severe explosions can result from ignition of hafnium powder or machining fines containing moisture in the concentration range of 5 to 10%.**
Other Precautions: Do not accumulate large quantities of fines or machining residues. Dispose of these materials daily.
FIRE DANGER: **FINE CHIPS, TURNINGS, OR GRINDING DUST PRODUCED FROM THIS METAL ARE FLAMMABLE**.
Work Practices: Implement engineering and work practice controls to reduce and maintain concentration of exposure at low levels. Use good housekeeping and sanitation practices. Do not use tobacco or food in work area. Wash thoroughly before eating or smoking. Do not blow dust off clothing or skin with compressed air. Maintain safety drench shower, eyewash capable of sustained flushing, and facilities for washing.

DOT Regulations:
Ingot, Pieces, Rod, Wire, Sheet, Foil:
Hazard Class: None
Powder:
Hazard Class: 4.2
Identification Number: UN2545
Packing Group: II
Proper Shipping Name: Hafnium powder, dry

The above information is believed to be correct, but does not purport to be all inclusive and shall be used only as a guide. ESPI shall not be held liable for any damage resulting from handling or from contact with the above product.

Issued by: S. Dierks
Date: May 2006

ELECTRONIC SPACE PRODUCTS INTERNATIONAL

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E-Mail: sales@espimetals.com

MATERIAL SAFETY DATA SHEET

I PRODUCT IDENTIFICATION

Trade Name: Copper Telluride
Chemical Family: Metal telluride
Molecular Weight: 186.53
Synonyms: Copper monotelluride
Formula: CuTe
CAS #: 12019-23-7

II HAZARDOUS INGREDIENTS

Hazardous Components	OSHA/PEL	ACGIH/TLV	Other	Percent	SEC. 302 (EHS) RQ	SEC. 304 SEC. 313
Copper Telluride	1 mg/m^3	1 mg/m^3	NE	0.0-100	No	Yes 1 lb. Yes
Tellurium Compounds	0.1 mg/m^3	0.1 mg/m^3	NE	0.0-100	No	Yes 1 lb. Yes

HMIS Ratings (0-4): **Health**: 3, **Flammability**: 0, **Reactivity**: 0

III PHYSICAL DATA

Boiling Point: NE or NA
Physical State: Solid
Specific Gravity (Water=1): NE
Vapor Pressure (mm Hg): NE
Appearance and Odor: Greyish-black powder and pieces, no odor.
Melting Point: NE or NA
Evaporation Rate: NA
Vapor Density (Air=1): NA
Solubility in Water: NE
% Volatile: NE or NA

IV FIRE AND EXPLOSION HAZARDS DATA

Flash Point: NE or NA
Method Used: Non-flammable
Flammable Limits: **LEL**: NA **UEL**: NA

Extinguishing Media: Not applicable. Use suitable extinguishing media for surrounding materials and type of fire.

Special Fire Fighting Procedures: Firefighters must wear full face, self-contained breathing apparatus with full protective clothing to prevent contact with skin and eyes. Fumes from fire are hazardous. Isolate runoff to prevent environmental pollution.

Unusual Fire & Explosion Hazards: When heated to decomposition, or on contact with acid or acid fumes, copper telluride may emit toxic fumes.

V HEALTH HAZARD INFORMATION

Health Hazards (Acute and Chronic):

To the best of our knowledge the chemical, physical and toxicological properties of copper telluride have not been thoroughly investigated and recorded. Copper compounds: In animals, inhalation of copper dust has caused hemolysis of the red blood cells, deposition of hemofuscin in the liver and pancreas, and injury to the lung cells. Injection of the dust has caused cirrhosis of the liver and pancreas, and a condition closely resembling hemochromatosis or bronzed diabetes (Sax, Dangerous Properties of Industrial Materials, eighth edition).

Elemental tellurium has relatively low toxicity. It is converted in the body to dimethyl telluride which imparts a garlic- like odor to breath and sweat. Heavy exposures may, in addition, result in headache, drowsiness, metallic taste, loss of appetite, nausea, tremors, convulsion, and respiratory arrest (Sax, Dangerous Properties of Industrial Materials, eighth edition).

Routes of Entry: Inhalation, Skin, Eyes, Ingestion

Acute Effects:

Inhalation: DANGER-POISON. May cause a metallic taste in the mouth, congestion of the nasal mucous membranes, dry mouth, irritation to the respiratory tract, nausea, vomiting, garlic odor to the breath, sweat and urine.
Ingestion: DANGER-POISON. May cause a dry mouth, suppression of sweat, garlic odor to breath and urine, and acute copper toxicity.
Skin: May cause irritation.
Eye: May cause irritation to the conjunctiva.

Chronic Effects:

Inhalation: May cause ulceration and perforation of the nasal septum, pharyngeal congestion, anorexia, nausea, depression to the central nervous system and somnolence.
Ingestion: May cause irritation to the gastrointestinal tract, anorexia, nausea, depression to the central nervous system, somnolence and chronic copper toxicity. May cause damage to the nervous system, kidneys and enlarge the liver.
Skin: May cause dermatitis.
Eye: No chronic health effects recorded.

Target Organs: May affect the respiratory system, skin, liver, central nervous system, and kidneys.
Carcinogenicity: **NTP?** No **IARC Monographs?** No **OSHA Regulated?** No

Signs and Symptoms of Exposure:

Inhalation: May cause a red, dry throat, metallic taste in mouth, garlic-like odor to breath, sweat and urine, loss of appetite, sleepiness, nausea, congestion of the nasal and pharyngeal, sneezing, headache, excitability, dizziness and

difficulty breathing.
Ingestion: May cause a dry mouth, garlic-like odor to breath and urine, loss of appetite, sleepiness, and nausea. Acute copper toxicity may cause: fever, tachycardia, hypotension, hemolytic anemia with intravascular hemolysis, oliguria, uremia, coma and cardiovascular collapse. Chronic copper toxicity may cause: nausea, vomiting, epigastric pain, yellow watery diarrhea, dizziness, general debility, jaundice, and green stools, saliva, and vomitus.
Skin: May cause redness, itching, and swelling.
Eye: May cause redness, itching, burning and watering.

Medical Conditions Generally Aggravated by Exposure: Pre-existing respiratory, gastric disorders, and an increased risk for individuals with Wilson's disease.

EMERGENCY AND FIRST AID PROCEDURES:

INHALATION: Remove victim to fresh air; keep warm and quiet; give oxygen if breathing is difficult and seek medical attention immediately.
INGESTION: Give 1-2 glasses of milk or water and induce vomiting; seek medical attention immediately. Never induce vomiting or give anything by mouth to an unconscious person.
SKIN: Remove contaminated clothing; brush material off skin; wash affected area with mild soap and water; seek medical attention if symptoms persist.
EYE: Flush eyes with lukewarm water, lifting upper and lower eyelids, for at least 15 minutes. Seek medical attention if symptoms persist.

VI REACTIVITY DATA

Stability: Stable

Conditions to Avoid (Instability): None
Incompatibility- Materials to Avoid: Acids and acid fumes

Hazardous Decomposition or Byproducts: None recorded
Hazardous Polymerization: Will not occur

VII SPILL OR LEAK PROCEDURES

Steps to Be Taken in Case Material Is Released or Spilled: Wear appropriate respiratory and protective equipment specified in Section VIII- Special Protection Information. Isolate spill area and provide ventilation. Vacuum up spill using a high efficiency particulate absolute (HEPA) air filter and place in a closed container for proper disposal. Take care not to raise dust.

Waste Disposal Method: Dispose of in accordance with Local, State and Federal regulations.

VIII SPECIAL PROTECTION INFORMATION

Respiratory Protection (Specify Type): NIOSH approved dust, mist, vapor cartridge respirator.
Ventilation: **Local**: To maintain concentration at or below PEL, TLV **Mechanical (General)**: Recommended
Protective Gloves: Rubber **Eye Protection**: Safety glasses
Other Protective Clothing or Equipment: Protective gear suitable to prevent contamination.

IX SPECIAL PRECAUTIONS

Precautions to Be Taken in Handling and Storage: Store in a cool, dry place in a tightly sealed container. Wash thoroughly after handling.

Work/Hygienic/Maintenance Practices: Implement engineering and work practice controls to reduce and maintain concentration of exposure at low levels. Use good housekeeping and sanitation practices. Do not use tobacco or food in work area. Wash thoroughly before eating and smoking. Do not blow dust off clothing or skin with compressed air.

Prepared by: S Dierks
Dated: June 1998