1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING

Product identifier
Product Name Hafnium Oxide
Other means of identification
Product Code SAC005
Synonyms Hafnium Oxide grades P, R, S and Spectro (Prod# 417, 404)

Recommended use of the chemical and restrictions on use
Recommended Use Alloy product manufacture.
Uses advised against

Details of the supplier of the safety data sheet
Manufacturer Address ATI, 1000 Six PPG Place, Pittsburgh, PA 15222 USA
Emergency telephone number Chemtrec: 1-800-424-9300

2. HAZARDS IDENTIFICATION

Classification
This chemical is not considered hazardous by the 2012 OSHA Hazard Communication Standard (29 CFR 1910.1200)

Label elements

<table>
<thead>
<tr>
<th>Appearance</th>
<th>Physical state</th>
<th>Odor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Powder</td>
<td>Solid</td>
<td>Odorless</td>
</tr>
</tbody>
</table>

Hazards not otherwise classified (HNOC)
Not applicable
Other Information

3. COMPOSITION/INFORMATION ON INGREDIENTS


<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>CAS No.</th>
<th>Weight-%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hafnium Dioxide</td>
<td>12055-23-1</td>
<td>96-100</td>
</tr>
<tr>
<td>Zirconium Dioxide</td>
<td>1314-23-4</td>
<td>0-4</td>
</tr>
</tbody>
</table>
4. FIRST AID MEASURES

First aid measures

Eye contact  In the case of particles coming in contact with eyes during processing, treat as with any foreign object.

Skin Contact  None under normal use conditions.

Inhalation  If excessive amounts of smoke, fume, or particulate are inhaled during processing, remove to fresh air and consult a qualified health professional.

Ingestion  IF SWALLOWED. Call a POISON CENTER or doctor/physician if you feel unwell.

Most important symptoms and effects, both acute and delayed

Symptoms  None anticipated.

Indication of any immediate medical attention and special treatment needed

Note to physicians  Treat symptomatically.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media  Non-combustible.

Unsuitable extinguishing media  Non-combustible.

Specific hazards arising from the chemical  Non-combustible.

Hazardous combustion products  Not applicable.

Explosion data
- Sensitivity to Mechanical Impact  None.
- Sensitivity to Static Discharge  None.

Protective equipment and precautions for firefighters

Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear.

6. ACCIDENTAL RELEASE MEASURES

Personal precautions, protective equipment and emergency procedures

Personal precautions  Use personal protective equipment as required.

For emergency responders  Use personal protective equipment as required.

Environmental precautions

Environmental precautions  Collect spillage to prevent release to the environment.

Methods and material for containment and cleaning up

Methods for containment  Prevent further leakage or spillage if safe to do so.

Methods for cleaning up  Sweep or shovel material into dry containers. Avoid creating uncontrolled dust.

7. HANDLING AND STORAGE

Precautions for safe handling
Advice on safe handling
Handle in accordance with good industrial hygiene and safety practice.

Conditions for safe storage, including any incompatibilities

Storage Conditions
Keep in properly labeled containers.

Incompatible materials
None known.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Control parameters

Exposure Guidelines

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>ACGIH TLV</th>
<th>OSHA PEL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hafnium Dioxide 12055-23-1</td>
<td>TWA: 0.5 mg/m³ Hf</td>
<td>-</td>
</tr>
<tr>
<td>Zirconium Dioxide 1314-23-4</td>
<td>STEL: 10 mg/m³ Zr</td>
<td>TWA: 5 mg/m³ Zr</td>
</tr>
</tbody>
</table>

Appropriate engineering controls

Engineering Controls
Avoid generation of uncontrolled particles.

Individual protection measures, such as personal protective equipment

Eye/face protection
When airborne particles may be present, appropriate eye protection is recommended. For example, tight-fitting goggles, foam-lined safety glasses or other protective equipment that shield the eyes from particles.

Skin and body protection
Wear protective gloves.

Respiratory protection
When particulates/fumes/gases are generated and if exposure limits are exceeded or irritation is experienced, proper approved respiratory protection should be worn. Positive-pressure supplied air respirators may be required for high airborne contaminant concentrations. Respiratory protection must be provided in accordance with current local regulations.

General Hygiene Considerations
Handle in accordance with good industrial hygiene and safety practice.

9. PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

<table>
<thead>
<tr>
<th>Physical state</th>
<th>Solid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>Powder</td>
</tr>
<tr>
<td>Color</td>
<td>white</td>
</tr>
<tr>
<td>Odor</td>
<td>Odorless</td>
</tr>
<tr>
<td>Odor threshold</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Property</th>
<th>Values</th>
<th>Remarks • Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Melting point/freezing point</td>
<td>2760 °C / 5000 °F</td>
<td></td>
</tr>
<tr>
<td>Boiling point / boiling range</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Flash point</td>
<td>-</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Evaporation rate</td>
<td>-</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Flammability (solid, gas)</td>
<td>-</td>
<td>Not flammable</td>
</tr>
<tr>
<td>Flammability Limit in Air</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Upper flammability limit</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Lower flammability limit</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Vapor pressure</td>
<td>-</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Vapor density</td>
<td>-</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>9.68</td>
<td></td>
</tr>
</tbody>
</table>
Water solubility               Insoluble
Solubility in other solvents -
Partition coefficient -  Not applicable
Autoignition temperature -  Not applicable
Decomposition temperature -  Not applicable
Kinematic viscosity -  Not applicable
Dynamic viscosity -  Not applicable
Explosive properties Not applicable
Oxidizing properties Not applicable

Other Information
Softening point -
Molecular weight -
VOC Content (%) Not applicable
Density -
Bulk density 89-180 lb/ft³

10. STABILITY AND REACTIVITY

Reactivity
Not applicable

Chemical stability
Stable under normal conditions.

Possibility of Hazardous Reactions
None under normal processing.

Hazardous polymerization Hazardous polymerization does not occur.

Conditions to avoid
Dust formation and dust accumulation.

Incompatible materials
None known.

Hazardous Decomposition Products
Not applicable.

11. TOXICOLOGICAL INFORMATION

Information on likely routes of exposure

Product Information

Inhalation Product not classified.
Eye contact Product not classified.
Skin Contact Product not classified.
Ingestion Product not classified.

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Oral LD50</th>
<th>Dermal LD50</th>
<th>Inhalation LC50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hafnium Dioxide 12055-23-1</td>
<td>&gt;2000 mg/kg bw</td>
<td>-</td>
<td>&gt;4.3 mg/L</td>
</tr>
<tr>
<td>Zirconium Dioxide 1314-23-4</td>
<td>&gt;5000 mg/kg bw</td>
<td>-</td>
<td>&gt;4.3 mg/L</td>
</tr>
</tbody>
</table>

Information on toxicological effects
Symptoms

None known.

Delayed and immediate effects as well as chronic effects from short and long-term exposure

Skin corrosion/irritation
Serious eye damage/eye irritation
Sensitization
Germ cell mutagenicity
Carcinogenicity

Product not classified.

Reproductive toxicity

Product not classified.

STOT - single exposure
STOT - repeated exposure

Product not classified.

Aspiration hazard

Product not classified.

Target Organ Effects

Aspiration hazard

Product not classified.

12. ECOLOGICAL INFORMATION

Ecotoxicity

This product as shipped is not classified for aquatic toxicity.

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Algae/aquatic plants</th>
<th>Fish</th>
<th>Toxicity to microorganisms</th>
<th>Crustacea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hafnium Dioxide 12055-23-1</td>
<td>The 72 h EC50 of Hafnium dioxide in water to Pseudokirchneriella subcapitata was was greater than the solubility limit of 0.008 mg Hf/L</td>
<td>The 96 h LC50 of Hafnium dioxide in water to Danio rerio was greater than the solubility limit of 0.007 mg Hf/L</td>
<td>-</td>
<td>The 48 h EC50 of Hafnium dioxide to Daphnia magna was greater than the solubility limit of 0.007 mg Hf/L</td>
</tr>
<tr>
<td>Zirconium Dioxide 1314-23-4</td>
<td>The 15 d NOEC of zirconium dichloride oxide to Chlorella vulgaris was greater than 200 mg/L</td>
<td>The 96 h LL50 of zirconium dioxide to Danio rerio was greater than 100 mg/L.</td>
<td>-</td>
<td>The 48 h EC50 of zirconium dioxide to Daphnia magna was greater than 100 mg/L</td>
</tr>
</tbody>
</table>

Persistence and degradability

Bioaccumulation

Mobility

Other adverse effects

13. DISPOSAL CONSIDERATIONS

Waste treatment methods

Disposal of wastes

Disposal should be in accordance with applicable regional, national and local laws and regulations.

Contaminated packaging

Disposal should be in accordance with applicable regional, national and local laws and regulations.

14. TRANSPORT INFORMATION
15. REGULATORY INFORMATION

DOT
Not regulated

International Inventories

<table>
<thead>
<tr>
<th>TSCA</th>
<th>Complies</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSL/NDSL</td>
<td>Complies</td>
</tr>
<tr>
<td>EINECS/ELINCS</td>
<td>Complies</td>
</tr>
<tr>
<td>ENCS</td>
<td>Complies</td>
</tr>
<tr>
<td>IECSC</td>
<td>Complies</td>
</tr>
<tr>
<td>KECL</td>
<td>Complies</td>
</tr>
<tr>
<td>PICCS</td>
<td>Not Listed</td>
</tr>
<tr>
<td>AICS</td>
<td>Not Listed</td>
</tr>
</tbody>
</table>

Legend:
TSCA - United States Toxic Substances Control Act Section 8(b) Inventory
DSL/NDSL - Canadian Domestic Substances List/Non-Domestic Substances List
EINECS/ELINCS - European Inventory of Existing Chemical Substances/European List of Notified Chemical Substances
ENCS - Japan Existing and New Chemical Substances
IECSC - China Inventory of Existing Chemical Substances
KECL - Korean Existing and Evaluated Chemical Substances
PICCS - Philippines Inventory of Chemicals and Chemical Substances
AICS - Australian Inventory of Chemical Substances

US Federal Regulations

SARA 313
Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA). This product does not contain any chemicals which are subject to the reporting requirements of the Act and Title 40 of the Code of Federal Regulations, Part 372

SARA 311/312 Hazard Categories

<table>
<thead>
<tr>
<th>Hazard Category</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute health hazard</td>
<td>No</td>
</tr>
<tr>
<td>Chronic Health Hazard</td>
<td>No</td>
</tr>
<tr>
<td>Fire hazard</td>
<td>No</td>
</tr>
<tr>
<td>Sudden release of pressure hazard</td>
<td>No</td>
</tr>
<tr>
<td>Reactive Hazard</td>
<td>No</td>
</tr>
</tbody>
</table>

CWA (Clean Water Act)
This product does not contain any substances regulated as pollutants pursuant to the Clean Water Act (40 CFR 122.21 and 40 CFR 122.42)

CERCLA
This material, as supplied, does not contain any substances regulated as hazardous substances under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) (40 CFR 302) or the Superfund Amendments and Reauthorization Act (SARA) (40 CFR 355). There may be specific reporting requirements at the local, regional, or state level pertaining to releases of this material

US State Regulations

California Proposition 65
This product does not contain any Proposition 65 chemicals

U.S. State Right-to-Know Regulations

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>New Jersey</th>
<th>Massachusetts</th>
<th>Pennsylvania</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zirconium Dioxide 1314-23-4</td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>
U.S. EPA Label Information
EPA Pesticide Registration Number  Not applicable

16. OTHER INFORMATION

<table>
<thead>
<tr>
<th>NFPA</th>
<th>Health hazards</th>
<th>Flammability</th>
<th>Instability</th>
<th>Physical and Chemical Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HMIS</th>
<th>Health hazards</th>
<th>Flammability</th>
<th>Physical hazards</th>
<th>Personal protection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1*</td>
<td>0</td>
<td>0</td>
<td>X</td>
</tr>
</tbody>
</table>

Prepared By
Issue Date  28-May-2015
Revision Date  22-Jan-2018
Revision Note
Updated Section(s): 2, 5, 8, 9, 10, 15

Note:
The information provided in this safety data sheet is correct to the best of our knowledge, information and belief at the date of its publication. The information given is designed only as a guidance for safe handling, use, processing, storage, transportation, disposal and release and is not to be considered a warranty or quality specification. The information relates only to the specific material designated and may not be valid for such material used in combination with any other materials or in any process, unless specified in the text.

End of Safety Data Sheet

Additional information available from:
Safety data sheets and labels available at ATImetals.com