Section 1: PRODUCT AND COMPANY IDENTIFICATION

A  Product Name  Hafnium Oxide

Synonyms  Hafnium Oxide grades P, R, S and Spectro (Prod# 417, 404)

Product Code  SAC005

B  Recommended Use  Alloy product manufacture

C  Supplier

Manufacturer  ATI, 1000 Six PPG Place, Pittsburgh, PA 15222 USA

Emergency Telephone  Chemtrec +1 703-741-5970

Section 2: HAZARDS IDENTIFICATION

A  GHS - Classification

Not a hazardous substance or mixture according to the Globally Harmonized System (GHS)

B  Label elements

Emergency Overview

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

C  Other Information

Hazards not otherwise classified (HNOC)

• Not applicable

Section 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>

Section 4: FIRST AID MEASURES

A  Eye contact

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

B  Skin Contact

None under normal use conditions

C  Inhalation

If excessive amounts of smoke, fume, or particulate are inhaled during processing, remove to fresh air and consult a qualified health professional
D  Ingestion
IF SWALLOWED Call a POISON CENTER or doctor/physician if you feel unwell

E  Symptoms
None anticipated.

F.  Indication of immediate medical attention and special treatment needed, if necessary
Treat symptomatically.

Section 5: FIRE FIGHTING MEASURES

A  Suitable extinguishing media
Non-combustible

Unsuitable extinguishing media
Non-combustible

B  Specific hazards arising from the chemical
Non-combustible

Hazardous combustion products
Not applicable.

C Special protective equipment for fire-fighters
Firefighters should wear self-contained breathing apparatus and full firefighting turnout gear.

Section 6: ACCIDENTAL RELEASE MEASURES

A  Personal precautions
Use personal protective equipment as required.

For emergency responders
Use personal protective equipment as required.

B  Environmental precautions
Collect spillage to prevent release to the environment

C. 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

Section 7: HANDLING AND STORAGE

A  Advice on safe handling
Handle in accordance with good industrial hygiene and safety practice

B  Storage Conditions
Keep in properly labeled containers

Incompatible materials
None known

Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

A  Control parameters

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Korea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hafnium Dioxide</td>
<td>-</td>
</tr>
<tr>
<td>Zirconium Dioxide</td>
<td>STEL: 10 mg/m³  TWA: 5 mg/m³</td>
</tr>
</tbody>
</table>

B  Engineering Controls
Avoid generation of uncontrolled particles

C  Personal Protective Equipment

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.

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. Wear protective gloves. Handle in accordance with good industrial hygiene and safety practice.

### Section 9: PHYSICAL AND CHEMICAL PROPERTIES

#### Information on basic physical and chemical properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Values</th>
<th>Remarks • Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>D pH</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>E Melting point/freezing point</td>
<td>2760 °C / 5000 °F</td>
<td>-</td>
</tr>
<tr>
<td>F Boiling point / boiling range</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>G Flash point</td>
<td>-</td>
<td>Not applicable</td>
</tr>
<tr>
<td>H Evaporation rate</td>
<td>-</td>
<td>Not applicable</td>
</tr>
<tr>
<td>I Flammability (solid, gas)</td>
<td>-</td>
<td>Not flammable</td>
</tr>
<tr>
<td>J Flammability Limit in Air</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>K Vapor pressure</td>
<td>-</td>
<td>Not applicable</td>
</tr>
<tr>
<td>L Solubility(ies)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Water solubility</td>
<td>Insoluble</td>
<td>-</td>
</tr>
<tr>
<td>Solubility in other solvents</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>M Vapor density</td>
<td>-</td>
<td>Not applicable</td>
</tr>
<tr>
<td>N Specific Gravity</td>
<td>9.68</td>
<td>-</td>
</tr>
<tr>
<td>O. Partition coefficient</td>
<td>-</td>
<td>Not applicable</td>
</tr>
<tr>
<td>P. Autoignition temperature</td>
<td>-</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Q. Decomposition temperature</td>
<td>-</td>
<td>Not applicable</td>
</tr>
<tr>
<td>R Kinematic viscosity</td>
<td>-</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Dynamic viscosity</td>
<td>-</td>
<td>Not applicable</td>
</tr>
<tr>
<td>S. Molecular weight</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

#### Other Information

- Explosive properties: Not applicable
- Oxidizing properties: Not applicable
- Softening point: -
- VOC Content (%): Not applicable
- Density: -
- Bulk density: 89-180 lb/ft³

### Section 10: STABILITY AND REACTIVITY

#### A Stability

Stable under normal conditions

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

#### B Possibility of Hazardous Reactions

- Hazardous polymerization: None under normal processing. Hazardous polymerization does not occur.

#### C Conditions to avoid

Dust formation and dust accumulation

#### D Incompatible materials

None known

#### E Hazardous Decomposition Products

Not applicable
Section 11: TOXICOLOGICAL INFORMATION

A  Information on likely routes of exposure
Inhalation  Product not classified.
Ingestion  Product not classified.
Eye contact  Product not classified.
Skin Contact  Product not classified.

B  Delayed and immediate effects as well as chronic effects from short and long-term exposure
Skin corrosion/irritation  Product not classified.
Serious eye damage/eye irritation  Product not classified.
Sensitization  Product not classified
Carcinogenicity  Product not classified
Germ cell mutagenicity  Product not classified
Reproductive toxicity  Product not classified
STOT - single exposure  Product not classified.
STOT - repeated exposure  Product not classified.
Target Organ Effects  Aspiration hazard  Product not classified

C  Numerical measures of toxicity

<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</td>
<td>&gt;2000 mg/kg bw</td>
<td>-</td>
<td>&gt;4.3 mg/L</td>
</tr>
<tr>
<td>Zirconium Dioxide</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.

Section 12: ECOLOGICAL INFORMATION

A  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</td>
<td>The 72 h EC50 of Hafnium dioxide in water to Pseudokirchneriella subcapitata was greater than the solubility limit of 0.007 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>The 48 h EC50 of Hafnium dioxide to Daphnia magna was greater than the solubility limit of 0.007 mg Hf/L</td>
<td></td>
</tr>
<tr>
<td>Zirconium Dioxide</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>The 48 h EC50 of zirconium dioxide to Daphnia magna was greater than 100 mg/L</td>
<td></td>
</tr>
</tbody>
</table>

B  Persistence and degradability  .

C  Bioaccumulation  .

D  Mobility  .

E  Other adverse effects

Section 13: DISPOSAL CONSIDERATIONS

A  Waste from residues/unused  Disposal should be in accordance with applicable regional, national and local laws and

Page 4 / 6
B Contaminated packaging

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

Section 14: TRANSPORT INFORMATION

| A UN/ID No. | Not regulated |
| B Proper shipping name | Not regulated |
| C Hazard Class | Not regulated |
| D Packing Group | Not regulated |
| E Marine pollutant | Not regulated |

Section 15: REGULATORY INFORMATION

A Industrial Safety and Health Law

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>ISHA - Harmful Substances Prohibited for Manufacturing, Importing, Transferring, or Supplying</th>
<th>Korea. Harmful Substances Requiring Permission</th>
<th>ISHA - Substances to be controlled - Organic Substances</th>
<th>ISHA - Substances to be controlled - Metals</th>
<th>ISHA - Substances to be controlled - Acids and bases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hafnium Dioxide</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Zirconium Dioxide</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

B Toxic Chemicals Control Law

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Toxic Chemical Classification Listing (TCCL) - Toxic Chemicals</th>
<th>Toxic Chemicals Control Law - Banned and/or restricted</th>
<th>Toxic Chemicals Control Law - Restrictions on use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hafnium Dioxide</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Zirconium Dioxide</td>
<td>Not applicable</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

C Dangerous Material Safety

Control

D Wastes Management

Dispose of in accordance with federal, state and local regulations

E Other Regulations

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Toxic Release Inventory Chemicals - Group 1</th>
<th>Toxic Release Inventory Chemicals - Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hafnium Dioxide</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Zirconium Dioxide</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

International Inventories

- DSL/NDSL: Complies
- EINECS/ELINCS: Complies
- ENCS: Complies
- IECSC: Complies
- KECL: Complies
- PICCS: Not Listed
- AICS: Not Listed

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
Section 16: OTHER INFORMATION

A Prepared By

B Issue Date 28-May-2015

C Revision Date 22-Jan-2018
Version 4
Revision Note Updated Section(s): 2, 5, 8, 9, 10, 15

D Other Information

Note:
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