SAFETY DATA SHEET

1.1. Product identifier

Product Code SAC005
Product Name Hafnium Oxide

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

1.2. Relevant identified uses of the substance or mixture and uses advised against

Recommended Use Alloy product manufacture

Uses advised against

1.3. Details of the supplier of the safety data sheet

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

1.4. Emergency telephone number

Emergency Telephone Chemtrec: +1-703-741-5970

2.1. Classification of the substance or mixture

Regulation (EC) No 1272/2008

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

2.2. Label elements

Emergency Overview

Appearance Powder Physical state Solid Odour Odourless

2.3. Hazards not otherwise classified (HNOC)

Not applicable

Other Information

3.1. Substances

## Section 4: FIRST AID MEASURES

### 4.1. Description of first aid measures

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

**Skin Contact**
None under normal use conditions.

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

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

### 4.2. Most important symptoms and effects, both acute and delayed

**Symptoms**
None anticipated.

### 4.3. Indication of any immediate medical attention and special treatment needed

**Note to doctors**
Treat symptomatically.

## Section 5: FIRE FIGHTING MEASURES

### 5.1. Extinguishing media

**Suitable extinguishing media**
Non-combustible.

**Unsuitable extinguishing media**
Non-combustible

### 5.2. Special hazards arising from the substance or mixture

**Non-combustible**

**Hazardous combustion products**
Not applicable.

### 5.3. Advice for firefighters

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

## Section 6: ACCIDENTAL RELEASE MEASURES

### 6.1. Personal precautions, protective equipment and emergency procedures

**Personal precautions**
Use personal protective equipment as required.

**For emergency responders**
Use personal protective equipment as required.

### 6.2. Environmental precautions

Collect spillage to prevent release to the environment.
6.3. 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.

6.4. Reference to other sections

See Section 12: ECOLOGICAL INFORMATION.

Section 7: HANDLING AND STORAGE

7.1. Precautions for safe handling

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

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

7.2. Conditions for safe storage, including any incompatibilities

Storage Conditions
Keep in properly labelled containers.

Incompatible materials
None known.

7.3. Specific end use(s)

Risk Management Methods (RMM)
Not required.

Section 8: EXPOSURE CONTROLS/PERSONAL PROTECTION

8.1. Control parameters

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>European Union</th>
<th>United Kingdom</th>
<th>France</th>
<th>Spain TWA</th>
<th>Germany TWA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hafnium Dioxide</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>TWA: 0.5 mg/m³</td>
<td>-</td>
</tr>
<tr>
<td>Zirconium Dioxide</td>
<td>-</td>
<td>TWA: 5 mg/m³</td>
<td>-</td>
<td>STEL: 10 mg/m³</td>
<td>-</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Italy</th>
<th>Portugal</th>
<th>Netherlands</th>
<th>Finland TWA</th>
<th>Denmark TWA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hafnium Dioxide</td>
<td>TWA: 0.5 mg/m³</td>
<td>-</td>
<td>-</td>
<td>TWA: 0.5 mg/m³</td>
<td>-</td>
</tr>
<tr>
<td>Zirconium Dioxide</td>
<td>STEL: 10 mg/m³</td>
<td>TWA: 5 mg/m³</td>
<td>-</td>
<td>TWA: 1 mg/m³</td>
<td>TWA: 5 mg/m³</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>Austria</th>
<th>Switzerland</th>
<th>Poland</th>
<th>Norway TWA</th>
<th>Ireland TWA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hafnium Dioxide</td>
<td>TWA: 0.5 mg/m³</td>
<td>-</td>
<td>TWA: 0.5 mg/m³</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Zirconium Dioxide</td>
<td>TWA: 5 mg/m³</td>
<td>TWA: 5 mg/m³</td>
<td>STEL: 10 mg/m³</td>
<td>TWA: 5 mg/m³</td>
<td>TWA: 5 mg/m³</td>
</tr>
</tbody>
</table>

Derived No Effect Level (DNEL)
No DNELs are available for this product as a whole.

Predicted No Effect Concentration (PNEC)
No PNECs are available for this product as a whole.

8.2. Exposure controls

Engineering Controls
Avoid generation of uncontrolled particles.
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 contaminate concentrations. Respiratory protection must be provided in accordance with current local regulations.

Environmental exposure controls
Section 6: ACCIDENTAL RELEASE MEASURES.

Section 9: PHYSICAL AND CHEMICAL PROPERTIES

9.1. 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>Physical state</td>
<td>Solid</td>
<td></td>
</tr>
<tr>
<td>Appearance</td>
<td>Powder</td>
<td>Odour</td>
</tr>
<tr>
<td>Colour</td>
<td>white</td>
<td>Odour threshold</td>
</tr>
<tr>
<td>Softening point</td>
<td>-</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Melting point/freezing point</td>
<td>2760 °C / 5000 °F</td>
<td>Not applicable</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>Upper flammability limit</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Lower flammability limit</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Vapour pressure</td>
<td>-</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Vapour density</td>
<td>-</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>9.68</td>
<td>Insoluble</td>
</tr>
<tr>
<td>Water solubility</td>
<td>Insoluble</td>
<td></td>
</tr>
<tr>
<td>Solubility(ies)</td>
<td></td>
<td>Not applicable</td>
</tr>
<tr>
<td>Partition coefficient</td>
<td>-</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Autoignition temperature</td>
<td>-</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Decomposition temperature</td>
<td>-</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Kinematic viscosity</td>
<td>-</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Dynamic viscosity</td>
<td>-</td>
<td>Not applicable</td>
</tr>
<tr>
<td>Explosive properties</td>
<td>Not applicable</td>
<td></td>
</tr>
<tr>
<td>Oxidising properties</td>
<td>Not applicable</td>
<td></td>
</tr>
</tbody>
</table>

9.2. Other information

<table>
<thead>
<tr>
<th>Property</th>
<th>Values</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Softening point</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Molecular weight</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>VOC Content (%)</td>
<td>Not applicable</td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Bulk density</td>
<td>89-180 lb/ft3</td>
<td></td>
</tr>
</tbody>
</table>

Section 10: STABILITY AND REACTIVITY

10.1. Reactivity

Not applicable

10.2. Chemical stability

Stable under normal conditions.

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

10.3. Possibility of hazardous reactions

Hazardous polymerisation
Hazardous polymerisation does not occur.

Possibility of Hazardous Reactions
None under normal processing.

10.4. Conditions to avoid

Dust formation and dust accumulation.

10.5. Incompatible materials

None known.

10.6. Hazardous decomposition products

Not applicable.

Section 11: TOXICOLOGICAL INFORMATION

11.1. Information on toxicological effects

Product Information

<table>
<thead>
<tr>
<th>Inhalation</th>
<th>Product not classified.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye contact</td>
<td>Product not classified.</td>
</tr>
<tr>
<td>Skin Contact</td>
<td>Product not classified.</td>
</tr>
<tr>
<td>Ingestion</td>
<td>Product not classified.</td>
</tr>
</tbody>
</table>

<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.

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.
Sensitisation  Product not classified.
Germ cell mutagenicity  Product not classified.
Carcinogenicity  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.
Section 12: ECOLOGICAL INFORMATION

12.1. Toxicity

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 Micro-organisms</th>
<th>Crustacea</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hafnium Dioxide</td>
<td>The 72 h EC50 of Hafnium dioxide in water to <em>Pseudokirchneriella subcapitata</em> was greater than the solubility limit of 0.008 mg Hf/L</td>
<td>The 96 h LC50 of Hafnium dioxide in water to <em>Danio rerio</em> was greater than the solubility limit of 0.007 mg Hf/L</td>
<td>-</td>
<td>The 48 h EC50 of Hafnium dioxide to <em>Daphnia magna</em> was greater than the solubility limit of 0.007 mg Hf/L</td>
</tr>
<tr>
<td>Zirconium Dioxide</td>
<td>The 15 d NOEC of zirconium dichloride oxide to <em>Chlorella vulgaris</em> was greater than 200 mg/L</td>
<td>The 96 h LL50 of zirconium dioxide to <em>Danio rerio</em> was greater than 100 mg/L</td>
<td>-</td>
<td>The 48 h EC50 of zirconium dioxide to <em>Daphnia magna</em> was greater than 100 mg/L</td>
</tr>
</tbody>
</table>

12.2. Persistence and degradability

12.3. Bioaccumulative potential

12.4. Mobility in soil

Mobility

12.5. Results of PBT and vPvB assessment

The PBT and vPvB criteria do not apply to inorganic substances.

12.6. Other adverse effects

Section 13: DISPOSAL CONSIDERATIONS

13.1. Waste treatment methods

<table>
<thead>
<tr>
<th>Waste from residues/unused products</th>
<th>Disposal should be in accordance with applicable regional, national and local laws and regulations.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contaminated packaging</td>
<td>Disposal should be in accordance with applicable regional, national and local laws and regulations.</td>
</tr>
</tbody>
</table>

Section 14: TRANSPORT INFORMATION

IMDG

14.1 UN/ID no | Not regulated |
14.2 Proper shipping name | Not regulated |
14.3 Hazard Class | Not regulated |
14.4 Packing Group | Not regulated |
14.5 Marine pollutant | Not applicable |
14.6 Special Provisions | None |
14.7 Transport in bulk according to Annex II of MARPOL 73/78 and the | Not applicable |
IBC Code

RID
14.1 UN/ID no Not regulated
14.2 Proper shipping name Not regulated
14.3 Hazard Class Not regulated
14.4 Packing Group Not regulated
14.5 Environmental hazard Not applicable
14.6 Special Provisions None

ADR
14.1 UN/ID no Not regulated
14.2 Proper shipping name Not regulated
14.3 Hazard Class Not regulated
14.4 Packing Group Not regulated
14.5 Environmental hazard Not applicable
14.6 Special Provisions None

ICAO (air)
14.1 UN/ID no Not regulated
14.2 Proper shipping name Not regulated
14.3 Hazard Class Not regulated
14.4 Packing Group Not applicable
14.5 Environmental hazard Not applicable
14.6 Special Provisions None

IATA
14.1 UN/ID no Not regulated
14.2 Proper shipping name Not regulated
14.3 Hazard Class Not regulated
14.4 Packing Group Not regulated
14.5 Environmental hazard Not applicable
14.6 Special Provisions None

Section 15: REGULATORY INFORMATION

15.1. Safety, health and environmental regulations/legislation specific for the substance or mixture

<table>
<thead>
<tr>
<th>Chemical Name</th>
<th>French RG number</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hafnium Dioxide</td>
<td>12055-23-1</td>
<td>-</td>
</tr>
<tr>
<td>Zirconium Dioxide</td>
<td>1314-23-4</td>
<td>-</td>
</tr>
</tbody>
</table>

European Union

Take note of Directive 98/24/EC on the protection of the health and safety of workers from the risks related to chemical agents at work

Authorisations and/or restrictions on use:
This product does not contain substances subject to authorisation (Regulation (EC) No. 1907/2006 (REACH), Annex XIV). This product does not contain substances subject to restriction (Regulation (EC) No. 1907/2006 (REACH), Annex XVII).

International Inventories

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

15.2. Chemical safety assessment

No chemical safety assessment has been performed for this product.

Section 16: OTHER INFORMATION

Prepared By

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

This material safety data sheet complies with the requirements of Regulation (EC) No. 1907/2006

Note:
The information provided in this Material 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.

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

End of Safety Data Sheet