SECTION 1: Identification of the substance/mixture and of the company/undertaking

1.1. Product identifier

<table>
<thead>
<tr>
<th>Product form</th>
<th>Mixture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical state</td>
<td>Liquid</td>
</tr>
<tr>
<td>Product name</td>
<td>HAFNIUM n-BUTOXIDE</td>
</tr>
<tr>
<td>Product code</td>
<td>AKH325.1</td>
</tr>
<tr>
<td>Formula</td>
<td>C16H36HfO4</td>
</tr>
<tr>
<td>Synonyms</td>
<td>HAFNIUM TETRABUTOXIDE; HAFNIUM TETRA-N-BUTOXIDE; HAFNIUM BUTYLATE; TETRA-N-BUTOXYHAFNIUM</td>
</tr>
<tr>
<td>Chemical family</td>
<td>METAL ALKOXIDE</td>
</tr>
</tbody>
</table>

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

Use of the substance/mixture: Chemical intermediate
For research use only

1.3. Details of the supplier of the safety data sheet

GELEST, INC.
11 East Steel Road
Morrisville, PA 19067
USA
T 215-547-1015 - F 215-547-2484 - (M-F): 8:00 AM - 5:30 PM EST
info@gelest.com - www.gelest.com

1.4. Emergency telephone number

Emergency number: CHEMTREC: 1-800-424-9300 (USA); +1 703-527-3887 (International)

SECTION 2: Hazards identification

2.1. Classification of the substance or mixture

<table>
<thead>
<tr>
<th>Classification (GHS-US)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flam. Liq. 2 H225</td>
</tr>
<tr>
<td>Skin Irrit. 2 H315</td>
</tr>
<tr>
<td>Eye Irrit. 2A H319</td>
</tr>
<tr>
<td>Repr. 2 H361</td>
</tr>
<tr>
<td>STOT SE 3 H336</td>
</tr>
<tr>
<td>STOT RE 2 H373</td>
</tr>
<tr>
<td>Aquatic Acute 2 H401</td>
</tr>
</tbody>
</table>

Aquatic Chronic 2 H402

Full text of H-phrases: see section 16

2.2. Label elements

GHS-US labeling

Hazard pictograms (GHS-US)

<table>
<thead>
<tr>
<th>Hazard pictogram</th>
</tr>
</thead>
<tbody>
<tr>
<td>GH502</td>
</tr>
<tr>
<td>GH507</td>
</tr>
<tr>
<td>GH508</td>
</tr>
</tbody>
</table>

Signal word (GHS-US): Danger

Hazard statements (GHS-US):

- H225 - Highly flammable liquid and vapor
- H315 - Causes skin irritation
- H319 - Causes serious eye irritation
- H336 - May cause drowsiness or dizziness
- H361 - Suspected of damaging fertility or the unborn child
- H373 - May cause damage to organs through prolonged or repeated exposure
- H401 - Toxic to aquatic life

Precautionary statements (GHS-US):

- P201 - Obtain special instructions before use
- P202 - Do not handle until all safety precautions have been read and understood
- P280 - Wear protective gloves/protective clothing/eye protection/face protection
- P210 - Keep away from heat, open flames, sparks. - No smoking
- P240 - Ground/bond container and receiving equipment
- P241 - Use explosion-proof electrical equipment
- P242 - Use only non-sparking tools
- P243 - Take precautionary measures against static discharge
- P260 - Do not breathe vapors
2.3. Other hazards
No additional information available

2.4. Unknown acute toxicity (GHS US)
No data available

SECTION 3: Composition/information on ingredients

3.1. Substance
Not applicable

3.2. Mixture

<table>
<thead>
<tr>
<th>Name</th>
<th>Product identifier</th>
<th>%</th>
<th>Classification (GHS-US)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hexane</td>
<td>(CAS No) 110-54-3</td>
<td>&lt; 60</td>
<td>Flam. Liq. 2, H225, Skin Irrit. 2, H315, Eye Irrit. 2A, H319, Repr. 2, H361, STOT SE 3, H336, STOT RE 2, H373, Asp. Tox. 1, H304, Aquatic Acute 2, H401</td>
</tr>
<tr>
<td>Hafnium-tetra-n-butoxide</td>
<td>(CAS No) 22411-22-9</td>
<td>&gt; 40</td>
<td>Skin Irrit. 2, H315, Eye Irrit. 2A, H319</td>
</tr>
</tbody>
</table>

SECTION 4: First aid measures

4.1. Description of first aid measures

First-aid measures general: Remove contaminated clothing and shoes. In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible). If possible show this sheet; if not available show packaging or label. Call a POISON CENTER or doctor/physician.

First-aid measures after inhalation: Remove victim to fresh air and keep at rest in a position comfortable for breathing. If you feel unwell, seek medical advice.

First-aid measures after skin contact: Wash with plenty of soap and water. Get medical advice/attention.

First-aid measures after eye contact: Immediately flush eyes thoroughly with water for at least 15 minutes. Remove contact lenses, if present and easy to do. Continue rinsing. Get medical advice/attention.

First-aid measures after ingestion: Never give anything by mouth to an unconscious person. Get medical advice/attention.

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

Symptoms/injuries: Causes damage to organs through prolonged or repeated exposure. Suspected of damaging fertility or the unborn child.

Symptoms/injuries after inhalation: May cause drowsiness or dizziness. May cause irritation to the respiratory tract.

Symptoms/injuries after skin contact: Causes skin irritation.

Symptoms/injuries after eye contact: Causes serious eye irritation.

Symptoms/injuries after ingestion: May be harmful if swallowed.

4.3. Indication of any immediate medical attention and special treatment needed
No additional information available

SECTION 5: Firefighting measures

5.1. Extinguishing media


Unsuitable extinguishing media: Do not use straight streams.
HAFNIUM n-BUTOXIDE
Safety Data Sheet

5.2. Special hazards arising from the substance or mixture
Fire hazard: Highly flammable liquid and vapor. Irritating fumes and organic acid vapors may develop when material is exposed to elevated temperatures or open flame.
Explosion hazard: May form flammable/explosive vapor-air mixture.

5.3. Advice for firefighters
Firefighting instructions: Use water spray to cool exposed surfaces. Exercise caution when fighting any chemical fire.
Protection during firefighting: Do not enter fire area without proper protective equipment, including respiratory protection. Avoid all eye and skin contact and do not breathe vapor and mist.

SECTION 6: Accidental release measures
6.1. Personal precautions, protective equipment and emergency procedures
General measures: Eliminate every possible source of ignition. Use special care to avoid static electric charges.

6.1.1. For non-emergency personnel
Protective equipment: Wear protective equipment as described in Section 8.
Emergency procedures: Evacuate unnecessary personnel.

6.1.2. For emergency responders
Protective equipment: Do not attempt to take action without suitable protective equipment. Equip cleanup crew with proper protection. For further information refer to section 8: “Exposure controls/personal protection”.

6.2. Environmental precautions
Prevent entry to sewers and public waters. Notify authorities if liquid enters sewers or public waters.

6.3. Methods and material for containment and cleaning up
For containment: Contain any spills with dikes or absorbents to prevent migration and entry into sewers or streams.
Methods for cleaning up: Clean up any spills as soon as possible, using an absorbent material to collect it. Sweep or shovel spills into appropriate container for disposal. Use only non-sparking tools.

6.4. Reference to other sections
See Heading 8. Exposure controls and personal protection.

SECTION 7: Handling and storage
7.1. Precautions for safe handling
Additional hazards when processed: Handle empty containers with care because residual vapors are flammable. Keep away from heat/sparks/open flames/hot surfaces. - No smoking.
Precautions for safe handling: Obtain special instructions before use. Do not handle until all safety precautions have been read and understood. Avoid all eye and skin contact and do not breathe vapor and mist. Provide good ventilation in process area to prevent accumulation of vapors. Take precautionary measures against static discharge. Use only outdoors or in a well-ventilated area. Use only non-sparking tools.
Hygiene measures: Wash hands and other exposed areas with mild soap and water before eating, drinking or smoking and when leaving work. Wash contaminated clothing before reuse.

7.2. Conditions for safe storage, including any incompatibilities
Technical measures: Proper grounding procedures to avoid static electricity should be followed. Use explosion-proof electrical equipment.
Storage conditions: Keep container tightly closed. Keep in a cool place. Store locked up.
Incompatible materials: Air. Water.
Storage area: Store in a well-ventilated place. Store away from heat.

7.3. Specific end use(s)
No additional information available

SECTION 8: Exposure controls/personal protection
8.1. Control parameters

<table>
<thead>
<tr>
<th>Substance</th>
<th>USA ACGIH</th>
<th>USA NIOSH</th>
<th>USA OSHA</th>
<th>USA IDLH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hexane (110-54-3)</td>
<td>ACGIH TWA (ppm)</td>
<td>NIOSH REL (TWA) (mg/m³)</td>
<td>OSHA PEL (TWA) (mg/m³)</td>
<td>US IDLH (ppm)</td>
</tr>
<tr>
<td></td>
<td>50 ppm</td>
<td>180 mg/m³</td>
<td>1800 mg/m³</td>
<td>1100 ppm (10% LEL)</td>
</tr>
</tbody>
</table>
HAFNIUM n-BUTOXIDE
Safety Data Sheet

8.2. Exposure controls
Appropriate engineering controls: Provide local exhaust or general room ventilation.
Personal protective equipment: Avoid all unnecessary exposure. Emergency eye wash fountains and safety showers should be available in the immediate vicinity of any potential exposure.

Hand protection: Neoprene or nitrile rubber gloves.
Eye protection: Chemical goggles. Contact lenses should not be worn.
Skin and body protection: Wear suitable protective clothing.
Respiratory protection: Where exposure through inhalation may occur from use, respiratory protection equipment is recommended. NIOSH-certified dust and mist (orange cartridge) respirator.

SECTION 9: Physical and chemical properties

9.1. Information on basic physical and chemical properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical state</td>
<td>Liquid</td>
</tr>
<tr>
<td>Appearance</td>
<td>Liquid.</td>
</tr>
<tr>
<td>Molecular mass</td>
<td>470.95 g/mol</td>
</tr>
<tr>
<td>Color</td>
<td>Straw.</td>
</tr>
<tr>
<td>Odor</td>
<td>Characteristic.</td>
</tr>
<tr>
<td>Odor threshold</td>
<td>No data available</td>
</tr>
<tr>
<td>Refractive index</td>
<td>No data available</td>
</tr>
<tr>
<td>pH</td>
<td>No data available</td>
</tr>
<tr>
<td>Relative evaporation rate (butyl acetate=1)</td>
<td>No data available</td>
</tr>
<tr>
<td>Melting point</td>
<td>&lt; 20 °C</td>
</tr>
<tr>
<td>Freezing point</td>
<td>No data available</td>
</tr>
<tr>
<td>Boiling point</td>
<td>280 - 285 °C @ 0.01 mm Hg (neat)</td>
</tr>
<tr>
<td>Flash point</td>
<td>-23 °C</td>
</tr>
<tr>
<td>Auto-ignition temperature</td>
<td>223 °C (hexane)</td>
</tr>
<tr>
<td>Decomposition temperature</td>
<td>No data available</td>
</tr>
<tr>
<td>Flammability (solid, gas)</td>
<td>Highly flammable liquid and vapor</td>
</tr>
<tr>
<td>Vapor pressure</td>
<td>0.01 mm Hg @ 25°C (neat)</td>
</tr>
<tr>
<td>Relative vapor density at 20 °C</td>
<td>&gt; 1</td>
</tr>
<tr>
<td>Relative density</td>
<td>0.87</td>
</tr>
<tr>
<td>VOC content</td>
<td>&lt; 45 %</td>
</tr>
<tr>
<td>Solubility</td>
<td>Insoluble in water. Reacts with water.</td>
</tr>
<tr>
<td>Log Pow</td>
<td>No data available</td>
</tr>
<tr>
<td>Log Kow</td>
<td>No data available</td>
</tr>
<tr>
<td>Viscosity, kinematic</td>
<td>No data available</td>
</tr>
<tr>
<td>Viscosity, dynamic</td>
<td>No data available</td>
</tr>
<tr>
<td>Explosive properties</td>
<td>No data available</td>
</tr>
<tr>
<td>Oxidizing properties</td>
<td>No data available</td>
</tr>
<tr>
<td>Explosion limits</td>
<td>1.2 - 7.5 vol % (lower; upper: hexane)</td>
</tr>
</tbody>
</table>

9.2. Other information
No additional information available

SECTION 10: Stability and reactivity

10.1. Reactivity
No additional information available

10.2. Chemical stability
Stable.

10.3. Possibility of hazardous reactions
Material decomposes slowly in contact with air by reaction with water.

10.4. Conditions to avoid
Heat. Open flame. Sparks.

10.5. Incompatible materials
Air. Water.

10.6. Hazardous decomposition products
**SECTION 11: Toxicological information**

### 11.1. Information on toxicological effects

**Acute toxicity:** Not classified

**Hexane (110-54-3)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LD50 oral rat</td>
<td>25 g/kg</td>
</tr>
<tr>
<td>LD50 dermal rabbit</td>
<td>3000 mg/kg</td>
</tr>
<tr>
<td>LC50 inhalation rat (ppm)</td>
<td>48000 ppm/4h</td>
</tr>
<tr>
<td>ATE US (oral)</td>
<td>25000.000 mg/kg body weight</td>
</tr>
<tr>
<td>ATE US (dermal)</td>
<td>3000.000 mg/kg body weight</td>
</tr>
<tr>
<td>ATE US (gases)</td>
<td>48000.000 ppmV/4h</td>
</tr>
</tbody>
</table>

**Skin corrosion/irritation:** Causes skin irritation.

**Serious eye damage/irritation:** Causes serious eye irritation.

**Respiratory or skin sensitization:** Not classified

**Germ cell mutagenicity:** Not classified

**Carcinogenicity:** Not classified

**Reproductive toxicity:** Suspected of damaging fertility or the unborn child.

**Specific target organ toxicity (single exposure):**
- May cause drowsiness or dizziness.

**Specific target organ toxicity (repeated exposure):** May cause damage to organs through prolonged or repeated exposure.

**Aspiration hazard:** Not classified

**Potential Adverse human health effects and symptoms:** The most toxic of the hexane metabolites is 2,5-hexanediol, which is potentiated by methylethylketone, causes neurological effects including neuropathy.

**Symptoms/injuries after inhalation:** May cause drowsiness or dizziness. May cause irritation to the respiratory tract.

**Symptoms/injuries after skin contact:** Causes skin irritation.

**Symptoms/injuries after eye contact:** Causes serious eye irritation.

**Symptoms/injuries after ingestion:** May be harmful if swallowed.

**Reason for classification:** Expert judgment

---

**SECTION 12: Ecological information**

### 12.1. Toxicity

**Ecology - general:** Toxic to aquatic life.

**Hexane (110-54-3)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LC50 fish 1</td>
<td>2.1 - 2.98 mg/l (Exposure time: 96 h - Species: Pimephales promelas [flow-through])</td>
</tr>
</tbody>
</table>

### 12.2. Persistence and degradability

No additional information available

### 12.3. Bioaccumulative potential

No additional information available

### 12.4. Mobility in soil

No additional information available

### 12.5. Other adverse effects

Other adverse effects: This substance may be hazardous to the environment.

Effect on ozone layer: No additional information available

Effect on the global warming: No known ecological damage caused by this product.

---

**SECTION 13: Disposal considerations**

### 13.1. Waste treatment methods

**Sewage disposal recommendations:** Do not dispose of waste into sewer.

**Waste disposal recommendations:** Dispose in a safe manner in accordance with local/national regulations. Dispose of contents/container to licensed waste disposal facility.

**Additional information:** Handle empty containers with care because residual vapors are flammable.

**Ecology - waste materials:** Avoid release to the environment.

---

**SECTION 14: Transport information**

### 14.1. UN number

**UN-No.(DOT):** 1993

**DOT NA no.:** UN1993
HAFNIUM n-BUTOXIDE
Safety Data Sheet

14.2. UN proper shipping name
Proper Shipping Name (DOT) : Flammable liquids, n.o.s. (HAFNIUM n-BUTOXIDE, 45% in hexane)
Department of Transportation (DOT) Hazard Classes : 3 - Class 3 - Flammable and combustible liquid 49 CFR 173.120
Hazard labels (DOT) : 3 - Flammable liquid

DOT Symbols : G - Identifies PSN requiring a technical name
Packing group (DOT) : II - Medium Danger
DOT Packaging Exceptions (49 CFR 173.xxx) : 150
DOT Packaging Non Bulk (49 CFR 173.xxx) : 202
DOT Packaging Bulk (49 CFR 173.xxx) : 242

14.3. Additional information
Other information : No supplementary information available.

Transport by sea
DOT Vessel Stowage Location : B - (i) The material may be stowed “on deck” or “under deck” on a cargo vessel and on a passenger vessel carrying a number of passengers limited to not more than the larger of 25 passengers, or one passenger per each 3 m of overall vessel length; and (ii) “On deck only” on passenger vessels in which the number of passengers specified in paragraph (k)(2)(i) of this section is exceeded.

Air transport
DOT Quantity Limitations Passenger aircraft/rail (49 CFR 173.27) : 5 L
DOT Quantity Limitations Cargo aircraft only (49 CFR 175.75) : 60 L

SECTION 15: Regulatory information
15.1. US Federal regulations
HAFNIUM n-BUTOXIDE (22411-22-9)
TSCA Exemption/Exclusion : CAUTION: This material is supplied for research and development purposes subject to the R&D exemption under TSCA, 40 CFR 720.36, and must meet the requirements of the exemption, including supervision by a "technically qualified individual" as defined by 40 CFR 720.3(ee). The use of this material for "commercial purposes" as defined by 40 CFR 720.3(r) is not permitted in the United States.

Hafnium-tetra-n-butoxide (22411-22-9)
Not listed on the United States TSCA (Toxic Substances Control Act) inventory
Hexane (110-54-3)
Listed on the United States TSCA (Toxic Substances Control Act) inventory
Listed on United States SARA Section 313
SARA Section 313 - Emission Reporting : 1.0 %

15.2. International regulations
Hafnium-tetra-n-butoxide (22411-22-9)
Listed on ELINCS (European List of Notified Chemical Substances)
Listed on PICCS (Philippines Inventory of Chemicals and Chemical Substances)
Hexane (110-54-3)
Listed on the AICS (Australian Inventory of Chemical Substances)
Listed on the Canadian DSL (Domestic Substances List)
Listed on IECS (Inventory of Existing Chemical Substances Produced or Imported in China)
Listed on the EEC inventory EINECS (European Inventory of Existing Commercial Chemical Substances)
Listed on the Japanese ENCS (Existing & New Chemical Substances) inventory
Listed on the Korean ECL (Existing Chemicals List)
Listed on NZioC (New Zealand Inventory of Chemicals)
Listed on PICCS (Philippines Inventory of Chemicals and Chemical Substances)
Japanese Pollutant Release and Transfer Register Law (PRTR Law)
Listed on the Canadian IDL (Ingredient Disclosure List)
Listed on INSO (Mexican national Inventory of Chemical Substances)
Listed on Turkish inventory of chemical
### 15.3. US State regulations

<table>
<thead>
<tr>
<th>HAFNIUM n-BUTOXIDE (22411-22-9)</th>
<th>U.S. - California - Proposition 65 - Carcinogens List</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>U.S. - California - Proposition 65 - Developmental Toxicity</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>U.S. - California - Proposition 65 - Reproductive Toxicity - Female</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>U.S. - California - Proposition 65 - Reproductive Toxicity - Male</td>
<td>No</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hafnium-tetra-n-butoxide (22411-22-9)</th>
<th>U.S. - California - Proposition 65 - Carcinogens List</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>U.S. - California - Proposition 65 - Developmental Toxicity</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>U.S. - California - Proposition 65 - Reproductive Toxicity - Female</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>U.S. - California - Proposition 65 - Reproductive Toxicity - Male</td>
<td>No</td>
</tr>
<tr>
<td>Hexane (110-54-3)</td>
<td>U.S. - California - Proposition 65 - Carcinogens List</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>U.S. - California - Proposition 65 - Developmental Toxicity</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>U.S. - California - Proposition 65 - Reproductive Toxicity - Female</td>
<td>No</td>
</tr>
<tr>
<td></td>
<td>U.S. - California - Proposition 65 - Reproductive Toxicity - Male</td>
<td>No</td>
</tr>
</tbody>
</table>

### SECTION 16: Other information

**Abbreviations and acronyms**
- Abbreviations: ND: Not Determined, No Data; NA: Not Applicable; LD: Lethal Dose; LC: Lethal Concentration; ATE: Acute Toxicity Estimates; H: hour; °: °C unless otherwise stated; mm: millimeters Hg; torr; PEL: permissible exposure level; TWA: time weighted average; TLV: threshold limit value; TG: Test Guideline; NIOSH: National Institute for Occupational Safety and Health; IARC: International Agency for Research on Cancer; NTP: National Toxicology Program; HMIS: Hazardous Material Information System; CAS No.: Chemical Abstract Service Registration Number; EC No.: European Commission Registration Number; EC Index No.: European Commission Index Number; OECD: The Organisation for Economic Co-operation and Development.

**Full text of H-phrases:**
- **Aquatic Acute 2**: Hazardous to the aquatic environment - Acute Hazard Category 2
- **Asp. Tox. 1**: Aspiration hazard Category 1
- **Eye Irrit. 2A**: Serious eye damage/eye irritation Category 2A
- **Flam. Liq. 2**: Flammable liquids Category 2
- **Repr. 2**: Reproductive toxicity Category 2
- **Skin Irrit. 2**: Skin corrosion/irritation Category 2
- **STOT RE 2**: Specific target organ toxicity (repeated exposure) Category 2
- **STOT SE 3**: Specific target organ toxicity (single exposure) Category 3
- **H225**: Highly flammable liquid and vapor
- **H304**: May be fatal if swallowed and enters airways
- **H315**: Causes skin irritation
- **H319**: Causes serious eye irritation
- **H336**: May cause drowsiness or dizziness
- **H361**: Suspected of damaging fertility or the unborn child
- **H373**: May cause damage to organs through prolonged or repeated exposure
- **H401**: Toxic to aquatic life

**HMIS III Rating**
- **Health**: 3 Serious Hazard - Major injury likely unless prompt action is taken and medical treatment is given
- **Flammability**: 4 Severe Hazard
- **Physical**: 1 Slight Hazard

Prepared by safety and environmental affairs.
HAFNIUM n-BUTOXIDE
Safety Data Sheet

Date of issue: 08/24/2015
Version: 1.0

SDS US (GHS HazCom 2012) - Custom

According to Federal Register / Vol. 77, No. 58 / Monday, March 26, 2012 / Rules and Regulations

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