

Safety Data Sheet

Version 2.0

Revision Date 12/08/2016

SDS Number 300000000066

Print Date 03/04/2017

1. PRODUCT AND COMPANY IDENTIFICATION

Product name : Germane

Chemical formula : GeH₄

Synonyms : Germane, Germanium Hydride, Germanium Tetrahydride, Germanomethane

Product Use Description : General Industrial

Manufacturer/Importer/Distributor : Versum Materials US, LLC
7201 Hamilton Blvd.
Allentown, PA 18195-1501
Exporter EIN No.475632014
www.versummaterials.com

Telephone : (610)481-4911

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2. HAZARDS IDENTIFICATION

GHS classification

Flammable gases - Category 1

Gases under pressure - Liquefied gas.

Acute toxicity - Inhalation Category 2

Specific target organ toxicity - repeated exposure - Category 2

GHS label elements

Hazard pictograms/symbols



Signal Word: Danger

Hazard Statements:

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H220:Extremely flammable gas.
H280:Contains gas under pressure; may explode if heated.
H330:Fatal if inhaled.
H370:Causes damage to organs.
Symptoms may be delayed.
May form explosive mixtures in air.

Precautionary Statements:

Prevention	: P210:Keep away from heat, hot surfaces, sparks, open flames, and other ignition sources. No smoking. P260:Do not breathe dust/fume/gas/mist/vapours/spray. P271:Use only outdoors or in a well-ventilated area P284:Wear respiratory protection.
Response	: P304+P340 :IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing. P310 :Immediately call a POISON CENTRE/doctor. P377 :Leaking gas fire: Do not extinguish, unless leak can be stopped safely. P381 :Eliminate all ignition sources if safe to do so.
Storage	: P403+P233:Store in a well-ventilated place. Keep container tightly closed. P405:Store locked up. P410+P403:Protect from sunlight. Store in a well-ventilated place.
Disposal	: P501:Disposal of contents/container to be specified in accordance with regulations.

Hazards not otherwise classified

Toxic by inhalation.
Inhalation may be fatal.
Symptoms may be delayed.
Use a back flow preventative device in the piping.
Use only with equipment purged with and inert gas or evacuated prior to discharge.
Use only with equipment of compatible materials of construction, rated for cylinder pressure.
Do not open valve until connected to equipment prepared for use.
When returning cylinder install valve outlet cap or plug leak tight.
Close valve after each use and when empty.
Extremely flammable liquefied gas.
May form explosive mixtures in air.
Vapors may spread long distances and ignite.
Immediate fire and explosion hazard exists when mixed with air at concentrations exceeding the lower flammability limit (LFL).
Do not breathe gas.
Direct contact with liquid can cause frostbite.
Self contained breathing apparatus (SCBA) may be required.

3. COMPOSITION/INFORMATION ON INGREDIENTS

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Components	CAS Number	Concentration (Volume)
Germane	7782-65-2	100 %

Concentration is nominal. For the exact product composition, please refer to technical specifications.

4. FIRST AID MEASURES

- General advice : Prompt medical attention is required in all cases of exposure. Remove victim to uncontaminated area wearing self contained breathing apparatus. Keep victim warm and rested. Call a doctor. Apply artificial respiration if breathing stopped.
- Eye contact : In the case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
Keep eye wide open while rinsing.
- Skin contact : If liquid product comes in contact with skin, avoid breathing vapor. Remove contaminated clothing and flush with plenty of lukewarm water for several minutes. Wash frost-bitten areas with plenty of water. Do not remove clothing. Cover wound with sterile dressing.
- Ingestion : Ingestion is not considered a potential route of exposure.
- Inhalation : Move to fresh air. If breathing has stopped or is labored, give assisted respirations. Supplemental oxygen may be indicated. If the heart has stopped, trained personnel should begin cardiopulmonary resuscitation immediately. In case of shortness of breath, give oxygen. Consult a doctor.
- Most important symptoms/effects - acute and delayed : Headache. Nausea. Tingling. Numbness. Symptoms may be delayed. Vomiting. Abdominal pain. Inhalation may provoke the following symptoms: Dark urine. Bronze coloration of skin. Individuals with anemia or pre-existing kidney, heart, liver or nervous system disease may be at increased risk.

Immediate Medical Attention and Special Treatment

- Treatment : May cause acute intravascular hemolysis and consequent renal failure. Bronze pigmentation of the skin may be confused with jaundice. Elevated T-wave changes on the EKG may reflect release of intracellular potassium into the plasma. Management of poisoning is dependent on treatment of the hemolytic episode and its consequences. Hemodialysis, peritoneal dialysis and exchange transfusions should be considered; consult with a competent nephrologist as soon as possible. If exposed or concerned: Get medical attention/advice.

5. FIRE-FIGHTING MEASURES

- Suitable extinguishing media : All known extinguishing media can be used.
- Specific hazards : Gas is heavier than air and may collect in low areas or travel along the ground where there may be an ignition source present. If flames are accidentally extinguished, explosive re-ignition may occur; therefore, appropriate measures should be taken (e.g. total evacuation to protect persons from cylinder fragments and toxic fumes should a rupture occur). Upon exposure to intense

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heat or flame, cylinder will vent rapidly and or rupture violently. Combustion by-products may be toxic. Move away from container and cool with water from a protected position. Keep adjacent cylinders cool by spraying with large amounts of water until the fire burns itself out. Do not allow run-off from fire fighting to enter drains or water courses. If possible, shut off the source of gas and allow the fire to burn itself out. Extinguish fire only if gas flow can be stopped. Do not extinguish a leaking gas flame unless absolutely necessary. Spontaneous/explosive re-ignition may occur. Extinguish any other fire.

Special protective equipment for fire-fighters : Use self-contained breathing apparatus.

6. ACCIDENTAL RELEASE MEASURES

- Personal Precautions, Protective Equipment, and Emergency Procedures : Evacuate personnel to safe areas. Remove all sources of ignition. Use self-contained breathing apparatus or positive pressure air line with mask and escape pack in areas where concentration is unknown or above the exposure limits. Never enter a confined space or other area where the flammable gas concentration is greater the 10% of its lower flammable limit. Wear self-contained breathing apparatus when entering area unless atmosphere is proved to be safe. Ventilate the area.
- Environmental precautions : Should not be released into the environment. Prevent further leakage or spillage if safe to do so. Prevent from entering sewers, basements and workpits, or any place where its accumulation can be dangerous.
- Methods for cleaning up : Ventilate the area. Approach suspected leak areas with caution. Keep area evacuated and free from ignition sources until any spilled liquid has evaporated. (Ground free from frost).
- Additional advice : If possible, stop flow of product. Increase ventilation to the release area and monitor concentrations. If leak is from cylinder or cylinder valve, call the emergency telephone number. If the leak is in the user's system, close the cylinder valve, safely vent the pressure, and purge with an inert gas before attempting repairs.

7. HANDLING AND STORAGE

Handling

Carbon steel, stainless steel, Monel, Hastelloy are preferred metals for handling this material. Kel-F and Teflon are the preferred elastomers. Viton and Nylon are acceptable. Cylinders should be stored upright with valve protection cap in place and firmly secured to prevent falling or being knocked over. Protect cylinders from physical damage; do not drag, roll, slide or drop. Do not allow storage area temperature to exceed 50°C (122°F). Only experienced and properly instructed persons should handle compressed gases/cryogenic liquids. Before using the product, determine its identity by reading the label. Know and understand the properties and hazards of the product before use. When doubt exists as to the correct handling procedure for a particular gas, contact the supplier. Do not remove or deface labels provided by the supplier for the identification of the cylinder contents. When moving cylinders, even for short distances, use a cart (trolley, hand truck, etc.) designed to transport cylinders. Leave valve protection caps in place until the container has been secured against either a wall or bench or placed in a container stand and is ready for use. Use an adjustable strap wrench to remove

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over-tight or rusted caps. Before connecting the container, check the complete gas system for suitability, particularly for pressure rating and materials. Before connecting the container for use, ensure that back feed from the system into the container is prevented. Ensure the complete gas system is compatible for pressure rating and materials of construction. Ensure the complete gas system has been checked for leaks before use. Employ suitable pressure regulating devices on all containers when the gas is being emitted to systems with lower pressure rating than that of the container. Never insert an object (e.g. wrench, screwdriver, pry bar, etc.) into valve cap openings. Doing so may damage valve, causing a leak to occur. Open valve slowly. If user experiences any difficulty operating cylinder valve discontinue use and contact supplier. Close container valve after each use and when empty, even if still connected to equipment. Never attempt to repair or modify container valves or safety relief devices. Damaged valves should be reported immediately to the supplier. Close valve after each use and when empty. Replace outlet caps or plugs and container caps as soon as container is disconnected from equipment. Do not subject containers to abnormal mechanical shock. Never attempt to lift a cylinder by its valve protection cap or guard. Do not use containers as rollers or supports or for any other purpose than to contain the gas as supplied. Never strike an arc on a compressed gas cylinder or make a cylinder a part of an electrical circuit. Do not smoke while handling product or cylinders. Never re-compress a gas or a gas mixture without first consulting the supplier. Never attempt to transfer gases from one cylinder/container to another. Always use backflow protective device in piping. Purge air from system before introducing gas. Installation of a cross purge assembly between the cylinder and the regulator is recommended. When returning cylinder install valve outlet cap or plug leak tight. Never use direct flame or electrical heating devices to raise the pressure of a container. Containers should not be subjected to temperatures above 50°C (122°F). Never attempt to increase liquid withdrawal rate by pressurizing the container without first checking with the supplier. Never permit liquefied gas to become trapped in parts of the system as this may result in hydraulic rupture. All piped systems and associated equipment must be grounded.

Storage

Containers should be stored in a purpose build compound which should be well ventilated, preferably in the open air. Full containers should be stored so that oldest stock is used first. Observe all regulations and local requirements regarding storage of containers. Stored containers should be periodically checked for general condition and leakage. Local codes may have special requirements for toxic gas storage. Protect containers stored in the open against rusting and extremes of weather. Containers should not be stored in conditions likely to encourage corrosion. Containers should be stored in the vertical position and properly secured to prevent toppling. The container valves should be tightly closed and where appropriate valve outlets should be capped or plugged. Container valve guards or caps should be in place. Keep containers tightly closed in a cool, well-ventilated place. Store containers in location free from fire risk and away from sources of heat and ignition. Full and empty cylinders should be segregated. Do not allow storage temperature to exceed 50°C (122°F). Smoking should be prohibited within storage areas or while handling product or containers. Display "No Smoking or Open Flames" signs in the storage areas. The amounts of flammable or toxic gases in storage should be kept to a minimum. Return empty containers in a timely manner. Flammable storage areas should be separated from oxygen and other oxidizers by a minimum distance of 20 ft. (6.1 m.) or by a barrier of non-combustible material at least 5 ft. (1.5 m.) high, having a fire resistance rating of at least 1/2 hour.

Technical measures/Precautions

Containers should be segregated in the storage area according to the various categories (e.g. flammable, toxic, etc.) and in accordance with local regulations. Provide sufficient air exchange and/or exhaust in work rooms.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering measures

Handle product only in closed system or provide appropriate exhaust ventilation at machinery.

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Provide natural or explosion-proof ventilation adequate to ensure concentrations are kept below exposure limits.

Personal protective equipment

- Respiratory protection : Keep self contained breathing apparatus readily available for emergency use. Use self-contained breathing apparatus or positive pressure air line with mask and escape pack in areas where concentration is unknown or above the exposure limits. Users of breathing apparatus must be trained.
- Hand protection : Sturdy work gloves are recommended for handling cylinders. Chemical-resistant, impervious gloves complying with an approved standard should be worn at all times when handling chemical products if a risk assessment indicates this is necessary.
- Eye protection : Safety glasses recommended when handling cylinders. A full faceshield should be worn in addition to safety glasses when connecting, disconnecting or opening cylinders.
- Skin and body protection : Cold temperatures may cause embrittlement of protective material resulting in breakage and exposure. Contact with cold evaporating liquid on gloves or suit may cause cryogenic burns or frostbite. Safety shoes are recommended when handling cylinders. Wear as appropriate: Flame retardant protective clothing.
- Special instructions for protection and hygiene : Provide good ventilation and/or local exhaust to prevent accumulation of concentrations above exposure limits. Ensure adequate ventilation, especially in confined areas.

Exposure limit(s)

Germane	Time Weighted Average (TWA): ACGIH	0.2 ppm	-
Germane	Recommended exposure limit (REL): NIOSH	0.2 ppm	0.6 mg/m3
Germane	Time Weighted Average (TWA): OSHA Z1A	0.2 ppm	0.6 mg/m3
Germane	Time Weighted Average (TWA) Permissible Exposure Limit (PEL): US CA OEL	0.2 ppm	0.6 mg/m3
Germane	Time Weighted Average (TWA): TN OEL	0.2 ppm	0.6 mg/m3

9. PHYSICAL AND CHEMICAL PROPERTIES

- Appearance : Liquefied gas. Colorless gas
- Odor : Pungent. Poor warning properties at low concentrations.
- Odor : Mixture contains one or more component(s) which have the following odor: Pungent.
- Odor threshold : No data available.

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pH	: Not applicable.
Melting point/range	: -267 °F (-166 °C)
Boiling point/range	: -127 °F (-88.5 °C)
Flash point	: Not applicable.
Evaporation rate	: Not applicable.
Flammability (solid, gas)	: Refer to product classification in Section 2
Upper/lower explosion/flammability limit	: 30 %(V) / 8 %(V)
Vapor pressure	: 640.00 psia (44.13 bara)
Water solubility	: No data available.
Relative vapor density	: 2.6 (air = 1)
Relative density	: No data available.
Partition coefficient (n-octanol/water)	: Not applicable.
Auto-ignition temperature	: 88 °C
Decomposition temperature	: No data available.
Viscosity	: Not applicable.
Molecular Weight	: 76.6 g/mol

10. STABILITY AND REACTIVITY

Chemical Stability	: Stable under normal conditions.
Conditions to avoid	: Heat, flames and sparks.
Materials to avoid	: Oxidizing agents. Oxygen.
Hazardous decomposition products	: Germanium oxide. Hydrogen.
Possibility of hazardous Reactions/Reactivity	: No data available.

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11. TOXICOLOGICAL INFORMATION

11.1. Information on toxicological effects

Likely routes of exposure

- | | |
|--------------------|---|
| Effects on Eye | : Contact with liquid may cause cold burns/frostbite. |
| Effects on Skin | : Contact with liquid may cause cold burns/frostbite. |
| Inhalation Effects | : Fatal intoxication possible with low concentrations. Exposure to concentrations as low as 250 ppm for a few minutes may be lethal. May be fatal if inhaled. |
| Ingestion Effects | : Ingestion is not considered a potential route of exposure. |
| Symptoms | : Headache. Nausea. Tingling. Numbness. Symptoms may be delayed. Vomiting. Abdominal pain. Inhalation may provoke the following symptoms: Dark urine. Bronze coloration of skin. Individuals with anemia or pre-existing kidney, heart, liver or nervous system disease may be at increased risk. |

Acute toxicity

- | | |
|-----------------------------------|---|
| Acute Oral Toxicity | : No data is available on the product itself. |
| Inhalation | : LC50 (1 h) : 622 ppm Species : Rat. |
| Acute Dermal Toxicity | : No data is available on the product itself. |
| Skin corrosion/irritation | : No data available. |
| Serious eye damage/eye irritation | : No data available. |
| Sensitization. | : No data available. |

Chronic toxicity or effects from long term exposures

- | | |
|---|---|
| Carcinogenicity | : No data available. |
| Reproductive toxicity | : No data is available on the product itself. |
| Germ cell mutagenicity | : No data is available on the product itself. |
| Specific target organ systemic toxicity (single exposure) | : No data available. |
| Specific target organ systemic toxicity (repeated exposure) | : No data available. |
| Aspiration hazard | : No data available. |

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Delayed and Immediate Effects and Chronic Effects from Short and Long Term Exposure

Repeated exposure can result in anemia, numbness or tingling of extremities and heart damage. Individuals with anemia or pre-existing kidney, heart, liver or nervous system disease may be at increased risk.
Asthma.

Information on the toxicity of germane is limited. The toxicity of germane appears to be similar to though less severe than that of arsine and stibine. Germane appears to exert its toxic effects by causing red blood cell lysis. Kidney and neurological effects are also likely. Mice exposed to germane at 15 ppm (48 mg/m³) or 79 ppm (247 mg/m³) for 1-4 months had decreased hemoglobin levels and erythrocyte counts.

12. ECOLOGICAL INFORMATION

Ecotoxicity effects

Aquatic toxicity : No data is available on the product itself.

Toxicity to other organisms : No data available.

Persistence and degradability

Biodegradability : No data is available on the product itself.

Mobility : Because of its high volatility, the product is unlikely to cause ground pollution.

Bioaccumulation : Refer to Section 9 "Partition Coefficient (n-octanol/water)".

Further information

Toxic to aquatic organisms.

13. DISPOSAL CONSIDERATIONS

Waste from residues / unused products : Destruction via incineration followed by scrubbing is the most commonly used method. In accordance with local and national regulations. Contact supplier if guidance is required. Return unused product in original cylinder to supplier. Must not be discharged to atmosphere.

Contaminated packaging : Return cylinder to supplier.

14. TRANSPORT INFORMATION

DOT

UN/ID No. : UN2192
Proper shipping name : Germane
Class or Division : 2.3
Label(s) : 2.3 (2.1)

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PIH Zone : B
Marine Pollutant : No

IATA

Transport Forbidden

IMDG

UN/ID No. : UN2192
Proper shipping name : GERMANE
Class or Division : 2.3
Label(s) : 2.3 (2.1)
Marine Pollutant : No

TDG

UN/ID No. : UN2192
Proper shipping name : GERMANE
Class or Division : 2.3
Label(s) : 2.3 (2.1)
Marine Pollutant : No

Further Information

Avoid transport on vehicles where the load space is not separated from the driver's compartment.

Ensure vehicle driver is aware of the potential hazards of the load and knows what to do in the event of an accident or an emergency. The transportation information is not intended to convey all specific regulatory data relating to this material. For complete transportation information, contact customer service.

15. REGULATORY INFORMATION

Toxic Substance Control Act (TSCA) 12(b) Component(s):

None.

Country	Regulatory list	Notification
USA	TSCA	Included on Inventory.
EU	EINECS	Included on Inventory.
Canada	DSL	Included on Inventory.
Australia	AICS	Not on Inventory.
Japan	ENCS	Included on Inventory.
South Korea	ECL	Included on Inventory.
Philippines	PICCS	Included on Inventory.
China	SEPA	Included on Inventory.

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EPA SARA Title III Section 312 (40 CFR 370) Hazard Classification

Acute Health Hazard Fire Hazard. Sudden Release of Pressure Hazard.

EPA SARA Title III Section 313 (40 CFR 372) Component(s) above 'de minimus' level

None.

US. California Safe Drinking Water & Toxic Enforcement Act (Proposition 65)

This product does not contain any chemicals known to State of California to cause cancer, birth defects or any other harm.

16. OTHER INFORMATION

NFPA Rating

Health : 4

Fire : 4

Instability : 3

Prepared by : Versum Materials, Product Regulatory Department

Telephone : (610)481-4911

Preparation Date : 03/04/2017

For additional information, please visit Versum Materials' Product Stewardship web site.

<http://www.versummaterials.com/productstewardship/>
