Product Safety Assessment

**DOW™ Metal Organic Products**


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### Product Overview

- **DOW™ metal organic products** are a group of high-purity, clear to light-colored liquids and powders. They are marketed under the trade names OPTOGRADE™ and THZGRADE™ precursors. For further details, see **Product Description**.
- **DOW metal organic products** are used in the manufacture of LEDs (light emitting diodes - used in the backlighting of flat panel displays for notebook computers and TVs and for general lighting), solar cells, semiconductor lasers, and other compound semiconductor devices, including communication lasers. For further details, see **Product Uses**.
- Direct consumer contact with these products is unlikely, as the final product is covered and sealed completely to avoid any reactions of the metal organic materials with air and/or water. Also, the process of making compound semiconductors using these metal organic products is done in a closed environment. For further details, see **Exposure Potential**.
- Contact with these materials can cause burns to the skin, eye, or respiratory tract. For further details, see **Health Information**.
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- It is unlikely that metal organic materials would persist in air, water, or soil due to their high reactivity with both air and water. For further details, see Environmental Information.
- Some metal organic products can be pyrophoric; they can ignite spontaneously when exposed to air at normal or slightly elevated temperatures. These materials can also react violently with water. For further details, see Physical Hazard Information.

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Manufacture of Product

- **Locations** – Dow manufactures metal organic products in Massachusetts, USA, and has packaging facilities for metal organic products in both Massachusetts, USA and Taoyuan, Taiwan. DOW™ metal organic products are available for purchase in Asia/Pacific, Europe, and North America.
- **Process** – These products are manufactured and purified by proprietary processes using oxygen-free environments. The purity criteria for semiconductor applications are stringent, requiring exceptionally low levels of metallic and organic impurities.

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Product Description

Some DOW™ metal organic products are high-purity, clear liquids, with some having a pale color (e.g., straw color). Other DOW metal organic products are high-purity powders with pale yellow coloration. They are marketed according to their purity under the trade names OPTOGRADE™ and THZGRADE™ precursors. They are sold in stainless steel cylinders, such as those shown in the photo. Each cylinder is topped with an inert gas headspace because these products can be highly reactive with both air and water.

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Product Uses

DOW™ metal organic products are used to grow thin films of compound semiconductors such as gallium nitride, gallium arsenide, indium phosphide and aluminum arsenide. These films form the inactive and active regions of light-emitting diodes (LEDs), solar cells, semiconductor lasers and transistors on substrates such as gallium arsenide, germanium, silicon carbide and sapphire, for uses such as those shown below.

- High brightness LEDs as alternatives to conventional lighting; and for backlighting in LED high-definition televisions
- High-efficiency solar cells for satellites and more
- Solid-state semiconductor lasers for Blu-Ray players and barcode scanners
The major use for these products (more than 75%) is in the production of LEDs (light emitting diodes) used in backlighting for flat panel displays for TVs, notebook computers, and monitors, in general lighting, and to lesser extents in the production of solar cells and semiconductor lasers.

Another low volume use for these materials includes communication lasers in fiber optic data networks.

**Exposure Potential**

DOW™ metal organic products are used by industry and are not sold to the general public. Based on the intended uses for these materials, the following exposures/releases are possible, though not probable:

- **Workplace exposure** – Customers sweep DOW metal organic vapors into the deposition reactor by bubbling inert carrier gases through the cylinder into a piping system connected to the reactor. The potential for exposure to DOW metal organic products, either in a manufacturing facility or in a customer’s facility, is minimized because of the strictly controlled conditions under which these materials are handled. To preserve the reactivity and the high-purity of these products, DOW metal organic products are produced, distributed, stored, and consumed in closed systems with an inert atmosphere. Employees working in manufacturing operations could be exposed during maintenance, sampling, testing, or other procedures. Each manufacturing facility should have a thorough training program for employees and appropriate work processes and safety equipment in place to limit exposure. See Health Information.

- **Consumer exposure to products containing DOW metal organic materials** – Dow does not sell metal organic products for direct consumer use and direct consumer contact with these metal organic products should not be possible. These metal organic products are sold to industrial facilities that use them to manufacture LEDs, transistors, semiconductor lasers and other compound semiconductor devices that are found in many consumer electronics. They are also used in the manufacture of solar cells that power satellites. The original DOW metal organic products are not present in the final product because they decompose to form metal-containing films during the industrial processes of manufacturing devices. The final devices only contain the metal portion of the original metal organic product. See Health Information.

- **Environmental releases** – DOW metal organic materials are maintained and used under strictly controlled conditions. As a result, environmental releases are expected to be minimal. During customer processing, the exhaust gases, composed of un-reacted metal organic vapor and carrier gas, are heated in a pyrolysis furnace or reacted with oxygen or water in a charcoal drum. Either option produces metal oxides and carbon dioxide as the ultimate breakdown products. Depleted cylinders may still contain small volume of unused product. The cylinders are returned to Dow where the unused product is reclaimed, purified, consolidated, and resold as part of Dow’s conservation efforts.

- **Large release** – Industrial spills or releases are infrequent because of the strict handling requirements for pyrophoric materials. The course of action during a spill depends on whether the metal organic product is pyrophoric or not. Pyrophoric materials will spontaneously ignite. This is addressed in the section entitled "In case of fire," below. All other metal organic products can be treated as follows: In the event of a small spill, focus on containing the spill to prevent contamination of soil and surface or ground water. Respiratory protection is necessary for cleaning up spills and leaks. Eliminate all sources of ignition immediately. Cover spilled material with dry sand or powdered limestone. Transfer decomposed material into suitable containers for disposal. See Environmental, Health, and Physical Hazard Information.
• **In case of fire** – Pyrophoric, self-reactive materials, like trimethylaluminium, will spontaneously ignite upon exposure to air or water. Some metal organic products can produce intense fires that resemble a flare. They will produce copious amounts of potentially harmful smoke and eventually result in formation of parent metal oxide residues (e.g., aluminum oxide, indium oxide, gallium oxide). Other metal organic materials are flammable liquids. In case of fire, deny any unnecessary entry into the area. Many metal organic materials can react violently with water so it is best to treat all of them as though they possess this hazard. Firefighters should wear positive pressure, self-contained breathing apparatus (SCBA) with an approved full-face mask and protective firefighting clothing. Follow emergency procedures carefully. Do not use wet chemical, water, or foam to extinguish the fire. Use dry-chemical powder followed by sand or powdered limestone. Gently agitate the sand or powdered limestone to slowly expose and burn off any un-reacted metal organic material. Once the fire has extinguished and cooled, transfer decomposed material into suitable containers for disposal. See **Health**, and **Physical Hazard Information**.

For more information, request the relevant Safety Data Sheet from the Dow Customer Information Group.

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**Health Information**

Health information for DOW™ metal organic products is summarized on the relevant Safety Data Sheets. It is important to note that health risks associated with individual products may vary based on their formulation or intended use. The Safety Data Sheet is the preferred source for specific health information. An overview of health information for DOW metal organic products appears below.

The primary hazard presented by Dow metal organic products is associated with the physical hazards of pyrophoricity, water-reactivity, and flammability. See **Physical Hazard Information** for further details on these hazards.

The health hazards are considered of secondary importance compared to the physical hazards. Of the health hazards associated with DOW metal organic products, users should be primarily concerned with the damaging corrosive properties. Contact with these materials can cause burns to the eye, skin, and/or respiratory tract. If the materials are swallowed, chemical burns to the mouth, throat, and digestive tract are possible. Similar effects are possible if the materials are inhaled: severe irritation of nose, throat, and respiratory tract and possible lung damage can occur.

**Chronic exposure**

Trimethylarsenic and trimethylantimony have been reported to damage DNA. Trimethylarsenic oxide, a likely breakdown product of trimethylarsenic, has been reported to cause cancer in experimental animals. Carbon tetrabromide belongs to the chemical class of halogenated hydrocarbons known to damage liver and kidneys upon repeated overexposure to vapors.

For more information, request the relevant Safety Data Sheet from the Dow Customer Information Group.

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**Environmental Information**

Environmental information for DOW™ metal organic products is summarized on the relevant Safety Data Sheets. Ecological information is not currently available for these products. Because of their reactivity and physical hazards, DOW™ metal organic products potentially released to the environment can pose a threat to aquatic life.

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environment would be unlikely to remain in air or water, as most are pyrophoric (will ignite spontaneously in air) and also react violently with water. The materials will be destroyed in air or water environments. Given that the soil environment includes moisture, it is doubtful that these products would remain in soil. Parent metal oxide residues (e.g., aluminum oxide, indium oxide, gallium oxide), similar to naturally occurring metal oxides, will form as a consequence of ignition and remain in the environment. These residues are not soluble in water so they are expected to remain in soil or sediment at the point where they are introduced to the environment.

The metal oxides formed during environmental degradation of DOW metal organic products are of varying toxicities to aquatic organisms, with algae often being the most sensitive. Most are toxic to aquatic invertebrates, while some are practically non-toxic to fish.

For more information, request the relevant Safety Data Sheet from the Dow Customer Information Group.

Physical Hazard Information

Physical hazard information for DOW™ metal organic products is summarized on the relevant Safety Data Sheets. Hazards may vary based on specific product formulation. The Safety Data Sheet is the preferred source for specific hazard information. An overview of hazard information for DOW metal organic products appears below.

Many DOW metal organic products are pyrophoric; they can ignite spontaneously when exposed to air at normal or slightly elevated temperatures. These materials also react violently with water, resulting in flammable vapor and metal oxides. Keep materials away from heat and sources of ignition. These materials should be stable under normal conditions. The storage area should be cool, dry, well ventilated, and out of direct sunlight.

For more information, request the relevant Safety Data Sheet from the Dow Customer Information Group.

Regulatory Information

Regulations may exist that govern the manufacture, sale, transportation, use, and/or disposal of DOW™ metal organic products. These regulations may vary by city, state, country, or geographic region. Information may be found by consulting the relevant Safety Data Sheet or Contact Us.

Additional Information

- Safety Data Sheet (request from www.dow.com/assistance/dowcig.htm)
- Contact Us (http://www.dow.com/assistance/thoughts.htm)
- Chemical Vapor Deposition Sources for Compound Semiconductors and SiGe: OPTOGRADETM and THZGRADETM Metal organics, Dow Electronic Materials, The Dow Chemical Company, Form No. ME04N111 Revision 8, April 8, 2010
- Chemical Vapor Deposition Sources for LED and Solar Applications, Dow Electronic Materials, The Dow Chemical Company, Form No. ME08N022 Revision 1, July 2009
- UNIFLOTM II Cylinder: Stable Delivery of Solid Precursors to MOCVD Reactors, Dow Electronic Materials, The Dow Chemical Company, Form Ref. No. ME09N010 Revision 0, May 2009

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- **Advanced CVD and ALD Precursors**, Rohm and Haas Electronic Materials, a wholly owned subsidiary of The Dow Chemical Company, Form No. ME05N045 Revision 3, January 2007

For more business information about these materials, visit the DOW CVD Precursors in Electronics & Entertainment web page at [www.dow.com/products/electronics/semiconductor/cvc_precursors/landing.page]?&industry=1000004&application=1011338.

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**References**

5. *Chemical Vapor Deposition Sources for Compound Semiconductors and SiGe: OPTOGRADE and THZGRADE™ Metal organics*, The Dow Chemical Company, Form No. ME04N111 Revision 7, August 2009, page ii.
8. *Chemical Vapor Deposition Sources for Compound Semiconductors and SiGe: OPTOGRADE and THZGRADE Metal organics*, The Dow Chemical Company, Form No. ME04N111 Revision 7, August 2009, pages i and iv.

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