

The information in these data sheets is **NOT COMPREHENSIVE**. For detailed information about the chemicals with which you work, please consult the Chemical Safety Handbook for the Semiconductor, Electronics and Photovoltaic Industries.

Semiconductor Extremely Hazardous Chemicals – Data Sheets

Toxic Hydride Gases

Examples:

- Arsine
- Diborane
- Germanium tetrahydride
- Hydrogen selenide
- Hydrogen sulfide
- Phosphine

Uses

Gases are often used as in diffusion, implant or deposition



Hazards

- Ignites on contact with air
- Primary hazard: **flammable**
- Secondary hazard: may be **toxic**
- Compressed gas is under pressure and can explode if the cylinder is heated
- By-products will form and coat exhaust lines and process pumps

Precautions

Requires pyrophoric (or toxic) gas controls that may include:

- Alarms that activate upon gas release
- Exhausted and monitored enclosures for the cylinder and any fittings
- Handling and cleaning procedures for opening delivery lines, chambers and exhaust lines

Key Information

TLVs (ppm)	IDLHs (ppm)	LC50s (ppm)	LELs (% in air)	UELs (% in air)	Odor
Under 10	Under 100	Under 200	0-4	75-100	Odors are detectable at levels over the exposure threshold.

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Corrosive Gases

Examples:

- Ammonia
- Boron trifluoride
- Hydrogen bromide
- Hydrogen chloride
- Tungsten hexafluoride

Uses

Gases used to:

- Etch silicon in etch processes
- Clean chambers in numerous processes



Hazards

- Primary hazard: **toxic**
- Secondary hazard: **corrosive**
- Compressed gas is under pressure and can explode if the cylinder is heated
- Fluorinated and chlorinated radicals hydrolyze with moisture in air to form hydrofluoric acid (HF) or hydrochloric acid (HCl) vapors

Precautions

Corrosive gas controls may include:

- Alarms that activate at occupational exposure limits
- Exhausted and monitored enclosures for the cylinder and any fittings
- Double contained piping or specially treated piping
- Handling and cleaning procedures for opening delivery lines, chambers and exhaust lines

Key Information

TLVs (ppm)	IDLHs (ppm)	LC50s (ppm)	LELs (% in air)	UELs (% in air)	Odor
Under 10	Under 100	Under 200	N/A	N/A	Odors are usually pungent or acrid. Many cause olfactory fatigue.

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Oxidizing Gases

Examples:

- Chlorine
- Chlorine trifluoride
- Fluorine
- Nitric oxide
- Nitrogen dioxide
- Ozone

Uses

Gases used for:

- Nitride deposition
- Chamber cleaning



Hazards

- Primary hazard: may be **toxic** or an **oxidizer**
- Compressed gas is under pressure and can explode if the cylinder is heated

Precautions

Oxidizing gas controls may include:

- Alarms that activate at occupational exposure limits
- Exhausted and monitored enclosures for the cylinder and any fittings
- Double containment piping
- Handling and cleaning procedures for opening delivery lines, chambers and exhaust lines

Key Information

TLVs (ppm)	IDLHs (ppm)	LC50s (ppm)	LELs (% in air)	UELs (% in air)	Odor
0.1 to 25	5 - 100	Under 500	N/A	N/A	Odors are detectable at levels just below or at the exposure threshold. Odor quality varies, most are sharp and pungent.

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Pyrophoric Gases

Examples:

- Silane
- Phosphine
- Germanium tetrahydride
- Disilane

Uses

Gases are often used as in diffusion, implant or deposition



Hazards

- Ignites on contact with air
- Primary hazard: **flammable**
- Secondary hazard: may be **toxic**
- Compressed gas is under pressure and can explode if the cylinder is heated
- By-products will form and coat exhaust lines and process pumps

Precautions

Requires pyrophoric (or toxic) gas controls that may include:

- Alarms that activate upon gas release
- Exhausted and monitored enclosures for the cylinder and any fittings
- Handling and cleaning procedures for opening delivery lines, chambers and exhaust lines

Key Information

TLVs (ppm)	IDLHs (ppm)	LC50s (ppm)	LELs (% in air)	UELs (% in air)	Odor
0.2 to 5	Not available	9600 (4 hr rat)	1	100	Minor gas leaks of silane will generally react and form silicon by-products at the leak point.

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Silane

Examples:

- Silicon tetrahydride (SiH_4)

Uses

Gas used as a silicon source in deposition and diffusion



Hazards

- Pyrophoric gas, highly ignitable or explosive in air
- Compressed gas is under pressure and can explode if the cylinder is heated

Precautions

Requires pyrophoric (or toxic) gas controls that may include:

- Alarms that activate at occupational exposure limits
- Exhausted and monitored enclosures for the cylinder and any fittings
- Double containment piping
- Only specially trained personnel can perform cylinder changes

Key Information

TLV (ppm)	LEL (% in air)	UEL (% in air)	Odor
5	1	100	Repulsive odor

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Flammable Gases

Examples:

- Acetylene
- Carbon monoxide
- Hydrogen
- Methane
- Propane

Uses

Used as:

- Carrier gases in deposition and implant
- Diffusion and as fuel in abatement and anneal



Hazards

- Primary hazard: **flammable**
- Compressed gas is under pressure and can explode if the cylinder is heated

Precautions

Requires hazardous gas controls that may include:

- Alarms that are set at 25% of the lower explosive level to activate alarms and shutoff gas flow
- Quantities above threshold levels must be in exhausted and monitored enclosures

Key Information

TLVs (ppm)	IDLHs (ppm)	LC50s (ppm)	LELs (% in air)	UELs (% in air)	Odor
N/A	N/A	N/A	4-10	75-100	Varies

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Highly Energetic Materials

Examples:

- Organometallic materials (OM)
- Diethylzinc
- Trimethylaluminum
- Trimethylgallium
- Trimethylindium

Uses

- Highly energetic source materials are solids and liquids
- Vapors are evaporated from source materials and used to deposit metals on substrates



Hazards

- Primary hazards:
 - **Flammable**
 - **Highly reactive to water or air**
- Secondary hazard: **corrosive**

Precautions

Requires stringent controls that may include:

- Highly energetic materials should be used in closed systems
- Installation and operation review using a process hazard analysis or other system safety approach
- Handling and cleaning procedures for opening delivery lines, chambers and exhaust lines

Key Information

- Due to air and moisture reactivity, low-level exposure is not considered a main hazard
- Fire and explosion risks due to spontaneous ignition is the hazard to control

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Corrosive Liquids

Examples:

- Hydrochloric acid (hydrogen chloride)
- Hydrofluoric acid (hydrogen fluoride)
- Sulfuric acid
- Nitric acid
- Phosphoric acid

Uses

Liquids used to:

- Etch silicon
- Strip photoresist from wafers
- Clean parts



Hazards

- Primary hazard: **corrosive**
- Secondary hazard: **toxic**
- Contact with skin will cause burns
- Inhalation or vapors can cause irritation and burning (significant inhalation of vapors can lead to chemical pneumonia)
- Mixing corrosives with incompatible materials, such as flammables, can lead to violent reactions (fire and explosion)

Precautions

Requires controls that may include:

- Ventilated hoods for any open use
- Handling and use procedures
- Safety eye and face wear, gloves and protective clothing
- Readily accessible safety shower

Key Information

TLVs (ppm)	IDLHs (ppm)	Odor
0.1 to 2	15 to 50	Sharp pungent odors, many with the ability to cause olfactory fatigue.

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By-products

Uses

Solids and **liquids** that form in chambers, exhaust lines and exhaust system equipment from deposition, diffusion and implant processes



Hazards

- Hazards are similar to the hazards from the original material
- Primary hazard: usually **toxic** from off-gassing when exposed to air
- Secondary hazard: **flammable**
- Can combine to form additional hazards:
 - Water-reactive
 - Toxic
 - Corrosive
 - Violent reactions (fire and explosion)

Precautions

Requires specialized controls that may include:

- Ventilation, monitoring and alarms to maintain exposure below limits
- Transportation, handling and cleaning procedures for opening chambers and exhaust lines
- Personal respirator, eye and face wear, gloves and protective clothing

Key Information

Assume all by-products have the same hazards as source materials and are reactive