SEMICONDUCTOR INDUSTRY ASSOCIATION

**SIA Comments**
**On the**
**Draft Scope of the Risk Evaluation for Formaldehyde**

**EPA-HQ-OPPT-2018-0438**

**CASRN 50-00-0 (including CASRN 30525-89-4)**

**Submitted June 8, 2020**

The Semiconductor Industry Association (SIA) submits these comments to the U.S. Environmental Protection Agency (EPA) on the Draft Scope of the Risk Evaluation for Formaldehyde (CASRN 50-00-0 (including CASRN 30525-89-4).

SIA is the trade association representing leading U.S. companies engaged in the design and manufacture of semiconductors. Semiconductors are the fundamental enabling technology of modern electronics that has transformed virtually all aspects of our economy, ranging from information technology, telecommunications, health care, transportation, energy, and national defense. The U.S. is the global leader in the semiconductor industry, and continued U.S. leadership in semiconductor technology is essential to America's continued global economic leadership. More information about SIA and the semiconductor industry is available at www.semiconductors.org.

Summary of SIA's Comments

Use of formaldehyde in semiconductor manufacturing occurs in very small quantities as a minor component in certain metal plating formulations under conditions of use during which direct human exposures to formaldehyde do not occur and environmental releases also are minimal, if any. Formaldehyde does not remain present in the finished article (wafer) following the plating operation. Formaldehyde also can remain unintentionally present in extremely small quantities as a byproduct/impurity in certain photolithography and chemical mechanical planarization (CMP) formulations that can be used in semiconductor production. When such formulations are used, human exposures to formaldehyde also do not occur, and environmental releases of the substance also would be minimal, if any. Similarly, when such photolithographic and planning operations are concluded, formaldehyde does not remain present in finished wafers produced in semiconductor facilities in the US. Formaldehyde may be present as an unintentional byproduct (<10 ppm) in certain finished semiconductor devices encased in a plastic casing or package. For SIA members "assembly, packaging and test" (APT), the process which prepares a finished IC for incorporation in a circuit board, occurs in facilities located outside the U.S. The formaldehyde byproduct is entrained in the plastic polymer and, thus, there are no commercial user or consumer exposures to, or direct contact of commercial users or consumers with, formaldehyde. These conditions of use are described in further detail later in these comments, and lead to the conclusion that the presence of formaldehyde in such small quantities and under the conditions of use in semiconductor manufacturing operations does not result in any direct human exposures to formaldehyde in the semiconductor workplace. Formaldehyde does not remain present in any finished wafer that might be incorporated into an electronic product to which commercial users or consumers might be exposed, and formaldhyde entrained in a plastic package is minor and not available for release to the environment. Thus, the conditions of use of Formaldehyde in semiconductor manufacturing occurs in small quantities, is incidental

in nature, and does not present an unreasonable risk to human health or the environment. The revised scope document should be edited to reflect the information described in these comments.

The remainder of this comment document provides a summary of the semiconductor industry's manufacturing process, our limited uses of Formaldehyde, and information on the conditions of use relevant to EPA's scoping exercise. The initial section provides background critical to understanding the processes involved in semiconductor manufacture so the reader can fully appreciate the following section describing the specific conditions of use involving trace amounts of Formaldehyde.

## I. Background on Semiconductor Manufacturing

### A. Overview of the Semiconductor Manufacturing Process

Semiconductor device fabrication is the process used to create integrated circuits that are present in electrical and electronic devices. An overview of semiconductor manufacturing process can be found in OECD emissions scenario documents.[1] The fabrication process (see Figure 1) begins with a wafer of semiconductor material varying in size from 150-300mm in diameter and includes a sequence of photographic and chemical processing steps during which electronic circuits are gradually created on the wafer substrate. These electrical circuits are made one layer at a time by the combination of putting a layer on the surface of the wafer and using a patterning process to then remove designated parts of the layer to leave behind a specific shape. Advanced semiconductors may contain billions of transistors on a layer of silicon the size of a square centimeter, so manufacturing must be rigorously controlled and conducted with great precision to achieve features at the nanoscale. The basic steps of semiconductor manufacturing include:

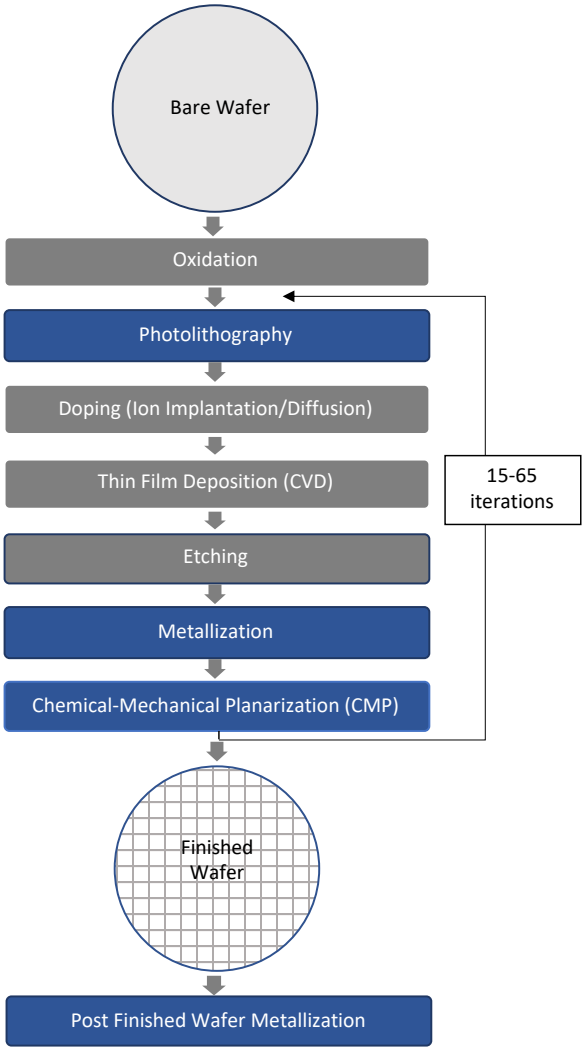
- Oxidation, a process usually performed at 800-1200 degrees C in a tube furnace, is a batch process that diffuses oxygen ($O_2$) or water ($H_2O$) vapor into the silicon wafer to form a silicon dioxide ($SiO_2$) layer that protects the wafer surface during subsequent steps.
- During the photolithography step, the wafer is coated with a layer of photoresist and subsequently covered with a mask that defines the specific patterns to be retained or removed in subsequent processes. In a typical processing scheme, the photoresist polymer formulation is applied to a spinning wafer, and then subjected to a pre-exposure bake to drive off a proportion of the solvent to impart dimensional stability to the film. Formaldehyde may be present in low concentrations as an impurity in certain lithography formulations.
- The coated wafer substrate is then exposed thru a patterned photomask, with actinic radiation from a light source of specified wavelength. Reflectivity of the semiconductor material during light exposure can be problematic. To absorb light and reduce reflections during the exposure, a layer of anti-reflective coating is typically utilized. An anti-reflective coating applied after the photoresist is referred to as a top antireflective coating (TARC) agent and an anti-reflective coating applied before the photoresist is referred to as a bottom anti-reflective coating (BARC) layer.

[1] ENV/JM/MONO(2015)5; ENV/JM/MONO(2004)14/REV1.

- After exposure, the coated wafer substrate undergoes a development process whereby the previously exposed regions are selectively dissolved and removed from the photoresist film. This leaves the wafer surface with a patterned coating of photoresist, where in selected regions the resist material is completely removed, and where in the remaining areas the photoresist forms a protective coating. The open areas of the substrate may then be subjected to additive processes like physical vapor deposition, chemical vapor deposition, diffusion, ion implant or plating; or subtractive process like a plasma etch.
- In Doping/Diffusion, atoms with one less electron than silicon (such as boron) or one more electron than silicon (such as phosphorus) are introduced into the area exposed by the etch process, to alter the electrical character (conductivity) of the silicon.
- In thin film deposition, thin layers or films are added to the wafer surface to change its electrical properties or to serve as masks.
- In etching, specific areas of a deposited film are chemically removed so that an underlying material is exposed or another material may be deposited. Etching may be performed in a wet process using solutions of acids, bases or oxidizers, or in a dry process using various gases in a plasma.
- Subsequent to the etch or deposition process, the residual photoresist and anti-reflective coating must be removed from the wafer surface. This final step, known as the photoresist strip step, must be accomplished in a manner that completely and uniformly removes the residual photoresist, without adversely impacting the surfaces of the materials comprising the underlying wafer substrate (Dean et al, 1992; Lee et al, 1994).
- Dielectric Deposition and Metallization – Following completion of the "front end," the individual devices are interconnected using a series of alternating metal depositions and dielectric films, with their respective patterning. Metallization may be accomplished via physical vapor deposition, chemical vapor deposition and plating, processes which all occur in totally enclosed complex pieces of equipment known as “tools” (described more fully below). Formaldehyde may be present in some copper plating chemistries as an additive as a trace component (<0.5%). No direct human exposure occurs during the plating process.
- CMP is a process that uses chemical and mechanical forces to smooth wafer surfaces. Formaldehyde may be unintentionally present in trace amounts (< 10 ppm) as a byproduct/impurity in some aqueous CMP slurry formulations. No direct human exposure occurs to formaldehyde during the planarization process.
- Passivation – After the last metal is patterned, a final insulating layer (passivation) is deposited to protect the circuit from damage and contamination. Openings are etched in this film to allow access to the top metal later by electrical probes and subsequent wire bonds.
- Post finished wafer metallization – Balls or bumps of solder are added to the finished wafer before dicing into individual chips. In some packages, the bump is used to connect the chip to a substrate, circuit board or another chip. Formaldehyde may be contained in electroless copper plating solutions and in trace amount in certain leveling agents used in electrolytic copper plating. Similarly, no direct human exposure to formaldehyde occurs during this plating process.
- Cleaning occurs in various parts of the process flow and is also an important part of the wafer fabrication process as semiconductor devices are highly susceptible to various kinds of contamination such as particles, metal ions, chemicals, bacteria, and airborne molecular contaminants.
- Assembly and Packaging – A diamond tooth saw slices the wafer into single chips. Sizes can vary from 1 x 1 mm to 76 x 56mm. Each chip is then assembled into an appropriate

package (usually plastic or ceramic) that provides the contact leads for the chip. In one type of interconnect a wire bonding machine attaches wires, a fraction of the width of a human hair, to the leads of the package. Formaldehyde is present as a byproduct of the polymerization reaction (<10 ppm) in mold compound, the plastic part of a plastic package.

*Figure 1: Overall Process Flow Diagram – Semiconductor Manufacturing*[2]
(Blue boxes signify steps where Formaldehyde may be present)
(Based on OECD, 2010)




[2] Wafers undergo multiple iterations of the steps from photolithography to CMP, as indicated by the return arrow.

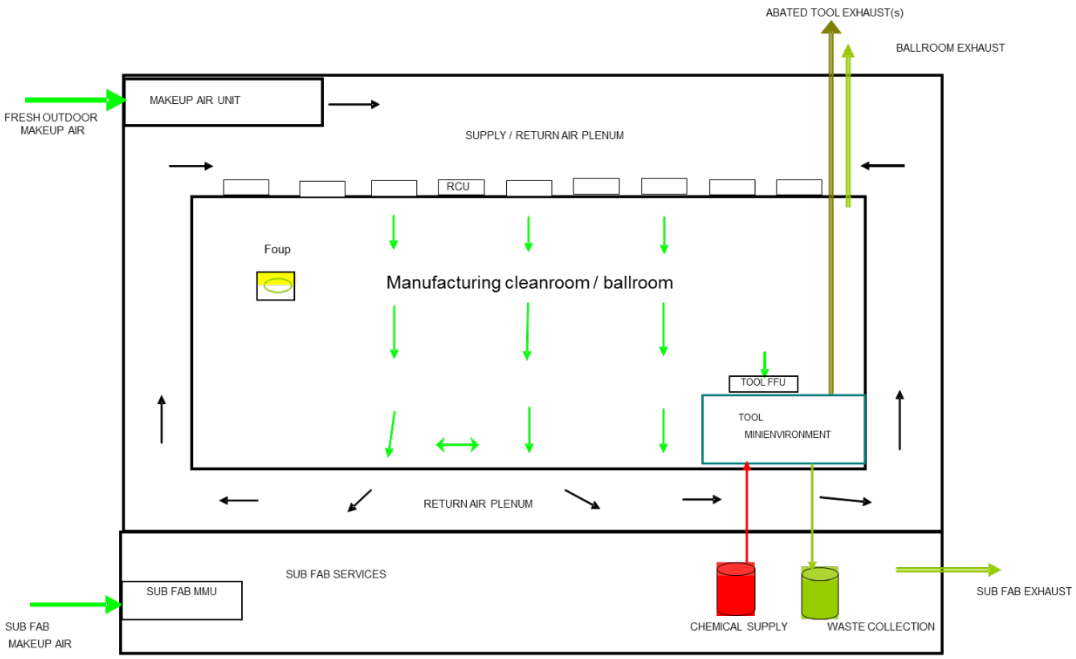
B. Semiconductor Manufacturing – Fab Cleanrooms and Equipment

The fabrication of semiconductors is conducted in specialized buildings known as “fabs” that involve the use of cleanrooms, and a hierarchy of design features that isolate workers and wafers from chemicals. The fab cleanroom design approach protects manufacturing personnel and is also critical to semiconductor wafer product quality. Figure 2 illustrates schematically the design of a typical 300mm fab. The fab consists of a cleanroom where the manufacturing operations are conducted, and an isolated ancillary space which contains chemical and air handling equipment, emission controls, and other infrastructure, and which is often located in an area within the building known as a “sub-fab”.

The fabrication of an integrated circuit on a silicon wafer involves a sequence of hundreds of additive, subtractive, photolithography, and cleaning steps that is accomplished by shuttling wafers between specialized manufacturing “tools” within which the individual unit operations are conducted on the wafer. The manufacturing tools, engineers and operators are located within the cleanroom, but the tools are enclosed and are supplied with chemicals, power, and other utility services from the subfab or other ancillary space.

As also indicated on Figure 2, fresh air is brought into the fab thru an air conditioning unit that controls the fab air temperature and humidity, and is recirculated through ultra-low particulate air (ULPA) filters before being exhausted to the building exterior. In a typical 300mm wafer manufacturing fab built in 2000, the entire volume of air in the fab cleanroom is replaced every 7 minutes, and the entire volume of air in the cleanroom is recirculated through the ULPA filters at a rate of once every 0.64 minute. This extensive level of air circulation and replacement provides an exceptional level of fab air cleanliness.

*Figure 2. Schematic of airflow in a typical Fab.*



In all semiconductor manufacturing, regardless of the level of sophistication of the factory, equipment systems operate with intrinsic controls that minimize or eliminate chemical liquid or vapor exposure potential during normal equipment operations. The equipment must be maintained frequently, which requires the operating parts of the equipment to be placed in stand-by (non-operating mode) and the opening of protective enclosures. During these maintenance activities, workers utilize protective equipment to reduce the potential for employee exposure. Older manufacturing equipment (150mm and older) is generally less sophisticated with varying degrees of protective equipment controls. In those cases, more PPE is used to protect the employee during operations. Even in these cases a high degree of engineering controls is used to ensure employee exposure is minimized including exhaust, interlocks, and monitoring. In all cases where engineering controls are not available, administrative controls are used to minimize the potential for exposure.

During fabrication, the wafers are highly susceptible to even minute amounts of contamination, and so the wafers are moved in and out of tools by robotics, placed robotically into enclosed boxes, known as front opening unified pods (FOUPs), and shuttled between tools via a computer controlled, automated transport system. Figure 3 shows manufacturing tools aligned along one of many corridors within a typical 300mm fab, and Figure 4 an automated transport system that shuttles FOUPs between tools.

*Figure 3. Photo of typical 300mm wafer manufacturing cleanroom.*

*Figure 4. Robotic system moves wafers inside enclosed containers (FOUPs).*

## II. Uses of Formaldehyde in the Semiconductor Industry

### A. Overview of Semiconductor Uses of Formaldehyde

In the highly-controlled semiconductor manufacturing process, the semiconductor industry Formaldehyde in small concentrations is used or may be contained in:

- Certain electroless copper plating solutions[3] at concentrations less than 0.5%. Copper may be used as an interconnect within the chip (metallization process) and in the post finished wafer metallization process.
- Certain leveling additives (see Attachment A) during electrolytic copper plating that are used to slow down the copper plating rates for a uniform, smooth surface. Formaldehyde is a trace component of this material.
- Certain chemical mechanical planarization (CMP) slurry formulations as an impurity.
- Certain lithography formulations as an impurity (0.0005-0.01%). Photoresists consist of three major constituents: a photoactive compound, a resin to provide structural stability and etch resistance and a solvent which allows for coating of the wafer.[4] The resin may be a synthetic polymer Novolac obtained by the reaction of phenol or substituted phenol with formaldehyde; thus, unreacted formaldehyde may remain unintentionally present at

[3] EPA-HQ-OPPT-2018-0438-0025.pdf. Note that formaldehyde is not listed as a component on copper plating bath SDSs, an indication that it is present at less than 1%; other confidential documentation provided to the semiconductor manufacturer lists concentration as less than 0.5%.
[4] Chris Mack, "Positive Photoresists – Exposure", The Lithography Tutor, 1994, http://www.lithoguru.com/scientist/litho_tutor/TUTOR05%20(Winter%2094).pdf.

very small quantities as an impurity in the resin. Formaldehyde may also be present in antireflective coatings as an impurity. The formaldehyde provides no functionality but cannot be removed cost effectively. The resins manufactured with formaldehyde are an industry standard and not considered to be replaceable.

- Mold compounds (as a byproduct (<10 ppm) of the polymerization reaction) used for plastic packages. For SIA members "Assembly, packaging and test" (APT), the process which prepares a finished IC for incorporation in a circuit board, occurs in facilities located outside the U.S. The formaldehyde provides no functionality to the mold compound but cannot be removed cost effectively. The formaldehyde byproduct is entrained in the plastic polymer and, thus, there are no commercial user or consumer exposures to, or direct contact of commercial users or consumers with, formaldehyde and it is not available for release to the environment.

Semiconductor formulations contain formaldehyde at concentrations less than 0.5% as an unintentional impurity or byproduct. When present as an impurity or byproduct, it cannot be cost effectively removed. Total use by the industry is small – no semiconductor facility's uses in this manner currently exceeds the TRI reporting threshold.

B. Importance of Formaldehyde in Semiconductor Manufacturing

The use of formaldehyde in plating is the most widely used and efficient additive for the purpose of ensuring a uniform, smooth surface during copper plating. The resins manufactured with formaldehyde for lithography are industry standard and not considered to be replaceable. Formaldehyde in mold compound is insignificant and provides no function, yet it cannot be cost effectively removed.

## III. Controls in Semiconductor Manufacturing

A. Controls Employed with Uses of Formaldehyde Containing Formulations

Use of Formaldehyde containing formulations in the semiconductor industry are subject to significant levels of control. Manufacturing tools are equipped with exhaust, interlocks to prevent an exposure during processing, a once-through closed path system, and pre-open cleaning procedures. Industrial Hygiene monitoring has been conducted showing exposures below the ACGIH threshold limit values (TLV) and OSHA permissible exposure limit (PEL).

B. Waste Management and Controls

Aqueous waste containing traces of Formaldehyde are disposed via industrial wastewater, which undergoes elementary neutralization prior to discharge to a publicly owned treatment works (POTW) for further treatment. Organic formulations containing trace amounts of formaldehyde are collected with other solvent waste and disposed via incineration, fuel blending or solvent recovery[5]. Plating baths are collected for disposal/recycling.

[5] ENV/JM/MONO(2004)14/REV1, OECD 2010.

C. Worker Exposure

Semiconductor fabs employ extensive and redundant controls to minimize the exposure of workers to chemicals of concern. The typical risk management measures and safety practices deployed at fabs to prevent Formaldehyde releases and worker exposure include the following:

- Fabs employ professional industrial hygienists that evaluate and control potential workplace exposures.
- Extensive engineering controls to prevent employee exposure.
- Extensive training in hazard communication, safe handling of chemicals, and proper use of personal protective equipment.
- Chemical storage, dispense and handling:
  - Segregated Storage per local codes
  - Automatic, ventilated, and fully enclosed supply and discharge systems
  - Personal protective equipment (PPE) worn during container change out (chemical resistant gown, chemical protective gloves, safety glasses/goggles, and face shield)
  - General ventilation and local exhaust ventilation
- Routine semiconductor manufacturing operations
  - Process tools are located in the clean room where a stringent clean regime is maintained as a requirement for production which also ensures no chemical releases
  - Closed systems
  - Continuous local exhaust ventilation under alarm
  - Automated chemical delivery (no chemical pouring)
- Invasive maintenance
  - Tool purged prior to invasive maintenance
  - Maintenance occurs at room temperature under local exhaust ventilation
  - Wearing of proper PPE as required.

Formulations containing formaldehyde are used in processes which take place in enclosed tools, under highly controlled conditions, and there is no expectation of worker exposure.

## IV. Conclusion

Formaldehyde is used in the semiconductor industry in limited steps and involving very small quantities. Formaldehyde is present as a minor component or impurity (almost immeasurable) in certain formulations. When present as an impurity or byproduct in semiconductor formulations, it cannot cost effectively be removed. Moreover, the operations occur within tools from which humans are excluded during normal operations and in manufacturing environments subject to extensive controls for specialized uses to meet stringent performance requirements. Formaldehyde does not remain present in finished wafers (articles) produced in semiconductor facilities in the US. Formaldehyde may be present as an unintentional byproduct (<10 ppm) in certain finished semiconductor devices encased in a plastic casing or package. For SIA members, “Assembly, packaging and test” (APT), the process which prepares a finished IC for incorporation in a circuit board occurs in facilities located outside the U.S. The formaldehyde byproduct is entrained in the plastic polymer and, thus, there are no commercial user or consumer exposures to, or direct contact of commercial users or consumers with, formaldehyde and no release to the environment. The conditions described above demonstrate that the

presence of formaldehyde in small quantities and under the conditions of use in semiconductor manufacturing operations does not present an unreasonable risk to human health or the environment.

Based on the foregoing, SIA requests that the Agency revise and correct the draft scoping document to note that: (a) formaldehyde is present only in minute (trace) quantities in a limited number of formulations used in enclosed processes in semiconductor manufacturing; (b) no direct worker exposures to formaldehyde occurs in any semiconductor operations involving its use; (c) formaldehyde does not remain present in semiconductor wafers produced under these conditions of use; and (d) there are no commercial user or consumer exposures to formaldehyde in products produced in the semiconductor manufacturing sector.

It is worth noting that EPA has recently announced its intention to exempt from the Fees Rules for High Priority substances, those high priority substances that are present only as impurities, byproducts, and in articles. Applying those same principles to the presence of Formaldehyde in formulations used in semiconductor operations, EPA should consider excluding from consideration in its risk evaluation semiconductor manufacturing operations involving trace quantities of formaldehyde. This would permit the Agency to focus it limited risk evaluation resources on those uses of formaldehyde that involve greater quantities and greater risk of human exposure or environmental releases.

As EPA continues its work on the scoping document for Formaldehyde and the future risk evaluation, we look forward to working closely with EPA to ensure an accurate characterizing the very limited uses of Formaldehyde in the semiconductor industry.

# Attachment A

# SPHEROLYTE LEVELLER 10



## SECTION 1. IDENTIFICATION

Product name : SPHEROLYTE LEVELLER 10

Product code : 1760761

**Manufacturer or supplier's details**

Company name of supplier : Atotech Deutschland GmbH

Address : Erasmusstrasse 20
Berlin 10553
Germany

Telephone : +4930349850

Company name of supplier : Atotech USA

Address : 1750 OVERVIEW DRIVE
ROCK HILL 29730
USA

Telephone : +18038173500

Prepared by
Product Safety Department (PSD): product-safety@atotech.com

Inquiries
Questions about content of Safety Data Sheets: product-safety@atotech.com

Emergency telephone : CHEMTREC +18004249300

Transport Medical : Rocky Mountain Poison Control Center: 303-623-5716

**Recommended use of the chemical and restrictions on use**

Recommended use : Plating agents and metal surface treating agents
Surface treatment

Restrictions on use : For industrial use only.

## SECTION 2. HAZARDS IDENTIFICATION

**GHS Classification**

Not a hazardous substance or mixture.

**GHS Label element**

Not a hazardous substance or mixture.

**Other hazards**

None known.

## SECTION 3. COMPOSITION/INFORMATION ON INGREDIENTS

| | | |
|---|---|---|
| Substance / Mixture | : | Mixture |
| Chemical nature | : | Aqueous solution |

**Hazardous ingredients**

No hazardous ingredients

This product may contain component (s) that are not listed under disclosure. All components not listed, do not contain hazardous materials above deminimus disclosure limits as defined by OSHA, NIOSH, ACGIH or Canadian WHMIS regulations and or guidelines. Please refer to other sections of the MSDS for information on safety, health and environmental guidelines and precautions.

## SECTION 4. FIRST AID MEASURES

| | | |
|---|---|---|
| General advice | : | If you feel unwell, seek medical advice (show the label where possible). |
| If inhaled | : | Move to fresh air. |
| In case of skin contact | : | In case of contact, immediately flush skin with plenty of water.<br>Take off contaminated clothing and shoes immediately.<br>Wash contaminated clothing before re-use. |
| In case of eye contact | : | Rinse immediately with plenty of water, also under the eyelids, for at least 5 minutes. |
| If swallowed | : | If swallowed, call a poison control center or doctor immediately.<br>Never give anything by mouth to an unconscious person.<br>Do not induce vomiting without medical advice. |
| Protection of first-aiders | : | First Aid responders should pay attention to self-protection and use the recommended protective clothing |
| Notes to physician | : | No information available. |

## SECTION 5. FIRE-FIGHTING MEASURES

| | | |
|---|---|---|
| Suitable extinguishing media | : | Use extinguishing measures that are appropriate to local circumstances and the surrounding environment. |
| Unsuitable extinguishing media | : | No information available. |
| Hazardous combustion products | : | No hazardous combustion products are known |

| | | |
|---|---|---|
| Specific extinguishing methods | : | Use a water spray to cool fully closed containers.<br>Collect contaminated fire extinguishing water separately. This must not be discharged into drains.<br>Fire residues and contaminated fire extinguishing water must be disposed of in accordance with local regulations. |
| Special protective equipment for fire-fighters | : | As in any fire, wear self-contained breathing apparatus pressure-demand, MSHA/NIOSH (approved or equivalent) and full protective gear. |

## SECTION 6. ACCIDENTAL RELEASE MEASURES

| | | |
|---|---|---|
| Personal precautions, protective equipment and emergency procedures | : | Use personal protective equipment.<br>Evacuate personnel to safe areas.<br>Keep people away from and upwind of spill/leak. |
| Environmental precautions | : | Should not be released into the environment. |
| Methods and materials for containment and cleaning up | : | Avoid formation of aerosol.<br>Dam up.<br>Soak up with inert absorbent material.<br>Keep in suitable, closed containers for disposal.<br>Clean contaminated floors and objects thoroughly while observing environmental regulations. |

## SECTION 7. HANDLING AND STORAGE

| | | |
|---|---|---|
| Advice on safe handling | : | For personal protection see section 8.<br>Smoking, eating and drinking should be prohibited in the application area.<br>Handle in accordance with good industrial hygiene and safety practice.<br>Avoid breathing mist or vapors. |
| Conditions for safe storage | : | Keep containers tightly closed in a dry, cool and well-ventilated place.<br><br>Do not freeze. |
| Recommended storage temperature | : | 1 - 8 °C |

## SECTION 8. EXPOSURE CONTROLS/PERSONAL PROTECTION

**Ingredients with workplace control parameters**

Contains no substances with occupational exposure limit values.

**Personal protective equipment**

| | | |
|---|---|---|
| Respiratory protection | : | In case of mist, spray or aerosol exposure wear suitable personal respiratory protection and protective suit. |

When workers are facing concentrations above the exposure limit they must use appropriate certified respirators.
In case of insufficient ventilation, wear suitable respiratory equipment.

Hand protection
Remarks : Wear protective gloves.The suitability for a specific workplace should be discussed with the producers of the protective gloves.Follow the instructions for use issued by the producer.

Eye protection : Tightly fitting safety goggles
Ensure that eyewash stations and safety showers are close to the workstation location.

Skin and body protection : Impervious clothing
Boots

Protective measures / Engineering measures : Ensure adequate ventilation, especially in confined areas.

Hygiene measures : Avoid contact with skin, eyes and clothing.
Wash hands before breaks and immediately after handling the product.
When using do not eat, drink or smoke.

## SECTION 9. PHYSICAL AND CHEMICAL PROPERTIES

| | | |
|---|---|---|
| Appearance | : | liquid |
| Color | : | colorless |
| Odor | : | No information available. |
| Odor Threshold | : | No data available |
| pH | : | 7.0 - 9.0 |
| Melting point/freezing point | : | not determined |
| Initial boiling point and boiling range | : | not determined |
| Flash point | : | Not applicable |
| Evaporation rate | : | No data available |
| Flammability (solid, gas) | : | Not applicable |
| Upper explosion limit | : | No data available |
| Lower explosion limit | : | No data available |
| Vapor pressure | : | ca. 23 hPa (20 °C) |

| | | |
|---|---|---|
| Relative vapor density | : | No data available |
| Density | : | 0.95 - 1.05 g/cm3 |
| Solubility(ies) | | |
| Water solubility | : | completely miscible |
| Partition coefficient: n-octanol/water | : | No data available |
| Autoignition temperature | : | No data available |
| Thermal decomposition | : | No data available |
| Viscosity | | |
| Viscosity, dynamic | : | No data available |
| Viscosity, kinematic | : | No data available |
| Oxidizing properties | : | Not applicable |

## SECTION 10. STABILITY AND REACTIVITY

| | | |
|---|---|---|
| Reactivity | : | None under normal processing. |
| Chemical stability | : | Stable under recommended storage conditions. |
| Possibility of hazardous reactions | : | No dangerous reaction known under conditions of normal use. |
| Conditions to avoid | : | To avoid thermal decomposition, do not overheat. |
| Incompatible materials | : | No data available |
| Hazardous decomposition products | : | No hazardous decomposition products are known. |

## SECTION 11. TOXICOLOGICAL INFORMATION

**Information on likely routes of exposure**
No information available.

**Acute toxicity**
Not classified based on available information.

Remark: The acute toxicity estimate (ATE) of the ingredients are derived using the LD50/LC50 values where available.

**Skin corrosion/irritation**
Not classified based on available information.

**Serious eye damage/eye irritation**

Not classified based on available information.

**Respiratory or skin sensitization**

Skin sensitization: Not classified based on available information.
Respiratory sensitization: Not classified based on available information.

**Germ cell mutagenicity**

Not classified based on available information.

**Carcinogenicity**

Not classified based on available information.

| | |
|---|---|
| **IARC** | No ingredient of this product present at levels greater than or equal to 0.1% is identified as probable, possible or confirmed human carcinogen by IARC. |
| **ACGIH** | No ingredient of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by ACGIH. |
| **OSHA specified** | No ingredient of this product present at levels greater than or equal to 0.1% is identified as a carcinogen or potential carcinogen by OSHA. |
| **NTP** | No ingredient of this product present at levels greater than or equal to 0.1% is identified as a known or anticipated carcinogen by NTP. |

**Reproductive toxicity**

Not classified based on available information.

**STOT-single exposure**

Not classified based on available information.

**STOT-repeated exposure**

Not classified based on available information.

**Aspiration toxicity**

Not classified based on available information.

**Further information**

**Product:**

Remarks: No data available

## SECTION 12. ECOLOGICAL INFORMATION

**Ecotoxicity**

No data available

**Persistence and degradability**

No data available

**Bioaccumulative potential**
No data available

**Mobility in soil**
No data available

**Other adverse effects**
No data available

**Product:**
No data available

## SECTION 13. DISPOSAL CONSIDERATIONS

**Disposal methods**

| | | |
|---|---|---|
| Waste from residues | : | Dispose of in accordance with local regulations.<br>Dispose of wastes in an approved waste disposal facility. |
| Contaminated packaging | : | Empty containers should be taken to an approved waste handling site for recycling or disposal. |

## SECTION 14. TRANSPORT INFORMATION

**International Regulation**

**UNRTDG**
Not regulated as a dangerous good

**IATA-DGR**
Not regulated as a dangerous good

**IMDG-Code**
Not regulated as a dangerous good

**Transport in bulk according to Annex II of MARPOL 73/78 and the IBC Code**
Not applicable for product as supplied.

**Domestic regulation**

**DOT / 49 CFR**
Not regulated as a dangerous good

## SECTION 15. REGULATORY INFORMATION

| | | |
|---|---|---|
| **TSCA 5a** | : | Not relevant |
| **TSCA_12b** | : | Not relevant |
| **DEA** | : | Not applicable |

**EPCRA - Emergency Planning and Community Right-to-Know**

**CERCLA Reportable Quantity**

| Ingredients | CAS-No. | Component RQ | Calculated product RQ |
|---|---|---|---|

| | | (lbs) | (lbs) |
|---|---|---|---|
| Formaldehyde | 50-00-0 | 100 | * |
| Methanol | 67-56-1 | 5000 | * |

*: Calculated RQ exceeds reasonably attainable upper limit.

**SARA 304 Extremely Hazardous Substances Reportable Quantity**

| Ingredients | CAS-No. | Component RQ (lbs) | Calculated product RQ (lbs) |
|---|---|---|---|
| Formaldehyde | 50-00-0 | 100 | * |

*: Calculated RQ exceeds reasonably attainable upper limit.

**SARA 311/312 Hazards** : No SARA Hazards

**SARA 302** : No chemicals in this material are subject to the reporting requirements of SARA Title III, Section 302.

**SARA 313** : This material does not contain any chemical components with known CAS numbers that exceed the threshold (De Minimis) reporting levels established by SARA Title III, Section 313.

**Massachusetts Right To Know**

No components are subject to the Massachusetts Right to Know Act.

**Pennsylvania Right To Know**

Formaldehyde 50-00-0 0 - 0.1 %

**New Jersey Right To Know**

No components are subject to New Jersey Right to Know Act.

**California Prop 65**

WARNING: This product contains a chemical known in the State of California to cause birth defects or other reproductive harm.

Methanol 67-56-1

Remarks: Components which are only displayed in Section 15 are being reported for local regulatory purposes. These components are not displayed in Section 3 due to one or more of the following conditions being met: being present in the product at concentration(s) below threshold limit values for reporting, not considered hazardous materials, health hazards or because they do not contribute to the overall GHS Classification of the final product as required by OSHA HazCom 2012 final rule ( 29 CFR 1910.1200).

**Substances currently restricted by WEEE/RoHS (European Directive 2002/96/EC , 2002/95/EC) or ELV (European Directive 2000/53/EC):**

| PBDE | PBB | CrVI | Hg | Pb | Cd |
|---|---|---|---|---|---|
| - | - | - | - | - | - |

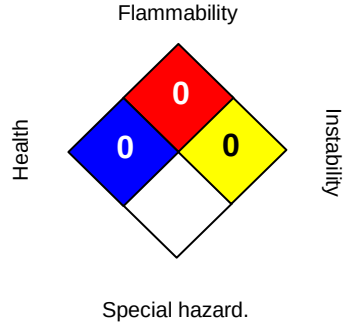
Please note: Current legislation restricting the use of certain substances applies to „homogeneous material“ in finished articles being supplied to the market. Substances deposited during surface finishing may have a composition (weight percent) higher than the weight percent of the sub-

stance in the operating solution from which the deposit is made. Atotech encourages its customers to implement systems to ensure their finished products comply with the regulations in force.

## SECTION 16. OTHER INFORMATION

### Further information

**NFPA:**




**HMIS III:**

| | |
|---|---|
| HEALTH | 0 |
| FLAMMABILITY | 0 |
| PHYSICAL HAZARD | 0 |

0 = not significant, 1 =Slight,
2 = Moderate, 3 = High
4 = Extreme, * = Chronic

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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.