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Chemical Fact Sheet:

Tetramethylammonium hydroxide (TMAH)



Tetramethylammonium hydroxide (CAS# 75-59-2) is used as a developer and an etchant in micro or nanofabrication. TMAH is a solid in the hydrated form or a colorless liquid when dissolved in water, it has a strong ammonia-like odor. TMAH is soluble in water, corrosive to metals and tissue and strongly alkali with a pH >13, even at low concentrations. TMAH is most commonly used during the fabrication of microchips, where it is used to remove unwanted materials from a semiconductor substrate to create a desired pattern. TMAH is commonly used at a 2.38% or 25% dilution for an etchant bath and micro-/nano-electronic developer.

Note: This guidance is for the occasional or small-scale use of TMAH typically in 2.38% or 25% solution. Contact the EHS Office to assure appropriate control measures are designed for your application if you plan:

- Large-scale ongoing process
- Frequent mixtures of small batches

Health Impacts:

Exposure to TMAH can have negative acute health impacts. TMAH is extremely toxic. As little as, 2% of the body exposed to TMAH can lead to paralysis and death. The TMAH⁺ cation is a ganglion inhibitor, blocking nerve transmissions. This can lead to cardiac and respiratory failure due to muscle inhibition. Other symptoms of TMAH exposure are blurred or double vision, pinpoint pupils, nausea, vomiting, diarrhea, salivation, urinary incontinence, muscle twitching and tremors.

Other acute dangers of TMAH are that it is corrosive and can cause chemical burns on the skin (2nd and 3rd degree), eyes and airways. If inhaled it can be corrosive to the nose, throat and lungs.

It is important to note that the LD50 for dermal exposure (LD50 is the amount of a chemical that is lethal to half of the experimental group when it is exposed to a chemical) for TMAH in

rats at a 2.38% concentration is 85.9 mg/kg meaning that it will only take 6 grams to provide a fatal dose to a normal 70 kg person. At 25% concentration the LD50 in rats is 28.7 mg/kg meaning only 2 grams in a 70 kg person can be a fatal dose.

Exposure Controls:

TMAH exposures to skin and eyes can result in serious burns, and dermal absorption may result in fatal systemic toxicity. Risk assessments for work involving TMAH may determine a level of required personal protective equipment (PPE) that is beyond the minimum mandatory laboratory PPE requirements. Each individual lab should perform a hazard assessment of their usage of TMAH to determine the best practices and PPE.

Engineering Controls: All work involving TMAH must be conducted inside a fume hood at least six inches from the sash. Keep the fume hood sash between you and the solution. The fume hood sash should be kept at an adequate operating height to ensure proper ventilation. Remove any organic or other incompatible chemicals from the fume hood when working with TMAH. It is recommended that work be done in a secondary container such as a tray to facilitate containment and assist in clean up procedures.

Personal Protective Equipment: Wear proper personal protective equipment for work with corrosives, including lab coat (CP/FR) or chemical apron, long pants, closed-toe shoes, and tight-fitting safety glasses or goggles. Since dermal exposure is extremely hazardous, no skin should be exposed if there is a potential for a splash. Sleeve guards and face shields may offer additional protection. Each lab space should conduct their own hazard assessment to determine what is the best level of PPE depending on their frequency of use, concentration, volume and specific research. For low concentrations and smaller volumes of TMAH 4 mil standard nitrile length cuff disposable gloves are allowed. For higher concentrations and larger volumes, double nitrile gloves are recommended. Another option could be chemical resistant multilayer or hybrid gloves (for example Ansell Microflex 93-260). (There are places on campus that have dual layered nitrile/neoprene gloves with a permeation time of >240 minutes, like MIT.nano).

Handling Procedures:

- Consult with your PI, laboratory supervisor and/or EHS Coordinator prior to initial use to discuss special hazards and precautions.
- Develop a written Lab Specific Standard Operating Procedure (SOP) for your application of TMAH that includes safety precautions for each step of your lab activities. Work must be done in a designated area. For development of a Lab Specific SOP, refer to the template on the MIT EHS website at: <https://ehs.mit.edu/chemical-safety-program/chemical-hygiene/>
- Do not work alone with TMAH. Work within sight or hearing of at least one other person who is familiar with the hazards and procedures.
- Make sure you have unimpeded access to eyewash and a safety shower.

- Do all work preparing and using of TMAH in a properly functioning fume hood. Put on personal protective equipment specified above.
- Only order the amount that you need, do not store large quantities of TMAH.
- Prepare only the amount you need for immediate use.
- Do not mix this solution with other chemicals unless a risk assessment has been performed.
- Locate and verify that appropriate spill cleanup materials are available, for small spills, including:
 - Proper PPE.
 - Base Neutralizer.
 - pH paper and hazmat absorbent mats.
 - Scraper to scoop into a hazardous waste bag.

Storage:

- Keep container tightly closed in a well-ventilated space. Keep locked up or in an area accessible only to qualified or authorized people.
- Store in original container.
- Store primary container in designated and compatible secondary containment.
- Store away from acids and flammables.
 - You can store TMAH in corrosive cabinet with other bases if they are compatible.

Waste Storage and Disposal:

1. Do not combine waste streams containing TMAH with other chemical waste.
2. Collect all TMAH waste separately, and store and label it according to the hazardous waste management guidelines.
 - a Hazardous Waste Classification: Toxic and Corrosive.
 - b Store in glass airtight container.
 - c Before putting waste into container make sure that there is no reaction actively occurring: so that pressure will not build up in the waste container.
3. Label the container with a red tag stating "Tetramethylammonium hydroxide" listing the specific chemical constituents and approximate percentages.
4. Keep the waste in a well-ventilated SAA, such as a fume hood or vented cabinet, separated from organic and other incompatible materials.
5. When submitting a pickup request, note in the comments section that your waste contains TMAH and is acutely toxic. This will ensure that the waste team brings the correct PPE and that the waste is removed in a timely manner.

Emergency Procedures:

- **Exposure Routes**
 - **Eye/Skin Contact:** Flush contamination from eyes/skin using the nearest emergency eyewash or shower for a minimum of 15 minutes. Remove any contaminated clothing.

- **Inhalation:** Move individual to fresh air, rescue breaths with barrier mask.
- **Ingestion:** Do not induce vomiting.

- **Response**

- There is no known antidote.
- Seek medical attention immediately, call 100 from a campus phone or 617-253-1212 from a cell phone.
 - When seeking medical attention, bring along a copy of this fact sheet, Safety Data Sheets (SDS) and your SOP.
- Ensure that detailed emergency procedures are included in your SOP.

- **Spills**

Notify personnel in the area and your supervisor.

- **Outside of Fume Hood**
 - Alert others and evacuate to a safe distance.
 - Contact EHS Office 617-452-3477 (9am to 5pm). Outside of that time, call Operations (100, from an MIT land line).
- **Inside of Fume Hood**
 - Close fume hood sash and contact EHS.
 - If trained and confident, you may assist in the clean-up effort of small amounts, wearing PPE described above and using appropriate spill supplies.
 - Collect debris in appropriate container and move it to your Satellite Accumulation Area (SAA). Label with appropriately completed hazardous waste tag and request a waste pickup.

For questions or additional information, contact the MIT EHS Office at 617-452-3477 or email environment@mit.edu.