Standard Operating Procedure - Piranha Solution

For chemical usage in the Keck Microfabrication Facility, B142

Only the commercial version of the Piranha solution, Nanostrip, is permitted in the facility. Refer to MSDS for detailed safety information on Nanostrip.

Quick Points

- Piranha solution is dangerous and unstable, and may cause skin burn or explosion.
- Full protection (splash barrier, splash goggle, apron, and safety gloves) is required.
- Use glass containers only. Do not use plastic containers.
- The waste solution must be given sufficient time (overnight) to cool down in an open container before transferring to a waste container for pickup by ORCBS.

1 - General information

1. A Piranha solution is a mixture of concentrated sulfuric acid (H₂SO₄) with hydrogen peroxide (H₂O₂), and is used to remove organic residues from substrates. The mixing ratio may vary depending on the application.

Piranha solution is dangerous and unstable, and the reaction can accelerate out of control causing explosion or skin burn. Piranha solution burns organic compounds, which is the property exploited for removing resist residues. If sufficient fuel (photoresist, IPA, and any hydrocarbon solvent) is provided for the Piranha solution, the reaction will generate enormous quantities of heat and gas.

There are other types of similar solutions, such as the mixture of H₃PO₄ hydrogen peroxide (H₂O₂), and ammonium hydroxide (NH₄OH) and hydrogen peroxide (H₂O₂). All are equally dangerous, and should be treated with great care.

2. Piranha users must get permission from the facility manager.

3. Any accident regarding the use of Piranha solutions must be reported without delay to the facility manager.

2 - Protection equipment

Protective equipment must be used when handling Piranha solutions. The protective equipment include: splash barrier, splash goggle, heavy duty rubber gloves, and an acid apron to wear on top of the cleanroom coverall.

A splash barrier is for face protection. Use the sash on fume hoods as a splash barrier. Keep the sash at or below the marked position. Do not raise the sash to a higher lever. If for any reason, the sash has be to raised to a higher lever, a full face shield must be worn as the splash barrier.

3 - Piranha solution handling

1. Piranha solutions, as well as any corrosive or hazardous substances, can only be used in the facility during normal operational hours and requires at all time the presence of a second knowledgeable user (buddy system).

2. Piranha solution can be used in the fume hood #2 & #3. Do not occupy the Fume Hood #1 which is always reserved for resist spinner.
3. The user must display the warning sign on the fume hood, and verbally inform other users present in the room that the Piranha solution is in use.

4. Remove wash bottles containing solvents (such as the spray bottles of acetone, isopropyl alcohol) from the Piranha deck. They can not share the same fume hood.

5. Piranha solutions should be under supervision at all time and can not be left unattended in order to prevent others from accidentally accessing the container. When taking short breaks, the bench/fume hood should be clearly marked and cordoned off by visible means.

6. Whenever handling Piranha, only use **glass containers** clearly labeled for its use.

7. Piranha solution is very energetic and potentially explosive. It is very likely to become hot, more than 100°C. Handle with care.

8. Before samples are placed in the Piranha solution, the bulk volume of the photoresist on the samples must be removed, and the samples must be dried. Piranhas are used to remove **residues** of photoresist, not the compounds themselves.

9. Leave the hot piranha solution in an open container until cool.

10. Never store **hot** piranha solutions in a closed container. Piranha stored in a closed container will likely explode.

11. Adding any acids or bases (Photoresist is a strong base) to Piranha solution or spraying it with water will accelerate the reaction. This practice must be avoided.

12. Mixing hot piranha with organic compounds may cause explosions. This includes acetone, photoresist, isopropyl alcohol, and nylon. This practice must be avoided.

4 - Piranha waste disposal

1. The waste of Piranha solution can not be discharged into sewage system, and must be disposed off through ORCBS.

2. The primary hazard from storage of piranha etch waste is the potential for gas generation and over pressurization of the container when the solution is still hot. If you store a hot solution in an airtight container, it will **explode**!

3. Prior to store the piranha waste solution, it must be left in an open container in order to cool down for several hours (overnight). It is your responsibility to make sure that the open container is very **clearly labeled** and left in the acid fume hood for cooling down.

4. Once cooled down, the solution must be transferred into a closed glass container for waste storage. The container must be very clearly labeled with the solution name and composition, as required by ORCBS, and must include **VERY VISIBLE** warning signs not to add any other types of chemicals.

5. For added safety, a poly-lined or plastic coated glass bottle fitted with a vented cap is recommended as a waste container for Piranha solution.

6. Waste containers for Piranha solution can not be kept in the facility. At the end of each work cycle (no longer than a day), the waste container must be transferred to Room B238 for disposal according ORCSB procedure for waste disposal.

5 - Emergency procedure
1. In case of large exposure, the victim should be removed from the contaminated area, placed under a safety shower while emergency personal is contacted (911).

2. All contaminated clothing should be removed immediately with appropriate gloves and safely discarded.

3. In case of contact with the skin, the affected area must be immediately rinsed with large amounts of water for at least 15 min.

4. In case of contact with the eye, irrigate the eye for at least 30 minutes, keeping the eyelids apart and away from eyeballs during irrigation. Place ice pack on eyes until reaching emergency room.

5. In case of inhalation, it may irritate the respiratory tract. Conscious persons should be assisted to an area with fresh, uncontaminated air. Seek medical attention in the event of respiratory irritation, cough, or tightness in the chest. Symptoms may be delayed.

6 - Supply and storage

1. Only the commercial version of the Piranha solution, Nanostrip, can be used and stored in KMF.

2. The expired Nanostrip must be removed from the facility and disposed off according ORCSB procedure for waste disposal.

3. Preparing Piranha solution by mixing sulfuric acid and hydrogen peroxide is not permitted in the facility.