

Piranha Etch:

Latest update 18.05.2026 Sabrina Eder

Standard Operating Procedure (SOP) Piranha Etch:

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"Piranha" is used to remove organic residues from substrates. There are two different kinds of piranha solution. The most common is the acid piranha: a 3:1 mixture of concentrated sulfuric acid (H_2SO_4) with hydrogen peroxide (H_2O_2). Also used is the base piranha: a 3:1 mixture of ammonium hydroxide (NH_4OH) with hydrogen peroxide (H_2O_2). Both are equally dangerous when hot, although the reaction in the acid piranha is self-starting whereas the base piranha must be heated to 60°C before the reaction takes off.

General

- Extremely corrosive.
- Causes destruction of living tissue at site of contact. Corrosive effects can occur not only on the skin and eyes, but also in the respiratory tract, causing respiratory tract irritation. Toxic if inhaled, causes severe burns and eye damage.
- Very strong oxidiser. May ignite flammable/combustible materials. DO NOT mix with ORGANIC materials, especially solvents (e.g. IPA, ethanol, acetone...). May result in explosion.

When working with a chemical for the first time, please consult a safety data sheet (SDS) to identify the material hazards and proper handling and storage procedures. If you have additional questions, please contact the Nanolab's Primary lab staff. **You may only use Piranha solution if you have received proper training and have been authorized by primary lab staff.**

There are many things that will cause the reaction to accelerate out of control. "Out of control" can mean anything from the piranha foaming and overflowing its container, to an explosion with a huge shock wave including glove and acid-gown shredding glass sharps. Piranhas burn organic compounds, **including human tissue!** If you provide sufficient fuel for them (i.e. photoresist, IPA), they will generate enormous quantities of heat and gas. **You should never start this process alone.** Also make sure the fumehood is not used by anybody else while the etching is going on. And, of course, wear the full suite of protective clothing (gloves, face shield, chemical apron is minimum!).

Personal Protective Equipment

The handling of Piranha solutions requires special protection equipment including: **a full face shield, heavy duty rubber gloves** (regular Nitrile gloves will not provide sufficient protection), as well as an **acid apron** to wear on top of the lab coat. Check for pinholes in gloves before putting them on. Remove any jewellery that you may be wearing on hands/wrist. **Only use in a fumehood!**

- Recommended Gloves: Ansell Microflex 93-260 (Nitrile & Neoprene composite), Honeywell™ POWERCOAT™ 950-30 Neofit Gloves (Heavy work, Neoprene)
- Identify the location of the nearest eyewash and shower and verify that they are accessible.
- Locate and verify that the appropriate spill kit is available.
- Plan your experiments and processes using only the smallest amount of solution necessary.

Piranha etch and Storage

- *Whenever handling Piranha, only use glass containers (**Pyrex**). Piranha can melt and even attack plastic containers. Containers used during the experiment must be very clearly labeled and a warning sign, visible by any user working under the fume hood, must be posted at all time to indicate that the solutions contains Piranha mixture.*
- *Mix the solution in the fume hood with the sash between you and the solution. Wear all protective equipment. When preparing the piranha solution, **always add the peroxide to the acid very slowly**. The H_2O_2 is added immediately before the etching process because it immediately produces an exothermic reaction and releases both O_2 and CO_2 . Initially when you add H_2O_2 to H_2SO_4 , the solution may smoke (water vapour) and will become very hot, and may bubble. Be very cautious. Ignition sources and H_2O_2 concentrations > 50% should be avoided. Typical H_2O_2 concentration used is 25 ~ 30 %.*
- *Piranha solution is very energetic and potentially explosive. It is very likely to become hot, more than **100°C**. Handle with care. **Picking up a beaker that is this hot will be very painful, might melt your gloves, and may cause you to spill it!***
- *Substrates should be rinsed and dried before placing them in a piranha bath. Piranhas are used to remove organic residue, not the compounds themselves.*
- *Leave the wafer(s)/ substrates submerged in the piranha solution for 30 minutes. After 30 mins, pour the piranha solution out of the vial into a large beaker/flask and rinse the samples thoroughly with water (fill and refill at least 10 times) (when pouring it out of the vial you can use a glass rod/pipette to make sure the wafer(s) don't fall out of the vial, don't use anything plastic/metallic).*
- *Leave the hot piranha solution in an open container until cool. (> 20 min).*
- *Never store hot piranha solutions. Piranha stored in a closed container will likely explode.*
- *Adding any acids or bases to piranha or spraying it with water will accelerate the reaction.*
- *Mixing hot piranha with organic (carbon-containing) compounds may cause an explosion. This includes acetone, photoresist, isopropyl alcohol, and nylon.*
- *Do not store wash bottles containing organic compounds on the piranha deck.*
- *Do not transport chemicals around the room in beakers. Never pour chemicals back into the original container.*
- *Do not store piranha. Mix fresh solution for each use. Excess solutions should be disposed properly.*
- *Keep the solution away from any metallic objects such as tweezers and spatulas.*

Piranha Waste Disposal

- *Dispose of the piranha solution by pouring it into a large beaker/flask and then diluting it with water (at least a 20:1 dilution).*
- *Leave standing for at least 1 hour to let the solution decompose.*
- *Then pour the fully decomposed and cooled solution slowly down the sink.*
- ***In case the neutraliser alarm goes off (loud signal and yellow button) stop pouring the solution down the sink. Wait until the drain alarm is off again before pouring the rest of the solution. The drain alarm means the neutralizer is full and needs to be emptied. This may take some time. NOTE: never continue to pour anything (even water) down the sink when the neutraliser alarm is on, you will overflow the neutraliser, potentially break the system and cause health and safety issues!***

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 air tight container, it will explode! Therefore, the lid of designated container for piranha waste must be left open for several hours (overnight) until to be cooled down enough. The container must be very clearly labeled with the solution name and composition and must include VERY VISIBLE warning signs not to add any other types of chemicals.

Emergency Procedures

In case of large exposure, the victim should be removed from the contaminated area, placed under a safety shower while emergency services / primary lab staff are contacted (Ambulance 113).

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

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

In case of contact with the eye, irrigate the eye for at least 15 minutes, keeping the eyelids apart and away from eyeballs during irrigation. Place ice pack on eyes until reaching emergency room.

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.

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...*Sabrina*