

Piranha Solution Process Specification

GENERAL PROCESS AND OPERATION SPECIFICATION
Piranha Solution

I. SCOPE AND AUDIENCE

- a. The purpose of this document is to describe the safety concerns associated with piranha solution, the process of mixing applicable chemicals, and usage for researchers utilizing AggieFab Nanofabrication Facility.

II. SAFETY

- a. **MAKE SURE THERE ARE NO TRACES OF ORGANIC COMPOUNDS - PHOTORESIST, SOLVENTS, ANYTHING WITH C-H BOND - ON YOUR SAMPLES.**
- b. Be sure that you are trained and signed off to create piranha.
- c. There **must** be another individual in cleanrooms who is aware that you are using acid and is familiar with the location of the acid spill clean-up kits.
- d. Acid gloves, acid apron, and face shield must be worn while making piranha – **no exceptions**. The use of safety glasses (double eye protection) is strongly recommended, but not required.
- e. The wet bench's clear cover/sash **must** be in the “down” position while making piranha solution – this prevents inhalation toxic fumes.
- f. The only chemicals allowed in the wet bench are sulfuric acid, hydrogen peroxide, and DI water. Remove **EVERYTHING ELSE** from the bench.
- g. **Only glassware can be used** (no plastic) to contain piranha solution and PTFE/Teflon to transport samples.
- h. **Do not use metal tweezers**. Piranha can etch certain metals and produce hydrogen gas, which can create the conditions for an explosion.
- i. **Piranha CANNOT be stored in waste bottles**. After one hour, it can be disposed of using the aspirator or by pouring down the drain with flowing water.
- j. If you are unsure about any procedure or indication while mixing or using chemicals, be sure to contact a staff member or trainer for assistance.

III. APPLICABLE DOCUMENTS, MATERIALS AND REQUIREMENTS

- a. Chemicals: Piranha uses sulfuric acid (H_2SO_4) and 30% hydrogen peroxide (H_2O_2).
- b. Appendix A: Accident Procedures

IV. OPERATION

- a. Turn on the sink DI water. This will be left on for the duration of usage.
- b. Properly annotate (5) secondary chemical labels for sulfuric acid (H_2SO_4), hydrogen peroxide (H_2O_2), piranha solution, 150 ° water, and room temperature water.
- c. Place the H_2SO_4 and H_2O_2 bottles inside the wet bench.
- d. Fill a glass beaker with DI water and place it on a hot plate set for 150 °C.
 - i. This will be used for the first DI water rinse. Heating it minimizes thermal shock to the samples.
- e. Fill another glass beaker with room temperature DI water for the second DI water rinse.

Piranha Solution

- f. Place samples onto a PTFE/Teflon holder (see Figure 2).
- g. Personal Protective Equipment:
 - i. Put on the face shield. Make sure it is tight around your head.
 - ii. Put on the acid apron and tie the string behind you.
 - iii. Put on acid gloves on over the apron's sleeves.
 1. If the gloves are old, hold them by the sleeves and rinse them off using sink DI water. Inspect the gloves for rips and deterioration.
 2. If the gloves are new, your nitrile glove fingertips can touch the acid glove fingertips. However, once you take the acid gloves off, you will need another person's help in putting them back on.



Figure 1. Proper PPE.

- h. Ensure the beakers have enough volume to safely contain the solution **after mixing** and the PTFE/Teflon holder.
 - i. Pour three (3) parts H_2SO_4 into a glass beaker.
 - ii. Pour one (1) part 30% H_2O_2 into a separate glass beaker.
- i. **Slowly pour the H_2O_2 into the H_2SO_4 beaker. ALWAYS ADD THE PEROXIDE TO THE ACID.**
- j. Submerge samples into the piranha.

Piranha Solution

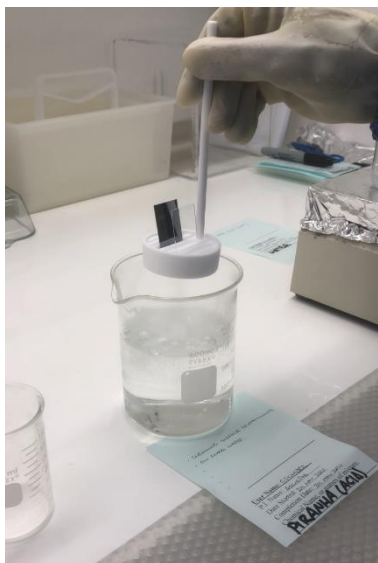


Figure 2. Submerging the samples with PTFE / Teflon holder.

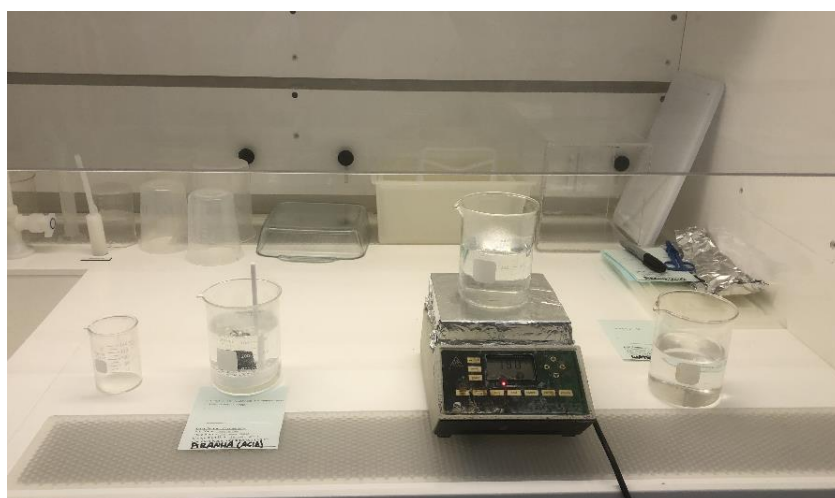


Figure 3. Complete / proper set up.

- k. After 10:00 minutes, place the warm DI water bath directly next to the piranha beaker.
- l. Remove the sample from the piranha and place it into the warm DI water bath.
- m. After 10:00 minutes, place the room temperature DI water bath directly next to the warm DI water bath.
- n. Remove the sample from the warm DI water bath and place it into the room temperature DI water bath.
- o. After 5:00-10:00 minutes, remove the sample from the room temperature DI water bath and dry using N_2 .
- p. Rinse the PTFE/Teflon holder with DI water.
- q. Rinse the acid gloves with DI water.
- r. Remove the gloves. **Do not allow the nitrile glove fingertips to touch the acid glove fingertips.**
- s. Drape the acid glove fingertips into the sink (without letting the gloves fall in).

- t. Disposal:
 - i. **The mixing of piranha solution creates an exothermic reaction. You must wait at least one hour to allow the piranha to cool before disposing of it.**
 - ii. Turn on the sink water and aspirator (if using aspiration to dispose of the piranha).
 - iii. Put on the face shield.
 - iv. Put on the acid apron.
 - v. Put on the acid gloves.
 - 1. **Nitrile glove fingertips cannot touch acid glove fingertips.**
 - 2. Find another user or staff member to help.
 - 3. Place one glove on by putting one hand inside of it and pulling the sleeve with the other hand.
 - 4. Have the other person hold the glove by the sleeve and allow the non-gloved hand to go in.
 - 5. Have the other person pull the sleeve to make it tight.
 - vi. Aspirator option (preferred):
 - 1. Aspirate the piranha.
 - 2. Rinse the beaker, aspirate the rinsing water, then rinse and aspirate again.
 - 3. Aspirate the remaining two beakers using the same procedure: aspirate, rinse, aspirate, rinse, aspirate.
 - 4. Wash off the mouth of the aspirator using the sink water.
 - vii. Drain option:
 - 1. Carefully and slowly pour the piranha down the drain. Take care to not let it splash.
 - 2. Rinse the beaker, pour the rinsing water down the drain, then rinse and pour again.
 - 3. Dispose of the remaining two beakers using the same procedure: pour, rinse, pour, rinse, pour.
 - viii. Place all beakers back in the drying oven or on the drying rack.
- u. Rinse the acid gloves using sink water.
- v. These steps must be accomplished with another user!
 - i. Remove the acid gloves.
 - ii. Remove the acid apron and face shield and place them back on the hooks.

V. SIGNATURES AND REVISION HISTORY

- a. Author of this document: Ethan Morse
- b. Author Title or Role: Student Technician
- c. Date: 16 October 2019
- d. Revision: Original

Approvals:

Technical Manager Signature: *Sandra G Malhotra*

Date: 7/10/21

Revision History:

Revision	Author	Date
Original Issue	Ethan Morse	16 October 2019
Rev A	C. J. Karber	9 July 2021
Rev B		
Rev C		
Rev D		
Rev E		