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| Standard Operating Procedure |
| Piranha Solution |

*This is an SOP template and is not complete until: 1) Lab Specific information is entered into the box below 2) Lab Specific information is added to the various sections, 3) completed SOP has been approved by the PI, and 4) completed SOP has been signed and dated by all relevant lab personnel.*

Keep a copy and in your lab safety shared folder or binder.

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| Department: | Click here to enter text. | | | |
| SOP Preparation Date: | Click here to enter a date. | SOP Approval Date: | | Click here to enter a date. |
| Principal Investigator: | Click here to enter text. | | | |
| Lab Manager Name: | Click here to enter text. | | | |
| Laboratory Phone: | Click here to enter text. | | Office Phone: | Click here to enter text. |
| Emergency Contact: | Click here to enter text. | | Contact Phone: | Click here to enter text. |
| Laboratory locations covered by this SOP (building / room number): | | | | |
| Click here to enter text. | | | | |

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| Type of SOP: |  | Process |  | Hazardous Chemical |  | Hazardous Class |

**Purpose**

Piranha solution is used to remove organic residues from substrates. Two different solutions are used. The most common is the acid piranha: a 3:1 mixture of concentrated sulfuric acid (H2SO4) with hydrogen peroxide (H2O2). Also used is the base piranha: a 3:1 mixture of ammonium hydroxide (NH4OH) with hydrogen peroxide (H2O2). 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 degrees before the reaction takes off.

There are many factors, which can cause the reaction to accelerate out of control. Examples of "Out of control" can mean anything from the piranha foaming out of its container and onto the hood bench, to an explosion with a huge shock wave including glove and acid-gown shredding glass sharps. Piranha solution burns organic compounds. If you provide sufficient fuel for them (i.e. photoresist, IPA), they will generate enormous quantities of heat and gas.

**Physical and Chemical Properties / Definition of Chemical Group**

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| CAS: | Sulfuric acid: 7664-93-9; Hydrogen peroxide: 7722-84-1 | GHS Oxidizer Hazard Pictogram**GHS Corrosive Hazard Pictogram** |
| Class: | Oxidizer, Corrosive |
| Molecular Formula: | H2SO4 and H2O2 or  NH4OH and |
| Form (physical state): | Liquid |
| Color: | Colorless |
| Boiling Point: | 120°C |

**Potential Hazards / Toxicity**

Piranha solution is very dangerous, being both strongly acidic and a strong oxidizer. Both liquid and vapor forms are extremely corrosive to skin and respiratory tract. Direct contact will create skin burns and will be extremely destructive to mucous membranes, upper respiratory tract and eyes. The Piranha solution is very energetic, exothermic, and potentially explosive. Mixing the solution is exothermic. The resultant heat can bring solution temperatures up to 120°C. Handle with care! When preparing the Piranha solution, always add the peroxide to the acid. One must allow the solution to cool reasonably before applying any heat. The sudden increase in temperature can also lead to violent boiling, or even splashing of the extremely acidic solution. Also, explosions may occur if the peroxide solution concentration is more than 50%. 30% peroxide in water solution is more reasonable. Piranha solution reacts violently with any organic materials. Avoid mixing with incompatible materials such as acids, bases, organic solvents (acetone, isopropyl alcohol) or nylon. Only use clean glass or Pyrex containers; Piranha solutions are not compatible with plastic.

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| **Potential Health Effects** | |
| **Inhalation:** | Harmful if inhaled. Material is extremely destructive to the tissue of the mucous membranes and upper respiratory tract. |
| **Skin:** | Harmful if absorbed through skin. Causes skin burns. |
| **Eyes:** | Causes severe eye burns. |
| **Ingestion:** | Harmful if swallowed. |

**HEIRARCHY OF CONTROLS:**

**Engineering Controls**

**Lab Specific Engineering Controls** (Add your lab’s specific engineering controls in this section).

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Use of piranha solution shall be conducted in a properly functioning chemical fume hood, which must be currently approved and certified by RMS. If the yellow certification sticker indicates certification is overdue (expiration date exceeds 1 year), contact RMS to request a fume hood re-certification.

**Administrative Controls**

**Lab Specific Administrative Controls** (Add your lab’s specific administrative controls in this section).

Click here to enter text.

Adhere to the processes outlined in this SOP.

**Personal Protective Equipment (PPE)**

**Lab Specific PPE requirements** (Add your lab specific PPE requirements in this section).

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**Hand Protection**

Handle with gloves. Neoprene or nitrile gloves are recommended.

**NOTE:** Consult with your preferred glove manufacturer to ensure that the gloves you plan on using are compatible with Piranha Solution.

Refer to glove selection chart from the links below:

<http://www.ansellpro.com/download/Ansell_8thEditionChemicalResistanceGuide.pdf>

OR

<http://www.allsafetyproducts.biz/page/74172>

OR

<http://www.showabestglove.com/site/default.aspx>

**Eye Protection**

* Wear chemical splash goggles or a face shield to protect from splash hazards and chemical vapors.

**Skin & Body Protection**

* Fire/flame resistant lab coat (100% cotton based)
* Full-length pants
* Closed-toe rubber or leather shoes
* Safety goggles (if splash hazard is present)

**Respiratory Protection**

Where risk assessment shows air-purifying respirators are appropriate use a full-face respirator with multi-purpose combination (US) or type ABEK (EN 14387) respirator cartridges as a backup to engineering controls. If the respirator is the sole means of protection, use a full-face supplied air respirator. Use respirators and components tested and approved under appropriate government standards such as NIOSH (US) or CEN (EU).

Respirators should be used only under any of the following circumstances:

* As a last line of defense (i.e., after engineering and administrative controls have been exhausted).
* When Permissible Exposure Limit (PEL) has exceeded or when there is a possibility that PEL will be exceeded. Contact RMS to schedule air monitoring.
* Regulations require the use of a respirator.
* An employer requires the use of a respirator.
* There is potential for harmful exposure due to an atmospheric contaminant (in the absence of PEL).
* As PPE in the event of a chemical spill clean-up process.

Lab personnel intending to use/wear a respirator mask must be trained and fit-tested. This is a regulatory requirement. Contact RMS and visit <https://riskmanagement.nd.edu/safety/occupational-health/respiratory-protection-plan/> for additional guidance.

**Hygiene Measures**

Avoid contact with skin, eyes, and clothing. Wash hands before breaks and immediately after handling the product.

**Special Storage & Handling Requirements**

**Handling**

* Before using Piranha solution, more stable methods of removing stains, tars, or clogs should be attempted. Often, glassware can be cleaned if left with a cleaning solution. An immediate example for a suitable substitute, prior to using Piranha, is 98% Sulfuric acid.
* Always use glass (preferably Pyrex) containers. Piranha will melt plastics.
* Piranha solution should be used freshly-prepared, due to the self-decomposition of hydrogen peroxide. Do not maintain a stock solution of the Piranha mixture.
* Prepare small amounts of solution to be used for each application. Mix the solution in a fume hood with the sash between you and the solution. The solution may be mixed before application or directly applied to the material, applying the Sulfuric acid first, followed by the peroxide.
* When preparing the piranha solution, always add the peroxide to the acid. Hydrogen peroxide concentrations should be kept below 30%, and should never exceed 50%.
* Piranha solution should never be left unattended if hot.
* Once finished, allow the hot piranha solution to cool in an open container. Once cooled down, put the waste solution in a container with a vented cap. Submit the waste solution as soon as possible to RMS on a [Chemical Discard Tag form](https://riskmanagement.nd.edu/safety/environmental/hazardous-waste/).
* Adding any acids or bases to piranha or spraying it with water will accelerate the reaction.
* Mixing hot piranha with organic compounds may cause an explosion. This includes acetone, photoresist, isopropyl alcohol (other organic solvents), and nylon.

**Storage**

* Use a vented cap (available upon request from RMS). Never seal containers containing Piranha solution. Avoid using airtight containers as pressure can build up inside of them. Never store piranha solutions. Oxygen given off during the self-decomposition, as well as the oxidation products of organic compounds can cause the container to rupture.
* Adding any acids or bases to piranha or spraying it with water will accelerate the reaction.
* Mixing hot piranha with organic compounds may cause an explosion. This includes acetone, photoresist, isopropyl alcohol (other organic solvents), and nylon.
* Do not stockpile or accumulate Piranha solution. Submit to EH&S for chemical waste pick-up as soon as possible.

**EMERGENCY ACTION PLAN (EAP):**

**Lab Specific EAP** (Add your lab’s specific emergency action plan variances in this section).

Click here to enter text.

**First Aid Procedures**

**If inhaled…** Move to fresh air. If the person is not breathing, give artificial respiration. DO NOT use mouth to mouth resuscitation. If breathing is difficult, give oxygen. Call 911 from a campus phone or (574) 631-5555 from a cell phone to report exposure to Notre Dame Police Dept. (NDPD) dispatch.

**In case of skin contact…** Remove all contaminated clothing. Immediately (within seconds) flush affected area for FIFTEEN (15) minutes. Call 911 from a campus phone or (574) 631-5555 from a cell phone to report exposure to Notre Dame Police Dept. (NDPD) dispatch.

**In case of eye contact…** Remove any contact lenses. Use nearest emergency eyewash immediately for at least 15 minutes. DO NOT allow victim to rub eyes or keep eyes closed. Call 911 from a campus phone or (574) 631-5555 from a cell phone to report exposure to Notre Dame Police Dept. (NDPD) dispatch.

**If swallowed…** DO NOT INDUCE VOMITING. Give large quantities of milk (preferable) or water. Never give anything by mouth to an unconscious person. Call 911 from a campus phone or (574) 631-5555 from a cell phone to report exposure to Notre Dame Police Dept. (NDPD) dispatch.

**Spill and Accident Procedure**

**Personal precautions**

Immediately evacuate area and ensure others are aware of the spill. If there is an imminent threat of a fire, pull the nearest fire alarm station to evacuate the building and dial 911 from a campus phone or 574-631-5555 from a cell phone. Follow Lab Specific Emergency Action Plan procedures.

**Environmental precautions**

Prevent further leakage or spillage – if safe to do so. Do not allow product to enter drains. Discharge into the environment must be avoided.

**Methods and materials for containment and clean-up**

Consider material compatibility prior to clean-up. Verify spill kit is available.

1. Immediately assess amount spilled, follow Lab Specific Emergency Action Plan procedures for hazardous materials incidents.
2. If a chemical exposure has occurred, a fellow lab worker shall call 911 from a campus line or 574-631-5555 from a cell phone to report exposure to Notre Dame Police Dept. (NDPD) dispatch.
3. Don compatible gloves and other protective PPE if not already being worn.
4. Secure / restrict access to the area of the spill to prevent spread of the chemical.
5. Use the available spill kit to stop and contain the spill. Bag the collected material.
6. Label and tag as hazardous waste and submit a pick-up request to RMS using the [online Chemical Discard Tag form](https://riskmanagement.nd.edu/safety/environmental/hazardous-waste/).

**Decontamination / Waste Disposal Procedure**

**Waste Labeling Requirements**

* Label waste container with the term “Hazardous Waste- Piranha Solution” and “Corrosive” (or corrosive GHS pictogram) to all piranha solution waste containers prior to the first drop of waste being added to the container.

**Store waste**

* Store hazardous waste in closed containers (use a vented cap to avoid overpressurization), in secondary containment and in a designated storage location.
* Double-bag dry waste using sealable transparent bags.
* Waste must be under the control of the person generating and disposing of it.

**Dispose of waste**

* Dispose of regularly generated chemical waste within 90 days.
* Use the [online Chemical Discard Tag form](https://riskmanagement.nd.edu/safety/environmental/hazardous-waste/) to request a pickup.
* Contact RMS at (574) 631-5037 for waste-related questions.

**Protocol / Procedure**

**Lab Specific Procedures** (Add your lab’s specific procedures in this section).

Click here to enter text.

**IMPORTANT NOTE: Any deviation from this SOP requires advance PI approval.**

**Documentation of Training**

* Prior to conducting any work with this material, Principal Investigator or designee must provide to his/her laboratory personnel specific to the hazards involved in working with this substance, work area decontamination, and emergency procedures.
* The Principal Investigator must provide his/her laboratory personnel access to this SOP and the Material Safety Data Sheet (SDS) provided by the manufacturer (available in [MSDSOnline](https://riskmanagement.nd.edu/safety/general-safety/hazard-communication-plan/)).
* The Principal Investigator must ensure that his/her laboratory personnel have attended appropriate/required laboratory safety training or refresher training within the last one year.

**I have read and understand the content of this SOP.**

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| Employee Name | Signature | Date |
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