Standard Operating Procedure

AQUA REGIA

Aqua regia is a corrosive, fuming yellow solution that is a 1:3 mixture of concentrated nitric and hydrochloric acids. It is commonly used to remove noble metals such as gold, platinum and palladium from substrates, particularly in microfabrications and microelectronics labs. It may also be used to wash glassware in order to remove trace amounts of organic compounds. Its fumes and yellow color are caused by reaction of nitric acid, HNO3, with hydrogen chloride, HCl, to form nitrosyl chloride (NOCl), chlorine (Cl2), and water; both chlorine and nitrosyl chloride are yellow-colored and volatile.

Potential Hazards

Aqua regia solutions are extremely corrosive and may result in explosion or skin burns if not handled with extreme caution. It 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. Aqua regia solutions are extremely corrosive and may result in an explosion, skin burns, or eye/respiratory tract irritation **Hydrofluoric Acid must not be handled while working alone.**

Personal Protective Equipment (PPE)

The University's Personal Protective Equipment Policy can be found here: http://ehs.yale.edu/PPEPolicy

Eye Protection

Safety goggles and a face shield must be worn.

Hand Protection

A utility style nitrile or neoprene glove, worn over an exam-style nitrile glove, must be worn when handling this solution.

Skin and Body Protection

A lab coat, along with long pants or clothing that covers the body to the ankles and closed-toe solid top shoes, must be worn.

Engineering Controls

Fume hoods, with the sash lowered to 12" to provide splash protection, must be used when handling aqua regia solution.

Handling/Storage

- Prepare the solution immediately prior to using. Never store aqua regia for long periods of time; it quickly loses its effectiveness due to oxidation of its reactive components.

- When preparing the aqua regia solution, always add the nitric acid to the hydrochloric acid slowly.
- Use glass, preferably Pyrex, containers. Aqua regia will melt some plastics and corrode most metals.
- Dissolving metals in aqua regia releases toxic gases, so always work with aqua regia in a fume hood.
- Aqua regia solution is very energetic and potentially explosive. It is very likely to become hot (up to 100°C). Handle with care.
- Adding any acids or bases to aqua regia or spraying it with water will accelerate the exothermic reaction.
- Leave the hot aqua regia solution in an open container until cool.
- Never store aqua regia in a closed container. It will oxidize over time to form toxic gases (i.e., nitrosyl chloride, nitrogen dioxide and chlorine), which will pressurize the container and possibly causing an explosion.
- Mixing aqua regia with organic compounds may cause an explosion.

Emergency Procedures

Eyewash/Safety Showers
An ANSI approved eyewash station that can provide quick drenching or flushing of the eyes must be immediately available in the laboratory where aqua regia is used. An ANSI approved safety drench shower must also be available within 10 seconds travel time as well. Ensure the locations of the eyewashes and safety showers, and how to activate them, are known prior to an emergency.

First Aid Procedures

If inhaled
Remove to fresh air. Call 911 for immediate medical attention.

In case of skin contact
Go to the nearest emergency shower if contaminated. Yell for assistance and rinse for 15 minutes, removing all articles of clothing to ensure contaminate is completely removed. Call 911 for immediate medical attention or follow up with Acute Care of Employee Health if skin contact was limited.

In case of eye contact
Go to the nearest emergency eyewash. Yell for assistance and rinse for 15 minutes. Call 911 for immediate medical attention.

Spills

Small Spill
If a small spill occurs inside a fume hood, lab personnel should be able to safely clean it up by following these spill clean up procedures:

- Alert people in immediate area of spill
- Wear personal protective equipment
- Use acid spill neutralizer to clean/neutralize spilled solution
- Collect residue, place in container, label and dispose of as hazardous waste

Larger Spill or Spill Outside a Fume Hood

- Call EHS for emergency assistance (203-785-3555)
- Evacuate the spill area
- Post someone or mark-off the hazardous area with tape and warning signs to keep other people from entering
- Stay nearby until emergency personnel arrive and provide them with information on the chemicals involved

Waste Disposal

Aqua regia can be drain disposed of after it is allowed to cool overnight and then neutralized with sodium bicarbonate. Once the pH is between 5.5 and 9.5, it can then be poured down the drain while flushing with copious amounts of water. **If the solution is contaminated with heavy metals (i.e. silver, chromium), the neutralized solution should be collected as hazardous waste.**

Lab Specific Protocol/Procedure:

Principal Investigator's Signature/Date