

GEORGIA INSTITUTE OF TECHNOLOGY

Cleanroom Processing Modules

Cleanroom processing information

Institute for Electronics and Nanotechnology

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Wafer Cleaning

Types of wafer cleaning: AMI Cleaning, Piranha Cleaning and RCA Cleaning

AMI Cleaning

- Acetone, methanol and isopropanol

Purpose: To remove photoresists, debris and residues from substrates

Location: general purpose fumehood

Chemicals: acetone, methanol, isopropanol and DI water (optional)

Supplies Needed: glass or Pyrex dish, tweezers, texwipes, nitrogen gun, chemical warning labels and PPE

Setup Procedures:

1. Find an available fumehood that is not currently being used for an acid or base process. Make sure the area is free of heat sources and incompatible chemicals. Please confirm the solvent waste container will not be filled to the top.
2. Fill out the chemical warning label (located at fumehood) with proper warning information (chemicals, contact information, process time and hazards).
3. Please notify research users in the area that you are going to be using solvents.
4. Setup the waste collection dish, texwipes and PPE gear.

Number of Substrates: 1

Process Procedures:

1. Securely hold the substrate with tweezers over the waste collection dish.
2. Squirt acetone evenly across the substrate for approximately 30 seconds (1 min).
3. Squirt methanol evenly across the substrate for approximately 30 seconds (1 min).
4. Squirt isopropanol evenly across the substrate for approximately 30 seconds (1 min).
5. (Optional) Rinse substrate with DI water for approximately 30 seconds (1 min).
6. Place your sample on a texwipe and blow dry with the nitrogen gun. Use a sweeping motion while working from one side of the sample to the opposite side (1 min).

Time: approximately 5 minutes

Comments:

- a. Do not spray your sample over the top of the solvent waste container. There are glass and Teflon dishes in the cleanroom for cleaning purposes.

- b. If you drop your sample in a dish, it is easily retrieved. However, if you drop it in the solvent waste container, there is no way to get it out.
- c. Spray methanol immediately after spraying acetone on your sample. If you let the acetone dry, it will leave a white residue.
- d. If you need to leave your sample soaking in acetone for an extended amount of time, be sure to add extra acetone to the container and cover the container with aluminum foil so that all the acetone does not evaporate.

Piranha Cleaning

Purpose: to remove organic material from sample (acidic solution)

Location: general purpose fumehood or CMOS cleaning station

Chemicals: sulfuric acid, hydrogen peroxide and DI water

Supplies Needed: 2 glass or Pyrex dishes, beakers or graduated cylinders, hotplate, tweezers, texwipes, nitrogen gun, chemical warning labels and PPE

Setup Procedures:

1. Find an available fumehood that is not currently being used for a solvent process. Make sure that the area is free of incompatible chemicals.
2. Fill out the chemical warning label (located at the fumehood) with proper warning information (chemicals, contact information, process time and hazards).
3. Please notify research users that you are going to be using heated acid.
4. Using bottle carries, bring a bottle of sulfuric acid and a bottle of hydrogen peroxide to the fumehood.
5. Setup the hotplate and set the temperature to 120°C, piranha solution dish, and put on your PPE gear.
6. Measure a precise amount of sulfuric acid into the piranha solution dish that is just enough to cover your sample.
7. Use the 4:1 (H_2SO_4 : H_2O_2) ratio to determine the amount of H_2O_2 to measure in a beaker or graduated cylinder.
8. Slowly pour the hydrogen peroxide into the piranha solution dish. The reaction begins immediately and produces large amounts of heat.
9. Place the piranha solution dish on the hotplate.
10. Let the solution come to temperature (10-15 min).
11. Prepare a DI rinse container while you wait. Fill out another chemical warning label. Triple rinse a glass or Pyrex dish with DI water, then fill the dish with DI water. Set the dish off to the side.

Number of substrates: 1

Process Procedures:

1. Using metal or peek tweezers, carefully place your sample into the piranha solution.
2. Return the chemical bottles to the chemical chase.
3. After 10-20 minutes, remove your sample from the piranha solution and place it into the container of DI water.
4. Take the piranha solution dish off the hotplate and allow it to cool. Turn off the hotplate.
5. Rinse your sample under running DI water (30 seconds).
6. Place your sample on a texwipe and blow dry with the nitrogen gun. Use a sweeping motion while working from one side of the sample to opposite side (1 min).
7. Once the piranha solution is cool (approximately 2-3 hours), while wearing PPE gear, carefully pour it down the sink with plenty of running city water.
8. Rinse the piranha solution container.

Time: approximately 45 minutes + cool down time

Comments:

- a. Do not use plastic tweezers or tweezers with a plastic or rubber coating as the piranha will dissolve it.
- b. Be sure to rinse your tweezers immediately after transferring your sample in and out of solution.

RCA Cleaning

- The RCA cleaning process consists of a SCI clean, an oxide etch, and a SCII clean.

SCI Cleaning

Purpose: to remove residual organic matter from samples (basic solution).

Location: general use fumehood or CMOS cleaning station

Chemicals: ammonium hydroxide, hydrogen peroxide, DI water

Supplies Needed: 2 glass or Pyrex dishes, hotplate, beakers or graduated cylinders, tweezers, texwipes, nitrogen gun, chemical warning labels and PPE

Setup Procedures:

1. Find an available fumehood that is not currently being used for solvent processing. Make sure the area is free of incompatible chemicals.
2. Fill out the chemical warning label (located at fumehood) with proper warning information (chemicals, contact information, process time and hazards).

3. Please notify the research users in the area that you are going to be using heated base.
4. Using bottle carriers, bring a bottle of ammonium hydroxide and a bottle of hydrogen peroxide to the fumehood.
5. Setup the hotplate, SCI solution dish, and put on your PPE gear.
6. Measure out amounts of NH_4OH , H_2O_2 , and water in beakers or graduated cylinders in a 1:1:5 ratio, enough to cover your sample.
7. Pour the water first, then ammonium hydroxide, then hydrogen peroxide into the SCI solution dish.
8. Turn the hotplate to 75-80°C and place the SCI solution dish on the hotplate and allow it to come up to temperature (10-15 min).
9. Prepare a DI water rinse container while you wait. Fill out another chemical warning label. Triple rinse a glass or Pyrex dish with DI water, then fill the dish with DI water. Set the dish off to the side.

Number of substrates: 1

Process Procedures:

1. Using metal or peek tweezers, carefully place your sample into the SCI solution.
2. Return the chemical bottles to the chemical chase.
3. After 10-20 minutes, remove your sample from the SCI solution and place into a container of DI water.
4. Take the SCI solution off the hotplate and turn the hotplate off.
5. Rinse your sample under running DI water (30 seconds).
6. Place your sample on a texwipe and blow dry with the nitrogen gun. Use a sweeping motion while working from one side of the sample to the opposite side (1 min).
7. Once the SCI solution is cool (after 1-2 hours), while wearing PPE gear, carefully pour it down the sink with plenty of running city water.
8. Rinse the SCI solution dish.

Time: approximately 45 minutes + cool down time

Comments:

- a. Do not use plastic tweezers or tweezers with a plastic or rubber coating as the SCI solution will dissolve it.
- b. Be sure to rinse your tweezers off immediately after transferring your sample in or out of the solution.

Oxide Etch

Purpose: to remove residual oxide

Location: general use fumehood or CMOS cleaning station

Chemicals: buffered oxide etch (BOE)

Supplies Needed: 2 plastic dishes, texwipes, tweezers, nitrogen gun, chemical warning labels, and PPE

Setup Procedures:

1. Find an available fumehood that is not currently being used for solvent processing. Make sure the area is free of incompatible chemicals.
2. Fill out the chemical warning label (located at fumehood) with proper warning information (chemicals, contact information, process time, and hazards).
3. Please notify the research users in the area that you are going to be using BOE.
4. Using a bottle carrier, bring a bottle of BOE to the fumehood.
5. Setup the BOE solution dish and put on your PPE gear.
6. Pour enough BOE into the plastic dish that will cover your sample.
7. Prepare a DI water rinse as well. Fill out another chemical warning label. Triple rinse a plastic dish with DI water, then fill the dish with DI water. Set the dish off to the side.

Number of substrates: 1

Process Procedures:

1. Place your sample into the BOE solution using plastic tweezers (30 seconds).
2. Remove your sample from the BOE solution and place into the DI water rinse container (30 seconds).
3. Rinse your sample under running DI water (30 seconds).
4. Place your sample on a texwipe and blow dry with the nitrogen gun. Use a sweeping motion while working from one side of the sample to the opposite side (1 min).
5. Carefully pour the BOE solution down the sink with plenty of running city water.
6. Rinse the plastic container.

Time: approximately 45 minutes + cool down time

Comments:

- a. BOE is hydrofluoric acid buffered in ammonium fluoride in a 1:6 ratio. The buffering agent allows for a more controlled etch of silicon dioxide.
- b. Approximate BOE etch rate: 20 Å/sec
- c. Do not use metal tweezers as BOE may react with them.

SCII Cleaning

Purpose: to remove residual metal from samples

Location: general use fumehood or CMOS cleaning station

Chemicals: hydrochloric acid, hydrogen peroxide, DI water

Supplies Needed: 2 non-metal containing dishes (Pyrex contains metal), non-metal containing beakers or graduated cylinders, hotplate, tweezers, texwipes, nitrogen gun, chemical warning labels, and PPE

Setup Procedures:

1. Find an available fumehood that is not currently being used for solvent processing. Make sure the area is free of incompatible chemicals.
2. Fill out the chemical warning label (located at fumehood) with proper warning information (chemicals, contact information, process time and hazards).
3. Please notify the research users in the area that you are going to be using heated acid.
4. Using bottle carriers, bring a bottle of hydrogen chloride and a bottle of hydrogen peroxide to the fumehood.
5. Setup the hotplate, SCII solution dish, and put on your PPE gear.
6. Measure out amounts of HCl, H₂O₂, and water in beakers or graduated cylinders in a 1:1:6 ratio, enough to cover your sample.
7. Pour the water first, then hydrochloric acid, then hydrogen peroxide into the SCII solution dish.
8. Turn the hotplate to 75-80°C and place the SCII solution dish on the hotplate and allow it to come up to temperature (10-15 min).
9. Prepare a DI water rinse container while you wait. Fill out another chemical warning label. Triple rinse a non-metal containing dish with DI water, then fill the dish with DI water. Set the dish off to the side.

Number of substrates: 1

Process Procedures:

1. Using plastic tweezers, carefully place your sample into the SCII solution.
2. Return the chemical bottles to the chemical chase.
3. After 10-20 minutes, remove your sample from the SCII solution and place into a container of DI water.
4. Take the SCII solution off the hotplate and turn the hotplate off.
5. Rinse your sample under running DI water (30 seconds).
6. Place your sample on a texwipe and blow dry with the nitrogen gun. Use a sweeping motion while working from one side of the sample to the opposite side (1 min).
7. Once the SCII solution is cool (after 1-2 hours), while wearing PPE gear, carefully pour it down the sink with plenty of running city water.
8. Rinse the SCII solution dish.

Time: approximately 45 minutes + cool down time

Comments:

- a. Do not use metal tweezers as the SCII solution will dissolve them.
- b. Be sure to rinse your tweezers off immediately after transferring your sample in or out of the solution.

CMOS Cleaning Station

Purpose: to remove residual organic, oxide and metal materials

Location: CMOS Station

Chemicals: please see sections for RCA Cleaning

Supplies Needed: Teflon boat, Teflon boat handle, beakers or graduated cylinders, and PPE

Setup Procedures:

1. Using bottles carriers, bring any chemical bottles that you may need to the cleaning station.
2. Put on your PPE gear.
3. To create solutions:
 - a. Please follow the previous instructions for creating ratios of SCI and SCII solutions.
 - b. For the pre-made piranha solution bath, you only need to add 50-100 mL of hydrogen peroxide.
 - c. For the pre-made BOE bath, you do not need to add anything.
4. If using a heated bath, turn on the appropriate heater.
5. Allow the bath to come to temperature (15-20 minutes).
6. Transfer your wafers to one of the Teflon boats at the station, and put a handle on the boat.

Number of Substrates: Multiple full wafers (up to a full cassette)

Process Procedures:

1. Once the bath is up to the proper temperature (see piranha cleaning and RCA cleaning sections), place the boat into the solution bath.
2. Turn on the timer.
3. Once the timer is done (10 minutes), hold the boat of wafers over the solution until it stops dripping.
4. Place the boat of wafers into one of the rinse baths.
5. Start the rinse bath.
6. Once the rinse bath is done (approximately 10 minutes), place a few texwipes on the fumehood counter and set your boat on them.

7. Remove the handle from the boat.
8. Place the boat in the spin-rinse dryer and press start.
9. Once the spin-rinse dryer is done (approximately 5 minutes), remove the blue boat and transfer your samples to your box.

Time: please see individual processes listed above

Comments:

- a. The CMOS Station has pre-made piranha and BOE baths
- b. There are also tanks for SCI and SCII solutions that must be mixed before use.
- c. The cleaning station should only be used for cleaning multiple wafers.
- d. There are no polymers allowed at the CMOS cleaning station.

Yes R-1 Plasma Cleaner

Purpose: to remove residual organics and thin oxides from the surface of a sample

Location: Pettit Cleanroom

Setup Procedures:

1. Make sure the electrode shelves are in place and secure.
2. Select the desired plasma recipe.

Number of substrates: 1 up to however many will fit on the substrate shelf

Process Procedures:

1. Place your sample in the process chamber.
2. Start the recipe.
3. Take note of the process parameters during the process step (6 min).
4. Select and run the vent process (1-2 min).
5. Remove your sample from the chamber.
6. Make sure the door is closed.

Time: approximately 15 minutes

Descum

Purpose: to remove residual resist and oxide from the surface of the sample.

Location: Pettit and Marcus Inorganic Cleanrooms

Tools required:

1. Pettit: Plasma Therm RIE

2. Marcus Inorganic: Vision RIE

Setup Procedures:

1. Make sure the backside of your sample is clean.
2. Program the standard descum recipe on the appropriate tool for 5 minutes or less. A typical descum is 30-60 seconds.

Number of substrates: up to four, 4" wafers

Process Procedures:

1. Place your sample in the process chamber.
2. Run the recipe.
3. Take note of the process parameters during the etch step (1 min or less).
4. Remove your sample from the chamber.
5. Run the standard cleaning recipe.

Time: approximately 15 minutes

Comments:

- a. Descum is only allowed to be run for up to one minute.

Gasonics Asher

Purpose: to strip photoresist from the front and back of sample

Location: Pettit and Marcus Inorganic Cleanrooms

Setup Procedures:

1. Lift both wafer boats to reset the sensors.
2. Put the boats back onto the sensors.
 - a. Make sure the h-bar of the boat is placed over the sensor lever.
 - b. The left boat should stay up.
3. Load the wafers to be processed into the left boat.
 - a. Make sure all the wafer flats are facing the machine.
 - b. Make sure the wafers are pushed all the way to the back of the boat.

Number of substrates: up to 10 full wafers

Process Procedures:

1. Choose and run the desired recipe (30, 60 or 90 seconds).
2. Allow the wafers to cool for 2-3 minutes after the process is done.

3. Remove the wafer boat.
4. Remove your samples from the wafer boat.
5. Replace the wafer boat back on the sensor.

Time: approximately 15 minutes

Comments:

- a. Only for use with full 4" wafers.
- b. Up to 1um of photoresist can be removed during an ashing cycle.
- c. Wafers will be heated (~250°C) during this process. Be careful when cleaning temperature sensitive samples.

Samco UV Ozone Dry Stripper

Purpose: to strip organic materials from samples using UV, ozone, and heat

Location: Marcus Cleanroom

Setup Procedures:

1. After turning on the machine, purge the chamber for 3 minutes.
2. Program your recipe.
 - a. Turn on the heater (if needed) and set the temperature to the desired level.
 - b. Input the process time.
3. Calibrate the oxygen flow.
 - a. Close and latch the chamber lid.
 - b. Start the recipe.
4. Once calibrated, stop the recipe and purge the chamber again for 3 minutes.
5. If using the UV lamp and ozone generator, turn them on.
 - a. If only using oxygen flow, do not turn on the ozone generator.

Number of substrates: 1

Process Procedures:

1. Open the lid and carefully place your sample inside using metal tweezers.
 - a. Your sample may slide around initially, but make sure it is back in the center of the chamber before the process.
2. Close the chamber lid, making sure that both latches are securely fastened.
3. Run the recipe (10 minutes or less).
4. Remove your sample from the chamber.
5. Close and latch the chamber lid before logging off the tool.

Time: approximately 20 minutes

Photolithography

Preparing Photoresist

Purpose: to prepare photoresist for spin coating

Location: Pettit or Marcus Cleanrooms

Chemicals: acetone, methanol, isopropanol, photoresist

Supplies Needed: glass or Pyrex container, texwipes, tweezers, nitrogen gun, fumehood, photoresist labels, chemical warning label, bottle carrier

Process Procedures:

1. Get an amber bottle from the staff office, if needed.
2. Take a stock bottle or your amber bottle out of the refrigerator, and allow it to warm up to room temperature (approximately 1 hour) by bringing it in a bottle carrier to a photoresist cabinet.
3. If you have a new amber bottle, clean it with an AMI rinse (see cleaning section) and print off chemical labels for it.
4. If you already have an amber bottle or your own stock bottle, they should be stored in one of the following locations:
 - a. Labeled photoresist cabinets.
 - b. Refrigerators in the chemical chase.

Time: approximately 5 minutes + time to warm up to room temperature

Comments:

- a. Photoresist must be at room temperature before use because it is very sensitive to temperature shock.

Spin Coating

Purpose: to uniformly spin resist or polymer onto a sample

Location: Pettit or Marcus cleanrooms

Chemicals: photoresist, acetone

Supplies Needed: spinner, spinner chuck, pipettes, aluminum foil, texwipes, bottle carriers, hot plate or oven, tweezers

Setup Procedures:

1. Set the hotplate or oven to the temperature needed for your pre-bake.
2. Make sure that your wafer is clean (see previous section).
3. Line the spinner bowl with aluminum foil, if necessary.
4. Choose the appropriate chuck so that your sample covers the entire chuck.
5. Properly line up the chuck with the shaft of the spinner. Do NOT force a chuck onto the shaft if it is not lined up.
6. Make sure that any screws are tight and not protruding above the chuck
7. Program your parameters according to the recipe on the photoresist data sheet.

Number of Substrates: 1

Process Parameters:

1. Place you sample on the spinner chuck
2. Run your recipe without photoresist to test the vacuum
3. Dispense your resist in two possible ways:
 - a. For a thinner resist, pipette from the amber bottle. Do NOT place a pipette in a stock bottle
 - b. For a thicker resist, pour from the amber bottle directly to your wafer. Do NOT pour directly from a provided stock bottle.
4. When dispensing your photoresist:
 - a. Make sure the resist is at room temperature
 - b. Remove any particles or bubbles in the resist
 - c. Dispense in a continuous stream, close to you wafer
 - d. Dispense only enough resist to coat your sample
5. Close the lid to the spinner (if it has one)
6. After starting the recipe, close the fumehood door.
7. Throw any pipettes used for dispensing resist in the labeled solvent trash cans.
8. Once the recipe is complete, remove your sample and place on the preset hotplate or oven rack.
9. Set a timer for your pre-exposure bake.
10. Clean the spinner and chuck with acetone and texwipes
 - a. Take the chuck off of the spinner to clean it
 - b. Throw all texwipes used into the solvent waste container
11. Close the fumehood door when you are done cleaning the spinner
12. Photoresist will be on your gloves, so they need to be changed immediately when you are done cleaning the spinner
13. When your hotplate/ oven timer goes off, set your samples on a texwipe on a counter to cool before returning them to the sample box.

Alignment/ Exposure

Purpose: to align the mask to the layers of processing under the photoresist or to simply expose resist through a mask

Location: Pettit and Marcus Cleanrooms

Supplies Needed: mask, mask holder, correct size wafer chuck, tweezers, blue tape (if necessary)

Setup Procedures:

1. Choose the proper exposure wavelength on the mask aligner tool and the intensity measurement tool.
2. Place the sensor of the intensity measurement tool in the center of the mask aligner chuck
 - a. If possible, measure the intensity through the mask.
 - i. Place the mask on top of the sensor so that dark space does not cover the sensor
 - b. If not enough clearfield space, measure with the sensor alone
 - i. Start a lamp test and not the intensity reading
 - ii. Calculate the exposure time by taking the dosage found on the photoresist data sheet and dividing by the measured intensity.
 - c. Be sure to subtract 1.0 mW/cm^2 from the measured intensity to account for loss from the mask if not able to measure through the mask
 - iii. Program the calculated time into the recipe on the mask aligner

Number of Substrates: 1

Process Procedures:

1. Load your mask onto the properly sized mask holder with the chrome side up, and then turn on the mask vacuum
2. Load the mask holder into the mask aligner. The chrome side should now be facing down.
3. Choose the mask aligner chuck so that you sample will not hang over the edges
4. Load the mask aligner chuck
5. Load your sample onto the chuck
 - a. If your sample does not cover the entire chuck, use blue tape to cover the rest
 - b. Cut a hole in the blue tape slightly smaller than your sample size
 - i. Cut the blue tape on a counter or table away from the mask aligner
 - ii. Do not cut on the chuck
 - iii. Do not cut the vacuum bladder for the vacuum chucks
6. Load your sample into the mask aligner
7. Align your sample as needed and expose

8. Unload your sample
9. Transfer you sample to the hotplate or oven for a post-exposure back, if needed.
10. Unload your mask

Development

Purpose: to remove exposed positive resist and unexposed negative resist

Location: general purpose fumehoods

Chemicals: developer

Supplies Needed: glass or Pyrex dish, PPE, timer, tweezers, bottle carrier, developer, texwipes, fumehood, chemical warning labels

Setup Procedures:

1. Look up the development time and developer type on the photoresist data sheet
2. Fill out a chemical warning label with the name of the developer being used
3. Find a plastic or glass container that will fit your sample
4. Using a bottle carrier, bring a bottle of developer to the fumehood you will be working at
5. Pour enough developer into the container to cover your sample

Number of Substrates: 1

Process Procedures:

1. Set a timer for development
2. Place your sample in the container and start the timer
3. Slightly agitate the container while developing
4. Stop developing once your timer has ended or when you no longer see photoresist coming off the sample
 - a. If you are unsure if your sample is finished developing, check it under a microscope with a UV filter
 - b. Under-developed features will have wide corners and thin spaces or a “rainbow” pattern where the resist is still in the feature
 - c. Over-developed features will have a rounded corners and thin lines
 - d. If you need to develop for more than the time on the data sheet states, add extra time in small increments, continuously checking under the microscope
5. Take your sample out of the developer and rinse under gently running DI water
6. Place your sample on a texwipe and blow dry with the nitrogen gun. Use a sweeping motion while working from one side of the sample to the opposite side.

7. Dispose of base developer in the sink with plenty of running city water. Solvent developers should be disposed of in the solvent waste jug.
8. Rinse the development container with DI water.

Comments:

- a. Under –exposed is better than over-exposed
- b. Be sure to note any differences in development times for later use

Deposition

Plasma Enhanced Chemical Vapor Deposition

Purpose: to deposit a layer of various materials onto the surface of the sample

Location: Marcus and Pettit Cleanrooms

Supplies Needed: test wafer/ wafer pieces, witness wafer/ wafer piece (if necessary), tweezers

Tools Available: Plasma Therm PECVD, Uxaxis PECVD, STS PECVD 1&2, Oxford ICP PECVD, Oxford PECVD 1&2

Setup Procedures:

1. Schedule time well in advance
2. Check that both the front and back sides of the wafer are clean and free of any debris. (see wafer cleaning section)
 - a. No photoresist allowed in PECVDs
3. Check that the clean recipe has been run on the tool
4. If the clean recipe was not run, start the clean process
 - a. Chamber cleanliness can be determined by monitoring the DC bias. Each machine has a DC bias that is typical of a clean chamber. This should be noted before tool use.
5. After the clean recipe is done, vacuum the chamber and wipe down the o-ring with a dry texwipe
6. Run a seasoning run on the tool
 - a. Run the recipe you intend to run without a sample, and deposit at least 2000 Angstroms to condition the chamber for the recipe
7. Run a deposition test on the tool
 - a. Using an extra clean wafer or wafer piece, run the tool for a few minutes (typically 2-3 minutes is fine).
 - b. Measure the deposition with an ellipsometer or reflectometer, and determine the deposition rate
 - c. Calculate how long the process step must be run for the deposition thickness desired

Number of Substrates: < 1 – 4 (4” samples)

Process Procedures:

1. Load the sample and a witness sample (if possible) into the tool and run the process
2. Watch the take notes on the parameters
 - a. Both set point and actual values
 - b. If the reflected power is high (2 watts+) stop the recipe and run the clean process again
3. Check and note the color of the plasma
 - a. Changes in color could be due to contamination
 - b. If contaminated, unload your sample and run the clean process
4. Measure the deposition to make sure it is what was expected
 - a. If the deposition is less than expected:
 - i. Calculate the deposition rate for the full run
 - ii. Place the wafer back into the tool and run using the new deposition rate to determine the time needed
5. Run the clean recipe on the tool after removing the sample
 - a. Stay by the tool until the plasma strikes
 - b. Run it for the full clean time
6. Log off the tool and cancel any scheduled time that was not used

Evaporation

Purpose: to deposit a directional layer of metal or dielectric to the surface of a sample

Tools: Denton Explorer, PVD 75 Filament Evaporator, CVC E-beam Evaporators, CHA Metal and Dielectric Evaporators

Supplies Needed: crucible, material to deposit, sample holder, kapton tape (if necessary), vacuum, isopropanol, texwipes, and tweezers

Setup Parameters

1. Schedule time well in advance
2. Check that the back side of the wafer is clean and the front side is free of any unwanted debris
 - a. If the evaporation is being used for liftoff, be sure to run your sample through a descum before. (see cleaning section)
3. After venting the chamber, clean the inside of the chamber
 - a. Vacuum the chamber carefully
 - i. Do not vacuum the crucible

- ii. Do not knock anything down into the vacuum lines or valves
 - b. Wipe down the chamber with isopropanol and a texwipe
 - i. Remove carbon deposits that may have formed
 - c. Make sure the o-ring is in place and clean it with isopropanol and a texwipe
- 4. Check the crystal of the deposition monitor
 - a. Change the crystal when the life is above 10
- 5. Check the crucibles being used in your process
 - a. Make sure that the crucibles have enough material inside of them for the intended deposition
 - b. Make sure that the crucibles have the material you intend to deposit and that it is melted
 - c. Make sure that the crucibles are not cracked or damaged
 - d. Check for contamination of the material
 - e. Wipe off the top of the crucible material with a texwipe and a very little amount of isopropanol
 - f. Finally make sure the crucible is sitting correctly in the holder
 - g. If required, make sure that the spacer is there as well

Number of Substrates: < 1 – 3 (4” wafer size)

Process Procedures

1. Mount your sample
 - a. Make sure that the sample is mounted securely to the chuck with kapton tape (if necessary)
2. Turn on the rotostrate, if applicable
3. Allow enough time for the tool to pump down to the necessary pressure
 - a. Typically the pressure is at LESS THAN 2×10^{-6} Torr
 - b. Lower pressures required for easily oxidizing materials (i.e. chrome should get to the 10^{-7} scale)
 - c. Most tools will take 30-90 minutes to reach this pressure
4. Check the recipe parameters
 - a. Parameters that can be changed: deposition rate, final thickness, crucible number, material deposited
 - b. Parameters that should not be changed: power, pressure, spin speed
5. Turn on the power supply
6. Start the recipe
7. Make sure the electron beam is hitting the middle of the crucible
 - a. If the beam is not in the middle of the crucible, adjust it
 - b. if you cannot adjust the beam to the middle of the crucible, stop the process and ask the staff for help
8. Watch to make sure that the material in the crucible does not run out during the process
 - a. Monitor the deposition rate during the run. If the rate begins to change noticeably, there could be an issue with the crystal monitor

9. Vent and clean the chamber if needed
 - a. Allow at least 10 minute to pass prior to venting. This allows the material to cool and prevents oxidation of the source material.
 - b. Clean if you see flaking on the walls or particles in the chamber
10. Un-mount the sample
11. Pump down the chamber and sign out of the tool
12. Cancel any unused time that was scheduled

Sputtering

Purpose: to deposit a conformal layer of metal or dielectric to the surface of a sample

Tools: Denton Discovery, CVC DC Sputterer, PVD RF Sputterer, Unifilm Sputterer

Supplies Needed: targets, kapton tape (if necessary), tweezers, vacuum, isopropanol, texwipes, multi-meter, test wafer/ wafer pieces, witness wafer/ wafer piece

Setup Parameters

1. Schedule time well in advance
2. Know the required powers for sputtering the material you want to deposit
3. Check that the back of the sample is clean and the front of the sample is free of any unwanted debris
4. Vent and clean the chamber
 - a. Vacuum inside the chamber
 - b. Wipe down the o-ring and the chamber with isopropanol and a texwipe
5. Clean off the target with isopropanol and a texwipe
 - a. Check the target thickness prior to insertion in the tool.
6. Insert the target into the tool
7. Test the target with a multi-meter
 - a. After putting the target in the tool, place one prong of the multi-meter on the target and one on the shutter or side of the chamber
 - b. Make sure the multi-meter is set to measure continuity
 - c. If the multi-meter measures a resistance (it should measure overload), the target is shorting and not inserted correctly
 - d. Reseat the target and try testing for a short again
 - e. If this becomes a problem and you can't get the target to stop shorting, please contact the staff
8. Make sure that the rotostrate is turning before closing and pumping down the tool
9. Run a deposition test on the tool
 - a. Using an extra clean wafer or wafer piece with a strip of tape across it, run the tool for a 5-10 minute deposition

- b. Measure the deposition with a profilometer and determine the deposition rate
- c. Calculate how long the process step must be run for the deposition thickness desired

Number of Substrates: < 1- 6 (4" wafer size)

Process Procedures

1. Allow enough time for the tool to pump down to process pressure
 - a. This will typically take 30-60 minutes
 - b. Make sure the tool gets down to at LEAST the 10^{-5} Torr scale
2. Make sure the plasma starts (if the tool has a view port)
3. Check the power, current, gas flows, and pressure
4. Watch the plasma to make sure it does not flicker or change color during the run (If the tool has a view port)
5. Take note of the parameters both set point and actual
6. Remove the sample and measure it to check the thickness of the deposition
7. If the deposition is not as thick as desired, calculate the deposition rate of the process.
Use this to figure out how much longer the sample needs to be run
8. After the process is finished, remove the target and put it in the appropriate storage location. (dry box or the table with a slot for each target)
9. Clean up the tool if necessary (Vacuum and wipe with texwipes and isopropanol)
10. Pump down the tool and cancel any unused time that was scheduled
11. If there is a log book for the tool, fill it with all of the required information from your process.

Thermal Deposition (Furnaces)

Purpose: to anneal or to deposit a layer of polysilicon, doped silicon, wet oxide, dry oxide, nitride, n-type and p-type doping, HTO

Location: Pettit and Marcus Inorganic Cleanrooms

Tools: Tystar Nitride Furnace Tubes 1-4 (Pettit), Tystar Poly Tubes 1-4 (Pettit), Lindberg Furnace Tubes 1-4 (Pettit), Tystar Mini Tubes 1-3 (Marcus)

Supplies Needed: appropriate size boat for sample, all supplies necessary for piranha clean, test wafer/wafer pieces, witness wafer/wafer piece (if necessary)

Setup Procedures:

1. Schedule enough time for the tool, well in advance of the process.
2. Run a test run to check the deposition rate.
 - a. For a test run, use a similar amount of wafers for a more accurate deposition rate.
3. Wafers must be piranha-cleaned immediately before they are put into the furnace (please see the cleaning section for more information).

4. Check the furnace tube and make sure it is not flaking.
5. Check to make sure the boat necessary for the size wafers you are processing is in the tube.
 - a. If you cannot find the boat you need, check the dry boxes across from the furnaces.

Number of substrates: pieces to 6" wafers, up to a full cassette of 4" wafers

Process Parameters:

1. Use the vacuum wand on the furnace to load your wafers onto the furnace boat.
 - a. If necessary, also load witness wafers.
2. Load the furnace boat onto the tube shelf.
3. Check the furnace periodically while the process is running.
 - a. Make sure the furnace does not go into a special hold (SHLD) step.
 - b. Check and note the parameters to make sure everything stays near the set point.
4. Allow the wafers to cool while the boat is out. (5 min)
 - a. If wafers cool too fast, they could shatter.
5. Remove the samples from the boat.
6. Measure the samples or witness wafers to check the deposition thickness.
7. Rerun the samples with the new deposition thickness, if necessary.
8. If the deposition is complete, log off the tool and cancel any unused time that was scheduled.

Etching

Plasma Reactive Ion Etching (RIE)

Purpose: plasma etching of dielectric films, silicon, metal and III-V layers

Location: Pettit & Marcus Inorganic Cleanrooms

Tools: Plasma Therm RIE (Pettit), Plasma Therm SLR RIE (Pettit), Vision RIE (Pettit & Marcus), Oxford Endpoint RIE (Marcus)

Supplies Needed: test wafer/wafer pieces, carrier wafer (if necessary), and tweezers

Setup Procedures:

1. Schedule time well in advance.
2. Make sure the back side of the wafer is clean and free of any debris or resist.
 - a. If etching with a mask, be sure to consider the selectivity of the mask material.
 - i. Do a test run if no data for selectivity for your mask material and the tool using to etch are available.
3. Make sure that the cleaning recipe has been run on the tool.

4. If the clean recipe was not run, start the clean process.
 - a. Chamber cleanliness can be determined by monitoring the DC bias. Each machine has a DC bias that is typical of a clean chamber. This should be noted before tool use.
5. After the clean recipe is done, wipe down the o-ring with a dry texwipe.
6. Run an etch test on the tool.
 - a. Run the tool with an extra patterned wafer or wafer pieces for a fraction of the normal etch time (depends on the thickness of what you are etching).
 - b. Measure the etch with a profilometer and determine the etch rate.
 - c. Calculate how long the process step must be run to etch the necessary amount of material.
7. Load the sample and a witness sample (if possible) into the tool and run the process.

Number of substrates: <1 – 4 (4” wafer size)

Process Procedures:

1. Watch the helium leak up rate, if applicable
 - a. If the helium leak up rate is too high (the tool alarms) clean the back of your sample and try again.
 - b. A low helium leak up rate means even backside cooling
2. Watch and take notes on the parameters
 - a. Both set point and actual values
 - b. If the reflected power is high (5-10% power set point) stop the recipe and run the clean process again
 - i. If this does not help lower the reflected power, stop the recipe and contact the staff
3. Check and note the color of the plasma
 - a. Changes in color could be due to contamination
 - b. If contamination is found, run the clean process
4. Measure the etch to make sure it is the depth that was expected
 - a. If the etch depth is less than expected:
 - i. Calculate the etch rate for the full run
 - ii. Place wafer back into the tool
 - iii. Use the new etch rate to determine the time needed for the etch
5. Run the clean recipe on the tool after removing the sample.
 - a. Stay by the tool until the plasma strikes
 - b. Run it for the full clean time
6. Log off of the tool and cancel any scheduled time that was not used

Inductively Coupled Plasma (ICP) Etch

Purpose: plasma etching of dielectric films, silicon, metal and III-V layers

Tools: Plasma Therm ICP, STS ICP, STS AOE, STS SOE, Oxford Cryogenic ICP, STS HRM

Supplies Needed: test wafer/ wafer pieces, carrier wafer (if necessary), tweezers

Setup Procedure:

1. Schedule time well in advance
2. Make sure the back side of the wafer is clean and free of any debris or resist
 - a. If etching with a mask, be sure to consider the selectivity of the mask material
 - i. Do a test run if no data for selectivity for your mask material and the tool being used to etch are available
 - b. If using an ICP that has a clamp, be sure that there is NO resist around the edges of the wafer. Resist anywhere near the edge will cause the wafer to stick to the clamp and get stuck in the chamber
3. Make sure that the cleaning recipe has been run on the tool
4. If the clean recipe was not run, start the clean process
 - a. Chamber cleanliness can be determined by monitoring the DC bias. Each machine has a DC bias that is typical of a clean chamber. This should be noted before tool use.
5. After the clean recipe, wipe the o-ring with a dry texwipe
6. Run an etch test on the tool
 - a. Run the tool with an extra patterned wafer or wafer piece for a fraction of the normal etch time (depends on the thickness of what you are etching)
 - b. Measure the etch with a profilometer and determine the etch rate
 - c. Calculate how long the process step must be run to etch the necessary amount of material
 - d. NOTE: it is better to under etch than over etch. The sample can always be etched again

Number of Substrates: 1

Process Procedures:

1. Load the sample and a witness sample (if possible) into the tool and run the process
2. Watch the helium leak up rate, if applicable
 - a. If the helium leak up rate is too high (the tool alarms) clean the back of your sample and try again
 - b. A low leak up rate means even backside cooling
3. Watch and take notes on the parameters
 - a. Both set point and actual values

- b. If the reflected power is high (5-10% Power set point) stop the recipe and run the clean process again
 - c. If this does not help lower the reflected power, stop the recipe and contact the staff
4. Check and note the color of the plasma
 - a. Changes in color could be due to contamination
 - b. If contamination is found, run the clean process
5. Measure the etch to make sure it is the depth that was expected
 - a. If the etch depth is less than expected
 - i. Calculate the etch rate for the full run
 - ii. Place wafer back into the tool
 - iii. Use the new etch rate to determine the time needed for the etch
6. Run the clean recipe on the tool after removing the sample
 - a. Stay by the tool until the plasma strikes
 - b. Run it for the full clean time
7. Log off of the tool and cancel any scheduled time that was not used.