Lab 1 sample process - Photolithography

Sample Preparation

Wafer scribing and cleaving

- Samples should be large enough to fit onto the spinner chuck with an overhang on all sides. Smaller samples will allow resist to enter and plug the spinner vacuum system, rendering it useless.
- Use vinyl gloves while handling the wafer.
- Avoid scratching the front surface of the wafer - always place the wafer on a fresh cleanwipe.
- For [100] silicon, all cleaves should be either parallel or perpendicular to the flat edge of the wafer so that the wafer cleaves along the natural cleavage planes.
- Tip for other material systems: Holding the scribe as vertical as possible can prolong tip life when cleaving tougher materials, and also generally results in superior cleaves, requiring less pressure.

☐ Place the silicon wafer face down on a clean wipe so that the dull side faces up.
☐ Using the diamond tipped scribe and a straight edge, make a small scratch in the direction of a cleave plane, running to the edge of the sample.
☐ Firmly press down on either side of the scratch to cleave the wafer into two pieces. Placing a glass slide under the cleanwipe such that the edge of the slide is aligned under the scored line on the wafer will permit greater stress concentration at the scratch.

Wafer cleaning

- **Work at the class 100 laminar flow bench.**
- **Use Latex or Nitrile gloves when handling solvents. Vinyl gloves offer no protection.**
- **Beakers must be labeled with contents, date and your name. If for some reason any solution is to be left unattended for a period of time, also leave a brief explanation, the time you will return, and a way to reach you.**
- **Beakers of cleaning solvents can be reused several times.**
- **All the groups will share the same set of cleaning solvents, so be careful not to contaminate the solutions. (ie. do not strip photoresist in the sample cleaning solutions)**
- **In case the existing cleaning solvents need to be replaced, dispose of them in the "Waste Solvent" bottle kept on the bench. Do not pour solvents down the drain.**
- **Bottles of cleaning solvents are kept in the cabinet under the cleaning bench.**
- **Empty bottles are placed in the bottle recycle can outside cleanroom (remove caps).**

- ☐ Blow off any residual silicon dust remaining from cleaving with nitrogen.
- ☐ Place the wafers to be cleaned in a wafer holder and then immerse in a beaker containing Acetone (ACE). Keep the beaker in the ultrasonic cleaner for 3 minutes.
- ☐ Repeat for 3 minutes in beaker of Isopropyl alcohol (ISO) in the ultrasonic cleaner.
- ☐ Rinse in running DI water .
- ☐ Gently but thoroughly blow each sample dry with Nitrogen.
- ☐ Place wafer on filter paper in oven for >3 minutes at 120°C to dehydrate the sample surface.

Photolithography

Resist application

- Remove samples from dehydration oven, and allow to cool.
- Set the rotation rate and time of the spinner using a scrap piece of silicon first to avoid a common error.
- When applying the resist to the sample, minimize contamination of the resist by letting drops of resist fall onto the sample. Avoid touching the photoresist on the sample with the dropper tube.
- A note about how much resist to use: The goal here is to get reasonable coverage, without being excessive. If there is insufficient resist to cover the bulk of the sample, the spinner may produce a graded thickness, making resist characterization very difficult. A few drops in the middle generally covers the center region of the sample. One or two more drops in each corner can encourage the resist to wet more of the sample, avoiding partial coverage.

- ☐ Remove samples from dehydration oven, and allow to cool.
- ☐ Arrange samples on filter paper under an inverted crystallizing dish
- ☐ Put a few drops of HMDS into a small Petri dish, and place this under the inverted dish with the samples.
- ☐ Allow to rest for 3 minutes
- ☐ Remove samples from HMDS ambient.

For each sample:

- ☐ Place sample on spinner chuck, verifying that there is overhang on all sides, and that the center of mass of the sample is near the center of the chuck.
- ☐ Turn on vacuum chuck, verifying that the sample is held firmly.
- ☐ Blow dry nitrogen onto sample to remove any dust that may have settled during prior steps.
- ☐ Let several drops of AZ-4210 photoresist fall onto the sample using the dropper bottle.
- ☐ Start the spinner.
- ☐ When finished, turn off vacuum chuck, and remove sample.
- ☐ Softbake on hotplate for 60 seconds at 95ºC

Expose and Develop

- ☐ Expose each sample for 17 seconds at 7.5 W/cm^2.
  - Clean your mask by soaking in either Acetone or Photoresist stripper for a few minutes, then rinsing in Isopropanol and deionized (DI) water
  - Remove mask plate from aligner
  - Turn off mask vacuum, and remove glass plate
  - Place mask against plate – verify Cr side is facing sample!
  - Turn on mask vacuum
  - Verify that sample chuck is not in raised position
  - Return mask plate to aligner
  - Lock down mask plate
  - Inspect chuck – is the hole pattern appropriate for the size of the sample? If not, use tape on the back side of the chuck to block extra holes.
  - Place sample on chuck, and slide into aligner.
  - Raise the chuck using the further of the two levers on the left side of the aligner. WATCH THE GAP BETWEEN THE SAMPLE AND THE MASK AS YOU DO THIS. (not paying attention to the sample as you raise it is a great way to destroy the mask). If the sample comes too close to the mask, lower the chuck using the potentiometer-style dial on the front of the machine before you proceed. When you are finished, the "contact" light on the aligner should come on.
  - Use the potentiometer-style dial on the front of the aligner to bring the sample into gentle contact with the mask. The resistance will increase on the dial as you do so. Continue watching the gap as you do this.
  - Looking through the microscope, you should see interference fringes as the resist makes contact to the mask. If these are too prominent – especially near the edge of the sample, sensitive resist processes may need to be modified to include edgebead removal.
  - If you are conducting an alignment, move the first lever on the left forward from the contact position to the separtation position. The corresponding indicator lights on the front panel should change.
  - Now you may move the sample with respect to the mask. There are three relevant micrometers. The one protruding directly out of the front is the y-control, the one on the right is for x-control, and the one which is oriented diagonally in the front is for rotation.
  - Once the sample is aligned to your satisfaction, put the sample back in contact mode.
  - Most exposures will only require soft contact. If this is desired, make sure the light is lit. Soft contact is only available in Standard Mode. If you wish to use a hard contact, be sure the gasket is in place around the chuck.
  - Raise the sample to the mask
  - Set the exposure time, on the outer dial, and units, on the inner dial.
  - Press the Exposure button.
  - Repeat above for all samples

- When removing a sample, please turn the pot. dial down one revolution before you move out of contact mode. This makes it harder for the next user to destroy their mask.
- If you used High Pressure Mode, be sure you are out of it before you leave the contact position.
- Replace your mask with the glass plate as you remove it.
- Clean the mask until any residual photoresist is removed.
- Be sure the area you were working in is free from clutter as you move on to the next step . . .

☐ Develop samples in a 1:4 solution of AZ-400K:DI for 40 seconds or until complete. Stir gently.
☐ Rinse in running water
☐ Blow dry with nitrogen
☐ Hardbake, if needed, on hotplate set to 110-115ºC