EXPERIMENT 4: Photolithography

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Purpose:

The purpose of this experiment is to provide an introduction to, and hands-on experience with, standard photolithographic techniques that are used to pattern a silicon wafer. Upon completion of this module, the researcher will be able to understand and perform all the steps in a conventional optical lithography process. This will be followed by an examination of the patterned wafer under a microscope.

Overview of Photolithography:

Photolithography is a common and basic step used in the creation of bioMEMS and biosensors. This fabrication technique has been used for many years in the fabrication of integrated circuits, transistors, and MEMS devices. The underlying principal of photolithography relies on the way certain polymeric compounds called photoresists (PR) respond to exposure by ultraviolet (UV) light. Areas that have been exposed to UV will exhibit selective solubility in a developing solution. There are two main types of photoresist – positive and negative. A positive resist will result in an exact copy of what is on the master pattern, while a negative resist will result in the inverse pattern. The lithography process presented in this lab module is capable of resolving features down to approximately 0.9 microns. The method of photolithography used in this module is called contact photolithography and a generalized process flow is presented in Figure 1.

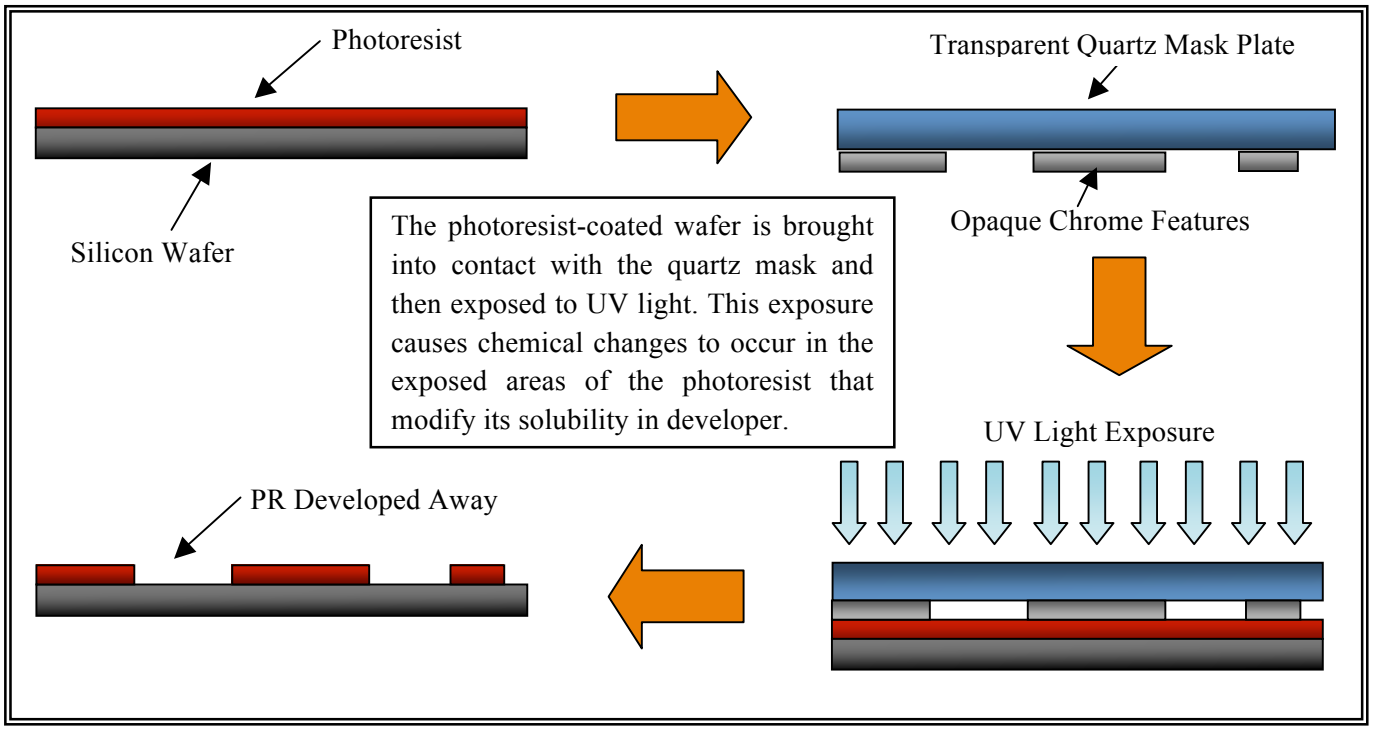

Figure 1: Generalized contact photolithography process. When the exposure is completed, the wafer is submerged in a developer to wash away the cross-linked sections of photoresist. The end result is an exact copy (or the inverse, if using a negative PR) of what is opaque on the mask plate.

Experiment Outline and Workflow:
In this lab module, researchers will carry out all steps of a contact photolithography process. This includes spin-coating, exposing, developing, inspection and hard-baking of a 2" Si wafer.

Procedures:

1. Spin-coating
    1.1. Prebake a silicon wafer at 125°C for 2 minutes.
    1.2. Pick the appropriate spinner chuck for a 2" wafer.
    1.3. Place the baked silicon wafer on the spinner chuck, being careful to center it properly.
    1.4. Turn on the spinner, and adjust the spin-speed to 4000 rpm. Set the timer for 30 sec.
    1.5. With the spinner still running, place 5-6 drops of HMDS on the wafer, wait a few seconds, then turn off the spinner.
    1.6. Pour enough AZ5214 onto the wafer to cover approximately 1/3 of the surface area.
    1.7. Activate the spinner and wait until it automatically stops.
    1.8. Soft bake the wafer at 125°C for 30 sec.

2. Exposure
    2.1. Turn the Quintel aligner ON and wait for the boot screen to finish its sequence. Fill out the log sheet at this time.
    2.2. On the right-side control panel, press the left-most LOAD button and rotate the lamp housing out of the way of the mask chuck. Press LOAD again to lock it in place.
    2.3. Load the mask and press VACUUM. Make sure the mask is held firmly.
    2.4. On the right-side control panel, press the left-most LOAD button and rotate the lamp housing back over the mask chuck. Press LOAD again to lock it in place.
    2.5. Slide out the wafer tray and place the wafer on the chuck (PR facing up).
    2.6. Press the right-most LOAD switch and slide the wafer tray in.
    2.7. Ensure that the wafer has risen to the mask and the aligner goes in to SEPARATION mode.
    2.8. Make any adjustments to the position of the wafer using the two joysticks for x, y, and theta.
    2.9. Set the exposure time to 15 sec.
    2.10. Press the EXPOSE button to start the exposure. DO NOT LOOK AT THE UV LIGHT!
    2.11. When the exposure is complete, slide the wafer tray out and remove the sample.
    2.12. On the right-side control panel, press the left-most LOAD button and rotate the lamp housing out of the way of the mask chuck. Press LOAD again to lock it in place.
    2.13. Turn off the mask VACUUM and remove the mask.
    2.14. On the right-side control panel, press the left-most LOAD button and rotate the lamp housing back over the mask chuck. Press LOAD again to lock it in place.
    2.15. Turn the Quintel Aligner OFF.

3. Develop/Inspect
    3.1. Transfer the exposed wafer to an acid hood.
    3.2. Fill a clean Pyrex dish about ½ full with MIF 319 Developer.
    3.3. Submerge the wafer in the developer and agitate for 1 min, 45 sec.
    3.4. Rinse the developed wafer with copious amounts of DI water.
    3.5. Dry the developed wafer using an N_2 gun.
    3.6. Inspect the developed wafer with optical microscope.
    3.7. Hard bake the developed wafer for 2 min at 125°C.