Ernst-Abbe-Hochschule Jena
University of Applied Sciences

Micro and Nano Technology

Laboratory Report

LITHOGRAPHY

Date of Experiment: 21.04.2024

Lab Instructor: Dr. Igor Konovalov

Submitted by:

1. Peer Mohamed Nabeel Shahul(651777)
2. Harsha Arravalli (651503)
3. Rajagopal Hariharan (651704)
4. Sabesh Charan Shyam Sundar (651776)

Abstract:

When creating a wide range of microfabricated devices, such as optoelectronics, microelectromechanical systems, and integrated circuits, photolithography is the main method of pattern transfer employed. In a general chemistry laboratory context, the underlying photochemical process of lithography makes for an appealing model system to teach photochemistry, polymer chemistry, reaction kinetics, and materials science to a wider audience. We describe an experiment in which we use optical lithography to print a silicon wafer by designing and fabricating a photomask.

Table of Contents

List of Figures

Procedure:

1.Surface pre-treatment:

For improved photoresist adherence, the hydrophobicity of the substrate's clean surface is required. Because the surface of oxidised silicon or glass is hydrophilic by nature, it needs particular treatment. For a few minutes, use the hot plate to heat the clean substrate to around 80 °C in order to allow physically adsorbed contaminants to desorb. The substrate and the open, harmful HMDS bottle should be placed on a holder, and both should be covered with an inverted beaker when the ventilation has been turned on. Give the substrate one to three minutes to come into touch with the HMDS vapour. The spin coating should be initiated in the wet air as soon as possible after exposure to HMDS (up to 1 minute is OK).

2.Spin Coating:

Figure 1:Spin coater

Place a glass substrate measuring 25 by 25 mm2 on the spin coater fixture, y. Spray the Positiv 20 solution sparingly (<0.1 ccm) perpendicularly in the centre of the rotating substrate to deposit photoresist only once per substrate. Using more solution than is necessary is pointless because it will be removed and end up at the spin coaters inner wall. After deposition, the solvent evaporates in about one minute. For the photoresist to dry, allow the substrate to rotate for 15 to 60 seconds. If both are placed on white paper, the coating on glass should be significantly darker than an uncoated substrate.

3.Baking:

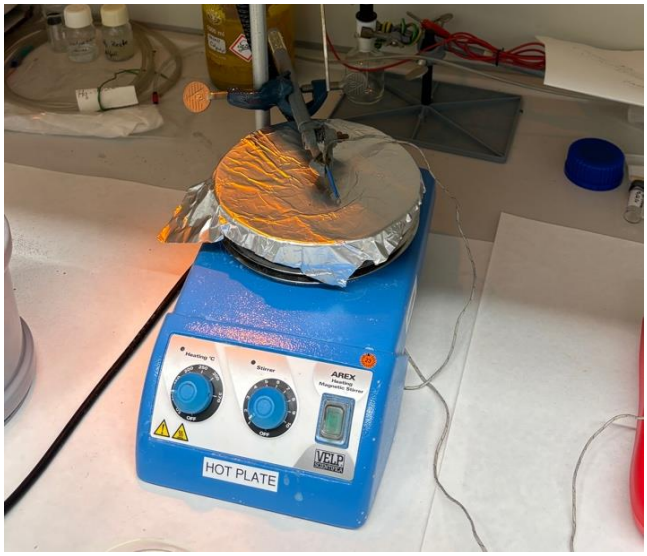

Figure 2:Baking equipment

Preheat the hot plate to 70-100 degrees Celsius. Place the coated substrate on the plate with the photoresist facing upwards and bake for 15. Use just yellow light and avoid directing it onto the substrate. Try to block as much white ambient light as possible. Thin layers of photoresist are extremely light sensitive, whereas a thicker coating can survive about a minute of diffused ambient light.

4.UV Exposure Sourcing:

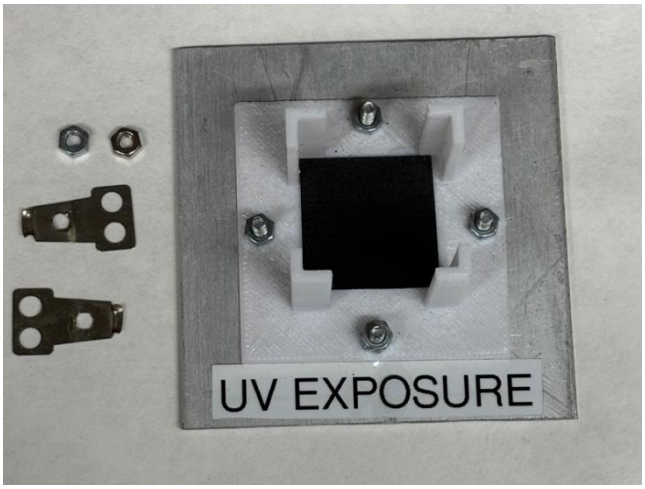

Figure 3:UV exposure

Place the substrate with photoresist facing upwards in the holder for exposure. If the substrate is transparent, the holder's background should be black so that light does not scatter back. Place the photomask on top of the photoresist, with the pattern facing downward and towards the photoresist.

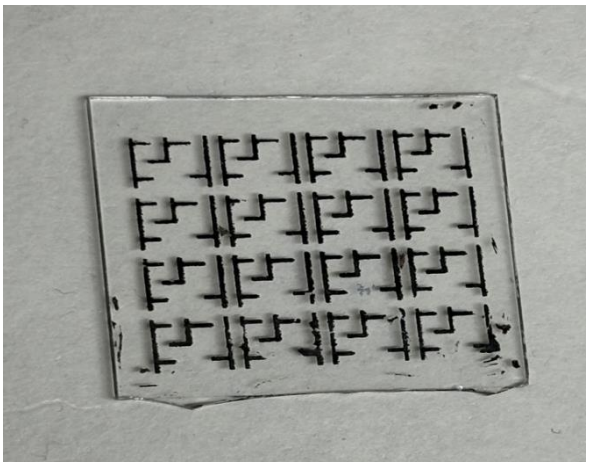

Figure 4:photomask

Clamp the stack to prevent any movement. Place the UV LED source on top and turn on the 12 V supply to it. Avoid moving anything in the exposure unit during the exposure. The initial exposure time is 15 seconds. Disassemble the equipment and place the photomask back into its box.

5.Development:

Prepare an aqueous solution of sodium metasilicate, 0.5 g per 10 ml water, meanwhile preserving the exposed substrate in the dark. Work further under yellow light. Put the substrate into the developer with the photoresist layer upwards and tilt the beaker gently from time to time. The development process takes from few seconds up to several minutes. Depending on the substrate, the contrast of the structure may be poor, so look attentively. After the structure appears, continue developing for about 10 % more time for thorough removal of the photoresist. If a subsequent etching is planned, you may try to wash the sample and to etch the structure to see whether the photoresist is sufficiently removed at the exposed locations. If not, wash the sample again and return to the development. It is almost impossible to overdevelop a properly exposed photoresist. Therefore, allow for additional development time when doing liftoff, since you cannot go back to development after deposition of a metallic film onto the photoresist.

Results:

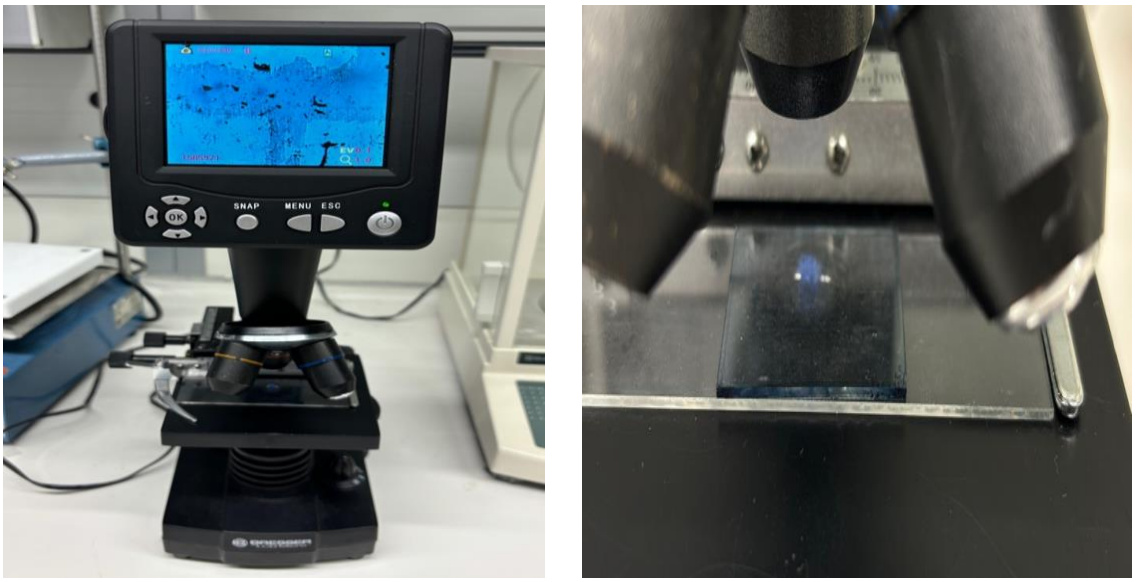

Figure 5:Microscopic view of etched substrate

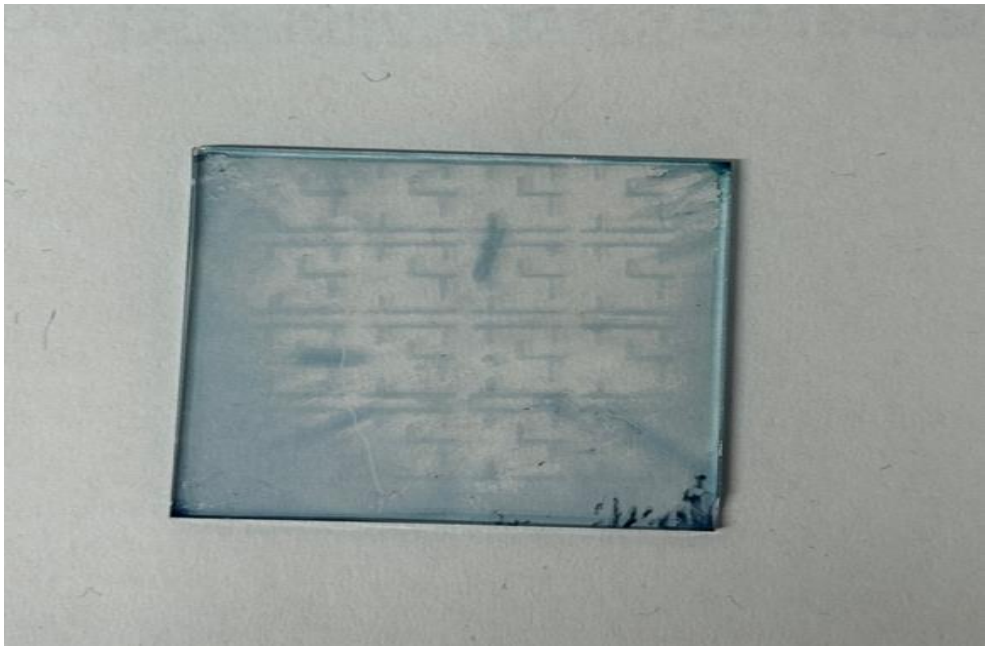

Figure 6:Etched Substrate

Issues faced:

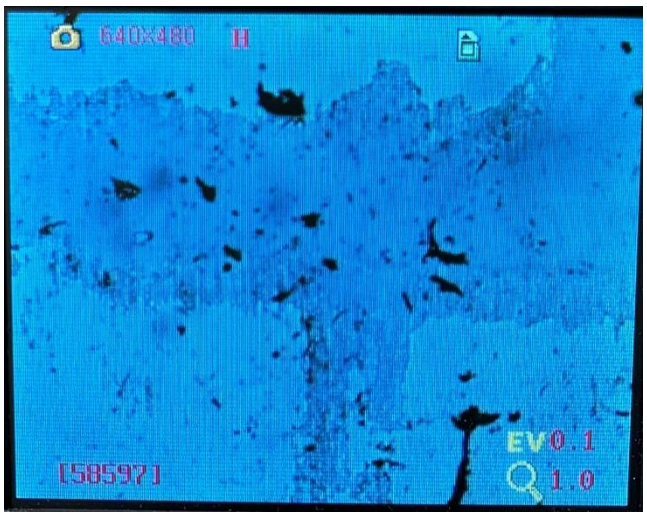

Figure 7:Uneven Development

After a thorough investigation of the sample, the group members noticed a small uneven print development on the glass surface. During the spin coating process, we accidentally dropped the glass sample in the bottom of the coating case. This can cause development due to partial removal of photoresist (Positive-20).

The next possibility of uneven development might be due to heating issues using thermocouple. This can also disturb the lithography process.When exposing it to the UV ray, the sample should have been exposed for another few minutes to enhance the development process .Additional circumstances such as room temperature, visible light expose and presence of moisture content in the air could have contributed to the uneven development.

Conclusion:

One of the most crucial and sophisticated steps in the I.C. fabrication process is photolithography. It's a very intricate process that is easily broken. In this particular process, new instruments and techniques were introduced. This included the priming and photoresist application spin coating machine. After that, the wafer was exposed to UV light and its surface was patterned. But this is only the initial photolithography stage required to etch the design into the wafer permanently. All that was left of the procedure was a pattern impression on the wafer. To properly construct several wells in the wafer, the etching procedure will be done multiple times during the I.C. fabrication process.