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# Photolithography Lab Worksheet

**Problem Statement:**
How can we create the sharpest, most accurate pattern on a glass disc using photolithography techniques adapted for a classroom?

**Objective**: Simulate the photolithography process used in semiconductor manufacturing by using gel nail polish as a photoresist and a UV lamp to develop a masked pattern on a glass disc. For each iteration of your work, you will follow the same basic procedures, outlined below.

**Success Criteria:**
- Pattern edges are sharp.
- Mask image matches final result.
- Unintended exposure is minimal.

| Materials Needed | |
|---|---|
| • 1 borosilicate glass disc<br>• acetone<br>• isopropyl alcohol (IPA)<br>• cotton swabs or lens wipes<br>• gel nail polish (clear, UV-curable)<br>• mask material (construction paper, foil, or printed transparency) | • UV light source (shared)<br>• water (for final rinse)<br>• tweezers or gloves<br>• timer or stopwatch<br>• small tray or petri dish for developing<br>• (optional) turntable<br>• (optional) microscope or magnifying lens |

| Step 1: Brainstorm, Plan, and Design |
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| 1. Sketch 2-3 possible mask designs.<br>2. Choose one based on:<br>   a. Level of detail (too fine may blur).<br>   b. Contrast between exposed/unexposed regions.<br>   c. Ease of cutting.<br>3. Predict how UV light might interact with the design.<br>4. Using construction paper or foil, cut a piece that is larger than the glass disc.<br>5. Create a pattern and cut it into the material. The pattern can be anything you like, and should fully encompass the area in which the nail polish was applied. |

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**Possible mask designs**

| Sketch #1 | Sketch #2 |
| --- | --- |
| Sketch #3 | **Chosen Design** |

How do you think UV light might interact with your chosen design?

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## Step 2: Apply "Photoresist"

1. Put on gloves.
2. Clean the glass disc in the following order:
    a. Wipe with acetone.
    b. Wipe with IPA.
3. Dry with a lint-free cloth or allow disc to air dry.
4. Using a sponge, foam brush, or soft applicator, apply a thin, even layer of clear gel nail polish (photoresist) across the glass disc.
5. Optional: After applying the clear gel nail polish to the glass disc, place the glass disc onto a turntable and lightly spin it to evenly spread the nail polish.
6. Let painted glass disc sit for 1–2 minutes to allow the nail polish to self-level.

## Step 3: Mask and UV Exposure

1. Place your opaque mask over the coated glass disc.
2. Ensure your mask lies flat and as close to the glass disc as possible. Note: You may need to be creative with spacers. The closer the mask is to the glass, the sharper your results will be.
3. **Engineering sub-problem:** How can you create a small, even gap between the mask and the glass disc to prevent smearing while keeping the mask close enough for a clear UV image?

4. Place under the UV light source (perpendicular, fixed height) and expose the sample for the time specified by your teacher.
5. **Predict**: How does distance affect the sharpness of the image?

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| Step 4: Develop the Pattern |
| --- |
| 1. Carefully remove the mask.<br>2. Gently swirl disc or dab the disc in a tray of acetone; avoid scrubbing to prevent damaging the cured pattern.<br>3. Rinse the disc with water to remove residue and dry gently.<br>4. Optional: Rest the glass disc on a hot plate heated to 50° C for 90 seconds. |
| **Step 5: Analyze** |
| 1. Observe the pattern that remains on the glass.<br>2. Compare this pattern with your original mask design and the success criteria. Record your answers below, addressing the following:<br>• How well did the image transfer?<br>• Are edges sharp or blurry?<br>• Are there overexposed or underexposed regions?<br>• Did mask alignment work as intended?<br>• What might have caused any flaws (e.g., thickness, mask gap, light angle, exposure time)?<br><br><br><br>3. List what you would do differently to improve your mask design. Hint: Think about what you can change (e.g., thickness of gel nail polish, mask gap, light angle, exposure time). |

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| Step 6: Iterate and Improve the Design |
|---|
| 1. Revise your mask (e.g., simplify shapes, improve opacity, reinforce edges).<br>2. Adjust photoresist application (e.g., thinner, smoother, more level).<br>3. Change exposure strategy (e.g., distance, time, alignment).<br>4. Perform Steps 2-5 in this worksheet.<br>5. Document what you changed and why. Note: This mirrors actual semiconductor process optimization. Also, note how your changes improved or didn't improve your design. |