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# Photolithography Overview for Microsystems Knowledge Probe Instructor Guide

## Notes to Instructor

This Knowledge Probe (KP) contains 16 questions to assess the participants' current knowledge of photolithography processes. This KP should be given as the start of the *Photolithography Overview Learning Module*.

The *Photolithography Overview for Microsystems Learning Module* consists of the following:

- **Knowledge Probe or Pre-assessment**
- Photolithography Overview for Microsystems
- Photolithography Terminology Activity
- Photoresist Thickness Activity
- Final Assessment Participant – multiple choice

This Instructor Guide (IG) contains both the questions and answers for the 18 questions.

For more learning modules related to microtechnology, visit the SCME website (<http://scme-nm.org>).

## Photolithography Overview Learning Module

This learning module provides an overview of the most common photolithography process used in the fabrication of microelectromechanical systems (MEMS), photolithography terminology and basic concepts. Students explore some of these concepts in the provided activities.

### Objective of this Knowledge Probe (KP)

The objective of this knowledge probe is to determine your current knowledge and understanding of the photolithography processes used to fabricate micro-sized devices or MEMS. This KP should help you identify areas in which you need a better understanding and also assist the instructor in knowing what needs to be emphasized.

Answer the following questions to the best of your knowledge. Do not worry if you don't know the answer. Select the answer that you "think" is correct.

## Photolithography Knowledge Probe

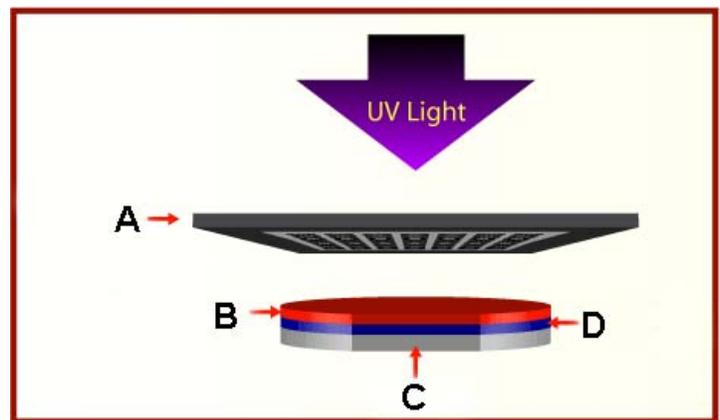
1. Which of the following **BEST** describes the photolithography process?
  - a. The process step that transfers a pattern into an underlying layer or the substrate's bulk.
  - b. The process step that defines and transfers a pattern into a resist layer on the wafer.
  - c. The process step that deposits a resist layer on the surface of the wafer.
  - d. The process step that aligns the various layers of a microsystem device to each other.

*Answer: b.*

2. What are the three (3) basic steps of the photolithography process?
  - a. Prime, expose, etch
  - b. Prime, coat, expose
  - c. Coat, mask, expose
  - d. Coat, expose, develop

*Answer: d. Coat, expose, develop*

3. What are the elements of the image labels (A, B, C, D), respectively?
  - a. Mask, photoresist, film to be etched, substrate
  - b. Mask, layer to be etched, photoresist, substrate
  - c. Mask, substrate, photoresist, metal layer
  - d. Mask, photoresist, primer, substrate



*Answer: a.*

4. The photoresist film is applied in which of the following photolithography steps.
  - a. Prime
  - b. Coat
  - c. Mask
  - d. Expose
  - e. Develop

*Answer: b.*

5. Prior to applying the photoresist layer, the surface of the wafer must be conditioned. Which of the following BEST describes the purpose of surface conditioning?
- Remove surface particles, dry the wafer's surface, create a hydrophilic surface
  - Dry the wafer, heat the wafer to better accept the resist, create a hydrophobic surface
  - Clean and dry the wafer, create a hydrophobic and more adhesive surface
  - Clean the surface, heat the wafer to better accept the resist and make it more adhesive

**Answer: c.**

6. What is the chemical used in surface conditioning?
- HMDS (Hexamethyldisilazane)
  - KOH (potassium hydroxide)
  - Piranha (sulfuric acid and hydrogen peroxide)
  - PMMA (polymethylmethacrylate)

**Answer: a. HMDS**

7. There are two basic types of photoresist – positive and negative. Which of the following statements is TRUE?
- With positive resist, the exposed regions are dissolved during develop.
  - With negative resist, the exposed regions are dissolved during develop.
  - With positive resist, the exposed regions are hardened during develop.
  - With negative resist, the exposed regions are hardened during develop.

**Answer: a.**

8. Which of the following determine the final thickness of photoresist after the coat process?
- The viscosity of the resist and the amount of time that the wafer spins
  - The spin speed after deposition of resist and the amount of time that the wafer spins
  - The amount of resist applied and the amount of time that the wafer spins
  - The spin speed of the wafer after deposition of resist and the viscosity of the resist

**Answer: d**

9. During the coating of photoresist, the thickness of the photoresist \_\_\_\_\_ with an increase in spin speed.
- Increases exponentially
  - Decrease exponentially
  - Increase linearly
  - Decreases linearly

**Answer: b.**

10. What is the purpose of the softbake after resist application?
- To remove residual solvent from the resist layer
  - To correct minor uniformity problems with the resist
  - To harden the resist for the expose process step
  - To harden the resist for the etch process step

**Answer: a**

11. The expose step follows the \_\_\_\_\_ process step.
- Surface conditioning
  - Coat
  - Soft bake
  - Hard bake

**Answer: c**

12. For the expose step, some photolithography equipment, such as steppers, use a small quartz plate that contains the pattern for just a few die or fields on a wafer. This plate is called a

- \_\_\_\_\_.
- Mask
  - Reticle
  - Partial mask
  - Die plate

**Answer: b**

13. Which of the following two UV light sources are commonly used to expose the photoresist?
- Mercury Vapor Lamps and excimer lasers
  - Mercury vapor lamps and compact fluorescent lamps
  - CO<sub>2</sub> Lasers and mercury vapor lamps
  - CO<sub>2</sub> Lasers and excimer lasers

**Answer: a**

14. After the coated wafer is placed into the photolithography expose equipment, it is \_\_\_\_\_ prior to being exposed.
- Baked
  - Cooled
  - Aligned
  - Coated

**Answer: c**

15. Which of the following could be the result of an underdeveloped resist layer?
- Misalignment of the resist pattern to the pattern in the underlying layer
  - Critical dimensions in the resist layer larger than specification
  - Overexposure of resist during the expose step
  - Too much resist left on the wafer preventing access to the underlying layer

**Answer: d. Too much resist left on the wafer preventing access to the underlying layer**

16. After the develop step, the wafers are inspected. Which of the following is NOT a critical parameters for this inspection?
- Resist thickness
  - Alignment
  - Line width or critical dimension
  - Defects (particles, scratches, etc.)

**Answer: a.**

17. The final test on a micro-sized accelerometer showed that the proof mass was offset from center causing the whole wafer to be rejected. Which of the following process steps is MOST likely this cause of this defect?
- Conditioning
  - Cost
  - Align
  - Expose
  - Etch

**Answer: c**

18. Arrange the following photolithography steps in the proper order from first (1) to last (12).

Order	Process Step
	Hard bake
	DI Rinse
	Apply HMDS
	Align
	Inspect for defects
	Initial Bake
	Coat with photoresist
	Expose
	Cool
	Develop
	Soft bake
	Nitrogen Dry

**Answer:**

<b>Order</b>	<b>Process Step</b>
11	Hard bake
9	DI Rinse
2	Apply HMDS
6	Align
12	Inspect for defects
1	Initial Bake
4	Coat with photoresist
7	Expose
3	Cool
8	Develop
5	Soft bake
10	Nitrogen Dry

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