

Etch Overview for Microsystems Knowledge Probe (Pre-test) Instructor Guide

Notes to Instructor

This Learning Module introduces the most common etch processes used in the fabrication of microsystems. Activities allow participants to demonstrate their understanding of the terminology and basic concepts of these processes. This knowledge probe helps to determine the participant's current understanding of the terminology and processes.

This Knowledge Probe (KP) contains 20 questions that can be used to assess the participants' current knowledge of the etch processes used for microsystems fabrication. This KP should be given prior to starting the Etch Overview Learning Module. By comparing the results of this KP with the results of the final assessment, you can determine the learning that took place due to the completion of this learning module.

The Etch Overview for Microsystems Learning Module consists of the following:

- Knowledge Probe (pre-test)
- Etch Overview for Microsystems PK
- Etch Terminology Activity
- Science of Thin Films Activity (SCME Kit available @ <http://scme-nm.org>)
- Bulk Micromachining: An Etch Process Activity (SCME Kit available @ <http://scme-nm.org>)
- Final Assessment

Introduction

The purpose of this assessment is to determine your current understanding of the etch processes used in the fabrication of microsystems.

1. For microsystems fabrication, the etch process normally follows which of the following process steps?
 - a. Deposition
 - b. **Photolithography**
 - c. Oxidation
 - d. DRIE

2. There are several types of layers used in the construction of microsystems. Each layer serves a purpose in the device's fabrication. Most of these layers are etched at some point during the process. What type of layer is used to define the pattern to be etched by exposing the areas in the underlying layer that are to be etched and protecting the areas that are not to be etched.
 - a. Conductive
 - b. Sacrificial
 - c. Structural
 - d. Etch stop
 - e. **Etch mask**

3. Bulk etch processes are normally used to etch which of the following?
 - a. Silicon nitride layers
 - b. **Silicon substrates**
 - c. Masking layers
 - d. Metal layers

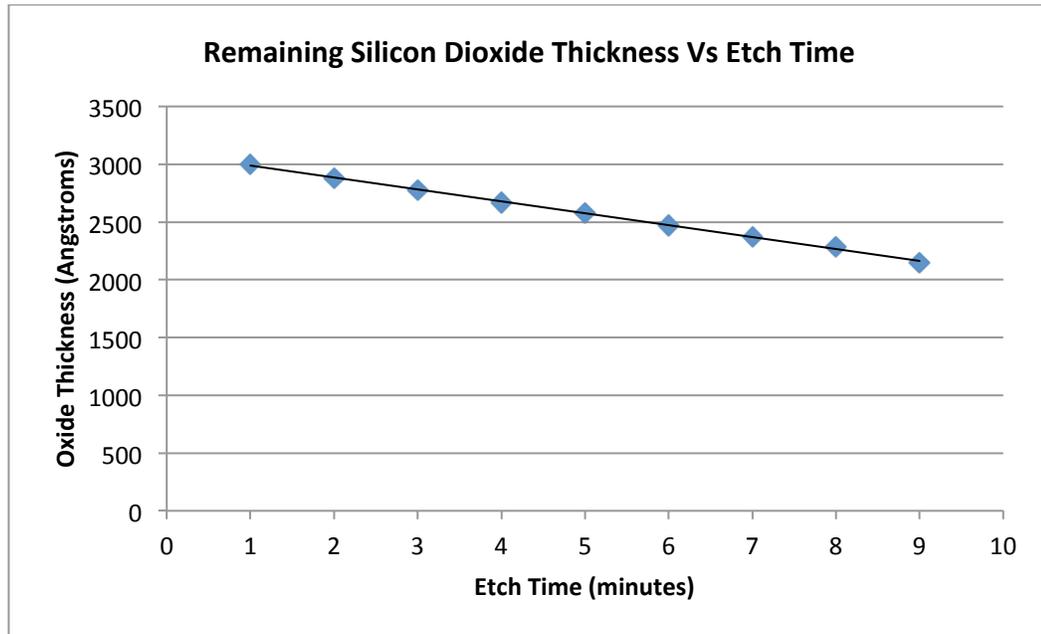
4. What type of layer is deposited between structural layers for mechanical separation and isolation, then removed during a "release etch" to free the structural layers and to allow mechanical devices to move.
 - a. Conductive
 - b. **Sacrificial**
 - c. Structural
 - d. Etch stop
 - e. Etch mask

5. What type of etch process is normally used to remove a sacrificial layer from underneath a structural layer without affecting the structural layer?
 - a. Physical dry etch
 - b. Chemical dry etch
 - c. **Chemical wet etch**
 - d. Reactive ion etch (RIE)

6. Which of the following statements BEST describes the difference between surface etch and bulk etch? “Surface etch removes...”
- only select material on the surface of the wafer while bulk etch removes material from below the wafer’s surface.
 - select material from a surface layer on top of the wafer while bulk etch removes select material from within the substrate or bulk of the wafer.**
 - select material from the masking layer, while bulk etch removes select material from an underlying layer.
 - select material from the topmost surface layer, while bulk etch removes select material from an underlying layer.
7. Which of the following BEST explains the primary difference between wet etch and dry etch processes?
- Wet etch uses a liquid etchant. Dry etch uses a gaseous etchant.**
 - Wet etch is a chemical etch. Dry etch is a physical etch.
 - Wet etch is a chemical reaction. Dry etch is a physical reaction.
 - Wet etch yields isotropic profiles. Dry etch yields anisotropic profiles.
8. A wet etch using KOH (potassium hydroxide) is to the silicon substrate as
- sandblasting is to patterned glass.
 - sandpaper is to the surface of wood.
 - flowing water is to the mud of a river bank.**
 - moisture and heat are to exposed iron.
9. Surface etch processes are normally NOT used to etch which of the following?
- Silicon nitride layers
 - Silicon substrates**
 - Silicon dioxide layers
 - Metal layers
10. KOH or potassium hydroxide etching is a wet etch process used to _____ remove silicon. This type of micromachining etch is referred to as a _____ etch.
- Isotropically, surface
 - Isotropically, bulk
 - Anisotropically, surface
 - Anisotropically, bulk**
11. A plasma is a soup of particles consisting of electrons, positive ions and radicals. During a plasma etch _____ are used to physically etch the wafer by striking the wafer with a high acceleration causing a sputtering of surface molecules.
- Electrons
 - Positive ions**
 - Free radicals
 - Positive ions and free radicals
 - Electrons and free radicals

12. During a plasma etch, _____ are adsorbed on the surface and chemically react with surface atoms or molecules creating volatile particles that are removed from the wafer's surface.
- Electrons
 - Positive ions
 - Free radicals**
 - Positive ions and radicals
 - Electrons and radicals
13. Which of the following does NOT apply to an anisotropic etch profile?
- A straight wall profile
 - Produced by a physical etch process
 - Produced by a selective wet etch process
 - High aspect ratios can exist
 - Shows undercutting below the mask**
14. Which of the following statements is always TRUE?
- Wet etch produces an anisotropic profile.
 - Dry etch produces an isotropic profile.
 - Dry etch is used to etch silicon substrates.
 - RIE uses both chemical and physical dry etching.**
 - Chemical wet etch is used to strip masking layers.
15. During a RIE process the RF power level and the process pressure are varied to process the desired etch. In order to increase the amount of physical etch within the process the RF power would be _____ and/or the process pressure would be _____.
- Increased, increased
 - Decreased, increased
 - Increased, decreased**
 - Decreased, decreased
16. What type of dry etch is normally used to fabricate cavities and deep trenches with high aspect ratios?
- RIE
 - DRIE**
 - Ion Milling
 - KOH
17. Which of the following statements BEST defines "etch rate"?
- The rate at which a film is removed from the wafer's substrate during an etching process.
 - The rate at which a film is deposited on a wafer's surface.
 - The amount of time it takes to remove a specific thickness of film.
 - The amount of film removed in a given amount of time.**

18. What is the approximate etch rate of the following process?
- a. 50 angstroms / minute
 - b. 100 angstroms / minute
 - c. 150 angstroms / minute
 - d. 200 angstroms / minute



19. Which of the following ratios is the MOST desired selectivity?
- a. 10
 - b. 50
 - c. 100
 - d. 200
20. An etch process is defined by the equation " $y = 103x + 90 \text{ \AA}$ ". What does the 103 and 90 represent, respectively?
- a. Etch rate and starting film thickness
 - b. Etch rate and total thickness etched
 - c. Starting film thickness and etch rate
 - d. Total thickness etched and etch rate.

Support for this work was provided by the National Science Foundation's Advanced Technological Education (ATE) Program through Grants. For more learning modules related to microtechnology, visit the SCME website (<http://scme-nm.org>).