

Name: _____ Date: _____ Class: _____

Student Worksheet (with answers)

Part 2: Active vs. Passive Etching

Safety

Wear safety glasses while using vinegar, for it contains dilute amounts of acid and will burn if splashed into the eye. Scissors can be a cutting hazard, so use caution.

Introduction

Scientists modify a wet etching process, depending on how they need the electrical component to be sculpted. This etching occurs at the nanoscale because the chemicals remove atoms and molecules from the substrate or the material being etched (cut). In this lab, you will simulate two methods:

- The *active method* will be simulated by introducing the etching solution drop-wise on the surface of the substrate and allow it to flow off the surface carrying with it the etched particles exposing new surface on the substrate.
- The *passive method* will be simulated by submerging the substrate in the etching solution and allow the etchant solution to do work on the surface of the substrate gently without agitation.

Materials

- safety glasses (one per student)
- 25 in. clear tape
- 2 antacid tablets
- pair of scissors
- metric ruler
- 1 Petri dish
- 1 pipette
- 50 ml vinegar
- 2 beakers, 100 ml each
- pair of tweezers
- 10× magnifier
- clock

Make a Prediction

1. Which method do you predict will make the deepest and smoothest best-etched pattern?

The passive method will produce a better surface.

2. Which method will create the larger etched channel?

The active etching will produce a larger channel.

Procedure

1. Tape each antacid tablet, leaving a 4 mm channel in the middle as you did in the prior lab.

Passive etching method:

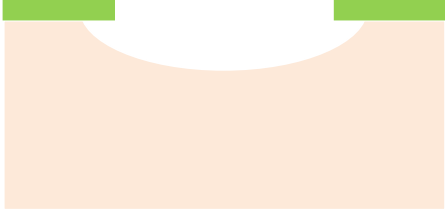
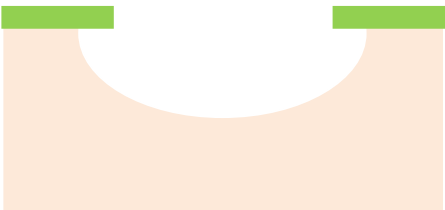
2. Place the masked substrate with the exposed masked surface facing upward in the Petri dish. Use a pipette to transfer enough etching solution to submerge the substrate. Allow it to sit for 15 minutes. Record your observations every 5 minutes in the table on the next page.
3. Use tweezers to remove the tablet and place it on a paper towel to dry. Observe etched surface with the magnifying lens, and describe the surface and the shape of the channel in the table on the next page.

Active etching method:

4. Use tweezers to hold a substrate with the exposed masked surface at about a 45° angle above a compartment in the Petri dish.
5. Use a pipette to drop the vinegar onto the exposed surface of the tablet at a rate of 30 drops per minute. Continue this process for 15 minutes, making observations of the etched surface every 5 minutes and recording your observations in the table below.
6. After the 15 minutes, use the tweezers to remove the tablet. Place it on a paper towel and allow it to dry. Make your observations of the etched surface using the magnifying lens. Describe the surface and draw the shape of the channel in the table below.

Record Your Observations

| | Passive Etching Method | Active Etching Method |
|---------------|---|---|
| 5 min | <i>Small and large bubbles of gas are forming on the exposed surface.</i> | <i>Bubbles of gas are forming on the surface of the substrate.</i> |
| 10 min | <i>The gas bubbles appear to build up on top of each other hiding the surface of the substrate.</i> | <i>The gas bubbles slide off the exposed surface as the liquid flows off the substrate.</i> |

| | | |
|---|---|--|
| <p>15 min</p> | <p><i>The channel formed at the edges of the substrate is more shallow than the rest of the channel.</i></p> <p><i>Accumulation of bubbles at the exposed outer edges of the substrate.</i></p> | <p><i>The depth of the channel was deeper and more undercutting was noticed at the edge of the substrate where the liquid dropped off.</i></p> |
| <p>Draw the final shape of the channel</p> |  |  |

Analyze the Results

1. Did the type of etching method have an effect on the edged surface?

The active etching appeared to have produced a deeper channel with a less porous surface.

2. *Undercutting* is the removal of substrate material (the tablet) from underneath the mask (the tape). Which etching method—active or passive—showed the most *undercutting*? Why?

Active etching showed the most undercutting. The flowing liquid carried away the etched particles exposing new, clean surface on the substrate to react with the new etching solution dropping on the substrate.

Draw Conclusions

3. Which etching method—active or passive—produced the best etching surface? Explain.

The passive method appears to produce a less porous surface with a smoother trench.

4. Which etching method—active or passive—yielded the deepest channel on the substrate? Why?

The active method produced a deeper channel, especially where the drops landed and where the fluid ran off the substrate.
