Name: _____Date: _____Class: _____

Student Worksheet

Part 1: Wet Etching

Safety

Wear safety glasses while using the etching solutions: vinegar, lemon juice, and Coca-Cola, for they all contain dilute amounts of acid and will burn if splashed into the eye. Scissors can be a cutting hazard, so use caution.

Introduction

In this lab, you will discover how scientists sculpt tiny electrical components that are used in an iPod or cell phone! You will do a *wet etching process* (also called "*acid etching*"), which is often used to make very tiny parts (integrated circuits containing transistors) used in a computer. Computers, cell phones, and iPods would not work without this process, so let's get started, and you can submit your resume to Intel later. Because of micro and nanotechnology the parts are getting smaller and smaller with transistors measuring between 20 and 50 nanometers, or billionths of a meter. This small size allows for millions of transistors to be in a single electronic device. But how do they make such small things? This lesson will help you learn about one of the methods called wet etching.

Materials per group

- safety glass (one per student)
- 25 in. electrical tape
- 25 in. Scotch® tape
- 25 in. masking tape
- 9 Alka-Seltzer® tablets
- 9 antacid tablets
- 9 art plaster molds
- pair of scissors
- metric ruler
- 9 index cards
- pen
- 9 Petri dishes, with 3 compartments in each Petri dish
- 3 beakers, 100 ml each
- 50 ml vinegar
- 50 ml lemon juice
- 50 ml Coca-Cola®
- 3 pipettes
- pair of tweezers
- 10× magnifying lens
- clock

Make a Prediction

1. Which of the three masks (types of tape) will adhere the best to all substrates?

_____

_____

2. Which of the three etching solutions (vinegar, lemon juice, or Coca-Cola®) will etch the most material away?

_____

_____

3. Which of the three substrates (Alka-Seltzer®, antacid tablet, art plaster) will be the best material to work with? The best material will:

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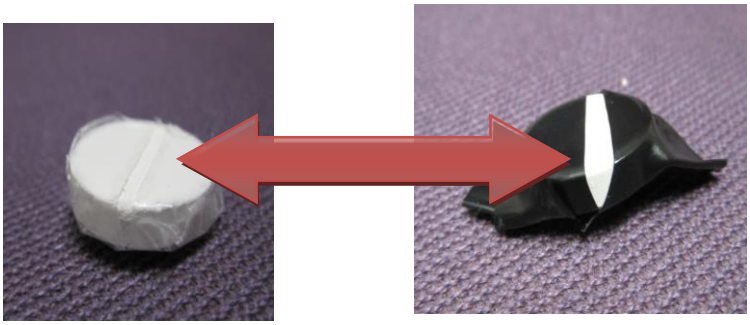
- produce the deepest channel
- make the smoothest surface
- be the easiest to handle
- not be fragile

_____

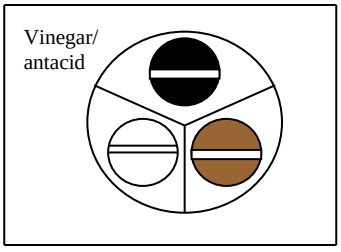
_____

Procedure

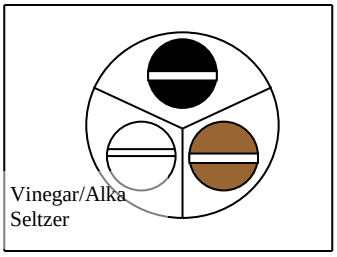
1. Tape 3 antacid tablets with electrical tape, so that there is a 4 mm gap in the middle as shown to the right.



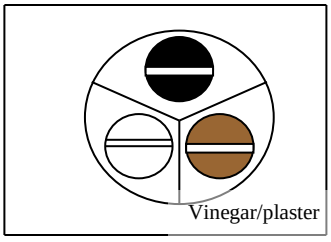
2. Tape 3 antacid tablets with clear Scotch tape and 3 antacid tablets with tan masking tape, in the same manner as you did in step 1.
3. Repeat steps 1–2, but this time tape the Alka-Seltzer® tablets.
4. Repeat steps 1–2, but this time tape the plaster molds. You should now have a total of 27 substrates (tablets) to test.
5. Outline a Petri dish on each index card.
6. Label one index card: *vinegar/antacid.* Set the Petri dish on top of the circle, and put the 3 taped (electrical, masking, clear tape) antacid tablets in each compartment of the Petri dish.



7. Label one index card: *vinegar/Alka-Seltzer*®. Set the Petri dish on top of the circle, and put the 3 taped (electrical, masking, Scotch® tape) Alka-Seltzer® tablets in each compartment of the Petri dish.



8. Label one index card: *vinegar/plaster.* Set the Petri dish on top of the circle, and put the 3 taped (electrical, masking, clear tape) plaster molds in each compartment of the Petri dish.
9. Repeat steps 6–8, but this time substitute the word *lemon juice* for the word *vinegar*.



10. Repeat steps 6–8, but this time substitute the word *Coca-Cola*® for the word *vinegar*.

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Rev: 01/2012

11. Use a pipette to drop the vinegar on the exposed surface of each tablet. How do you know whether a reaction is taking place? How do you know whether the reaction is fast or slow? Write your observations in the table on the next page.
12. Add enough vinegar to completely submerge the exposed surface of all tablets and let them set for 10 minutes.
13. Repeat steps 11–12 with the petri dish labeled lemons juice. This time use an unused pipette with lemon juice.
14. Repeat steps 11-12 with the petri dish labeled Coca-Cola®. This time use an unused pipette with Coca-Cola®.
15. Use tweezers to remove all tablets from the Petri dishes and let them dry on a paper towel.
16. Observe the condition of the masks to see how well they stuck to the substrate. Write your observations in the table.
17. Observe each tablet with a magnifying lens. Answer the questions in the table.

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Record Your Observations

	a. How well did these acids react with the substrate? b. How well did these acids etch the substrate for the *best* channel?		
	Vinegar	**Lemon juice**	**Coca-Cola®**
Plaster			
Antacid			
Alka-Seltzer®			

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Rev: 01/2012

	Did the mask (tape) adhere well to the substrate?		
	Black electrical tape	**Clear Scotch® tape**	**Masking tape**
Plaster			
Antacid			
Alka-Seltzer®			

Analyze the Results

1. Why did bubbles form on the exposed surface of the substrate?

2. Draw what the channel looked like in the space below. Label all parts: substrate, undercutting and mask.

3. Did this channel undergo an *isotropic etch* or an *anisotropic etch*? Justify your answer.

4. Why do you think this shape was formed?

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Rev: 01/2012

Draw Conclusions

5. Did the type of etching solution determine the amount of gas forming on the surface?

6. Which of the masking materials performed best? Justify your answer.

7. What was the best substrate to make a channel? Explain.

8. Why would the etching process be considered nanotechnology? _____

9. Why would engineers want to make integrated circuits that have transistors in the nanoscale?

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