Student Guide

Name:_____Date:_____Class:_____

Superhydrophobicexpialidocious: Learning about Hydrophobic Surfaces

Safety
Wear goggles; do not squirt anyone or anything with the liquids or the compressed air.

Introduction: You have been amazed by the difference between hydrophilic and hydrophobic surfaces! Now it's time to try to go even further and try to make a material "superhydrophobic" or really afraid of water! In this activity, you will be using sandpaper and pieces of Teflon to determine if you can make the Teflon superhydrophobic. To determine if superhydrophobic, you will be measuring contact angles of drops of water.

Pre-lab questions: Answer in your lab notebook

1. Which grit of sandpaper will change the surface of the Teflon to be the most hydrophobic?
2. What is the independent variable?
3. What is the dependent variable?

Materials: (per lab group)

- Teflon piece
- Sandpaper
- Safety goggles, 1 per student
- Sharpie
- Acetone
- Distilled water
- 2 wash bottles: 1 for acetone, 1 for distilled water
- 2 glass beakers (250-500ml)
- Air can
- Tweezers
- Paper towels
- 1 small beakers of colored water or dropper bottles of colored water
- 1 disposable pipette or syringe
- Digital camera or a cell phone with a good camera
- Protractor
- Dark piece of construction paper, to use as a background when taking pictures.
- Resealable baggie to store Teflon pieces
- Paper clip to scratch the Teflon

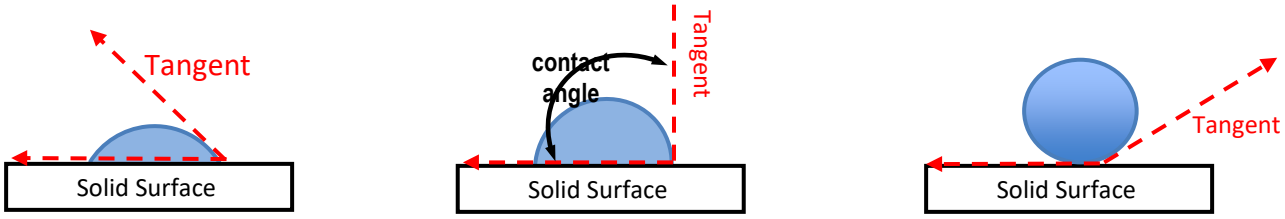
Procedure Day 1:

1. Put on goggles.
2. Using the paperclip, scratch an "X" on one corner of the Teflon piece. This will mark the back or the control side.
3. Turn the Teflon over. Using your sandpaper, sand the Teflon for 20 seconds.
4. You now want to **AVOID TOUCHING THE SURFACE!** Using the tweezers, grab a corner and wash it with acetone. Make sure you hold it over the **acetone waste beaker**.
5. Next, wash it with distilled water, over the **water waste beaker.**
6. Holding the piece with tweezers, carefully dry both sides with the compressed air. Not too close or it will blow the piece away!

Observations/Results:

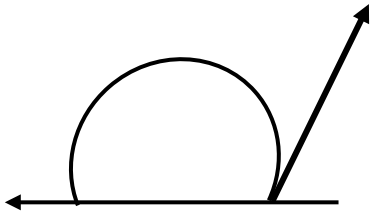
1. Place **ONE** drop of colored water on the rough or sanded side. What do you observe?
    a. Draw shape of drop in lab notebook
2. Place **ONE** drop of colored water on the control side, what do you observe?
    a. Draw shape of drop in lab notebook
3. Using the tweezers, now tilt the piece and squirt a steady stream of water on the control side (**over the waste water beaker**), how does the water react? Now squirt a stream over the sanded side. Compare/contrast each side and write your observations.

READ: So how do we know how water resistant your Teflon is? Scientists measure the contact angle of a droplet to find out if it is hydrophilic, hydrophobic or superhydrophobic. The contact angle is the angle where a liquid meets a solid surface. It is simply measured by drawing a horizontal line along the surface and drawing a tangent line where the liquid drop meets the solid surface.



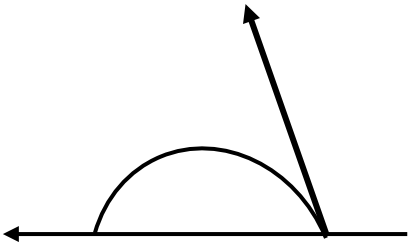
Hydrophilic < 90° **Hydrophobic ≥ 90°** **Superhydrophobic > 150°**

Practice finding the angle on these drops with the protractor and circle whether it is hydrophobic, hydrophilic or superhydrophobic:



Degree =

hydrophilic/hydrophobic/superhydrophobic



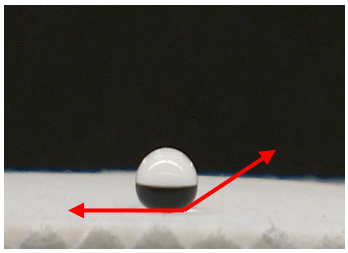
Degree =

hydrophilic/hydrophobic/superhydrophobic

Procedure Day 2:

You are now going to take a picture of a water droplet to find the contact angle and how hydrophobic it is!

1. Place the Teflon piece, sanded side up on the edge of your table, it must be flat!
2. Place one drop of colored water on the front edge of the Teflon.
3. Prop up a dark piece of construction paper behind the Teflon. (so you can see the drop better).
4. Using the digital camera, or your smart phone, take a picture of the drop. Try to get the clearest image possible.
5. Upload this image into your computer or send it to yourself from your phone so that it can be uploaded to your computer.
6. Bring up the picture on your computer. On the picture, using the drawing tools, draw a horizontal line across the solid surface under the drop and a tangent line where the drop touches the surface. **DO NOT resize the picture (unless you lock the aspect ratio first), or it will distort your angle!**
7. Place the protractor on the screen and fine the contact angle of the droplet.
8. Record the in the data table.

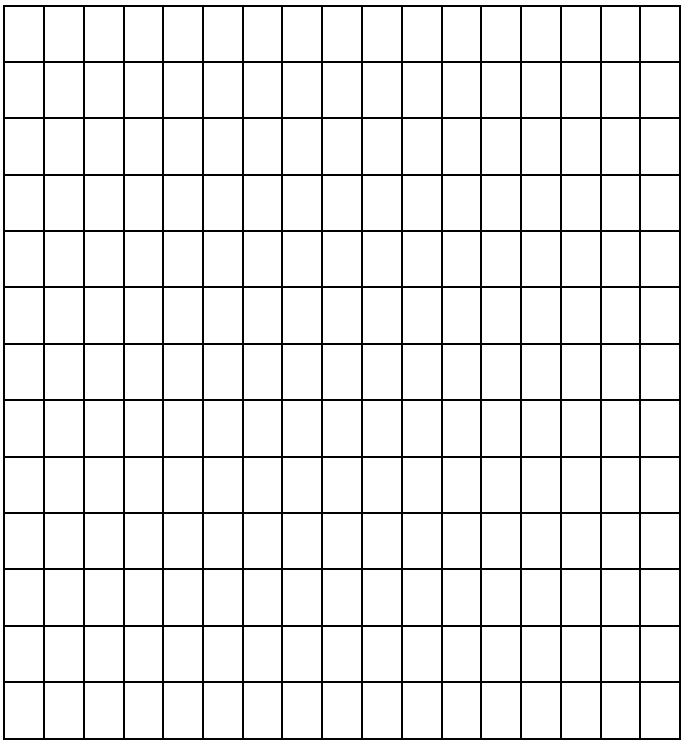


Data Table:

Sandpaper grit #	Class Contact angles	Average Contact angle	Hydrophilic or Superhydrophilic?

Analyze the Results: Graph the angle vs. grit size. **Angle on the x-axis, grit on the y-axis**

Effect of grit size on contact angle



Draw Conclusions

1. Which grit is had the greatest contact angle? The least?

2. Was your hypothesis correct? Why or why not?

3. Explain any sources of error.

4. Explain why you think a certain grit produced the greatest contact angle? Look at the teacher SEM images of the different sandpaper grits to help you explain it.

5. How does this lab compare with the Part 1 lab? How are they different?

6. What does hydrophobicity and superhydrophobicity have to do with nanoscale science?

7. How is a superhydrophobic material useful? Create/Design a new commercial product that is superhydrophobic.

Optional: Activity extension

Design an experiment to test other materials that you would like to examine their movement across the Teflon or items you treated in Part 1 (chemical). What other variables would you test? Would you want to use other liquids such as an oil? Maybe a more viscous or acidic material? What other materials would you add to the surface to examine hydrophobicity? Dirt, dust, grease pen? Design your experiment and have the instructor approve your design before testing. Follow the experimental procedures of above. Write up your results and then share as a short presentation to the class.