



Hydrophobic and hydrophilic surfaces- Lotus Effect



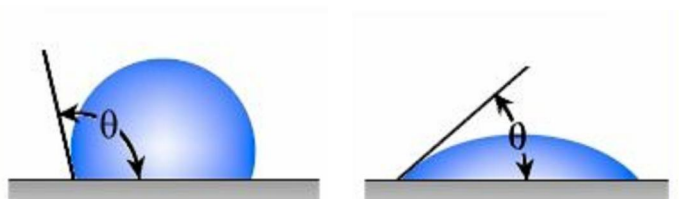
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PART ONE

Equipment

- different kind of leaves (at least one among lotus, nasturtius, cabbage)
- samples of parafilm, wax paper, plastic, glass, filter paper, aluminium
- pasteur pipette or eye-dropper
- glass filled with water
- scottex
- photcamera
- tripod (optional)
- goniometer

All materials may be classified according to how much they are either hydrophobic or hydrophilic, namely their wettability (**adhesion** of a liquid onto a surface). To do this you measure the **contact angle** of a single drop deposited on the surface of interest. This is the angle formed by the tangents at the liquid-gas and solid-liquid interfaces and its vertex on the contact line between the three phases. See above pictures.



A qualitative appraisal is already possible at first glance, but you may want a more quantitative classification (see table).

Table 1

Contact angle °	Surface classification
0°	superhydrophilic
>30°	hydrophilic
30-90°	intermediate
90-140°	hydrophobic
>140°	superhydrophobic



Procedure

Contact angle

On the desk you have samples of different materials.

1. With a pipette deposit on each sample one single drop. If possible try to make the drops all with the same dimensions.
2. Take a photo of the drop for each sample.

N.B. Tips about taking the photos:

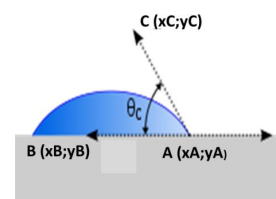
- You should position the camera so as to be at the same level of the drop/surface interface.
 - Avoid surfaces with too much reflectance both on the desk and in the background.
 - The background colour should enhance the contrast with the drop
 - Use a tripod or any other fixed stand.
3. Print the photos or, even better, paste them into a digital document (doc, ppt, paint, etc...). Do not deform the original proportions when you drag and drop!
 4. Plot the contact angle and measure it with a goniometer or by applying trigonometry*.
 5. Use *Table 1* as reference and classify the samples from superhydrophilic to superhydrophobic, Fill in a new table (Table 2).

Table 2

Material	Contact angle	Classification
.....		

* With trigonometry:

$$\theta_c = \arctg(m) \text{ dove } m = (y_c - y_A) / (x_c - x_A)$$



PART TWO

Equipment

➤ aerogel	➤ colander and spoon
➤ samples of superhydrophobic textile, both cotton and synthetic	➤ oil, vinegar, alcohol



➤ magic sand, common sand	➤ 4 glasses or beakers
➤ sample of selfcleaning glass	➤ 3 Pasteur pipettes

Superhydrophobic materials already exist in Nature (you have observed some leaves from lotus to cabbage ones) and now researchers and engineers are trying to reproduce them artificially. You have some examples of applications listed here:

a. water and dirt repellent textiles– Deposit a single drop of water, vinegar, oil on the different textile samples (100% cotton, synthetic, nanostructured). Use a different pipette for each liquid. With the paper towel kindly wipe the drop out. Write down your observations contact angle measurement included.

b. Selfcleaning glass – Deposit a single drop on the glass and observe what happens. Can you still talk of Lotus effect? Why?

c. Aerogel – Nowadays among building materials you can find thermoinsulating sheet covered with a thin aerogel layer. Find the contact angle and classify the material.

d. Magic sand- Pour the magic sand in a plate and deposit a water droplet on it. Write down your observations.

Afterwards you may try with alcohol and oil droplets ¹. Does anything change?

To complete your observations pour some magic sand into a glass filled with water what happens? Stir the sand and try to collect it with a spoon. Which are the differences with the common sand?

Can you devise possible new applications for these materials? Discuss the topic with your group.

¹ Careful: deposit the oil drop on a tiny bit of magic sand only. Once the sand has been in contact with oil and grease you should not mix it again with the other one since it will be irremediably damaged.