Liquid Marbles and microfluidic devices

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Equipment

- Soot lycopodium powder, graphite, superhydrophobic aerogel powder
- colander
- Pasteur pipette
- videocamera
- tripod
- Tracker software
- pestle
- post it stickers
- incline
- goniometer
- glycerol
- computer

The increasing miniaturization in chemical analysis processes– "lab on a chip" – together with many advantages (reduction in the amount of reagents used, shorter reaction time, portability, possible integration within digital devices) still brings along a few issues just because based on the manipulation of extremely small volume of liquid. To start moving drops of quite small dimensions huge forces are needed plus you often have leakage issues. As a rule microfluidic devices with extremely thin ridges and canals are employed, however recently a tendency in single drops manipulation emerged. These drops are encapsulated in superhydrophobic powders and are known as "liquid marbles".

Your task is to test the best way to transport extremely small liquid quantities on a solid surface exerting the smallest possible force with no leaks neither contamination issues. You are very welcome to add any consideration about pros and cons of different methods.

Procedure

1.Choosing the best hydrophobic powder for encapsulation

First of all you should evaluate which powder to use for the superhydrophobic coating of the liquid marbles. You may test soot, lycopodium powder, graphite (grind it into a fine powder with a pestle and mortar: you should reach the same consistency of powder sugar); superhydrophobic aerogel in granules(you should grind this too). If you have enough time you may also think to test other different materials powder.

1. Fix the incline tilt at the desired angle: ϑ = ……

2. Put a bit of soot on the paper standing on the support just next to the top end of the incline .
3. With a Pasteur pipette gently put a water and glycerol drop on a small heap of the powder. The drop should roll down the heap side and as it rolls it gets coated finally becoming a liquid marble. Try if possible to make drops all of the same radius R. Write down your observations in a table.

Powder	Drop coating: does it work ?	Are there any liquid leaks?
…..		

4. Evaluate the efficacy of the different powders as you keep both the tilt angle and the drop dimension fixed. You may also want to measure

    - contact angle
    - rolling (tilt) angle
    - contact angle hystheresis

2. Study the drop motion versus tilt angle θ and its own radium R.

Study the rolling motion of liquid marbles according to the incline tilt angle ϑ and their own radium R (you can measure this last one in the video frames through the calibration bar in Tracker). With the pipette let single drops fall in sequence over the superhydrophobic heap.

Videorecord the rolling motion of each drop and then with Tracker calculate and plot s = s(t), v = v(t), a=a(t).

1. Estimate the friction coefficient in each case.
2. Compare data with those obtained in Lab2 regarding water drops motion on superhydrophobic surfaces. Discuuss the results with your group: are they counterintuitive? Why? What happens as R decreases?

3. Further researching

- Test the effect of the liquid density : try different proportions of water and glycerol.
- Find how strong and elastic are the liquid marbles
- Devise and test different ways to move the drops. (For instance try to use a charged plastic rod and move the drops thanks to the electrostatic field).
- What happens to liquid marbles on a liquid surface?