Surface Roughness and Hydrophobicity of leaves

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Abstract

Superhydrophobicity has attracted great attention in the scientific as well as industrial community throughout the globe, owing to its potential applications like self-cleaning, anti-fouling, anti-corrosion, dust free building glasses and solar cells. In present study we investigate the effect of surface roughness, aging and solution impurity on the hydrophobicity of leaves. The Contact Angle and the Slide-Off angle are estimated using innovative techniques, and will form the measure of characterisation for this study. Different types of Hydrophobicity are directly observed from the experiments and are correlated with Dust-Cleaning ability of the surfaces. Hence, with this preliminary study, we present some interesting observations of natural hydrophobic surfaces.

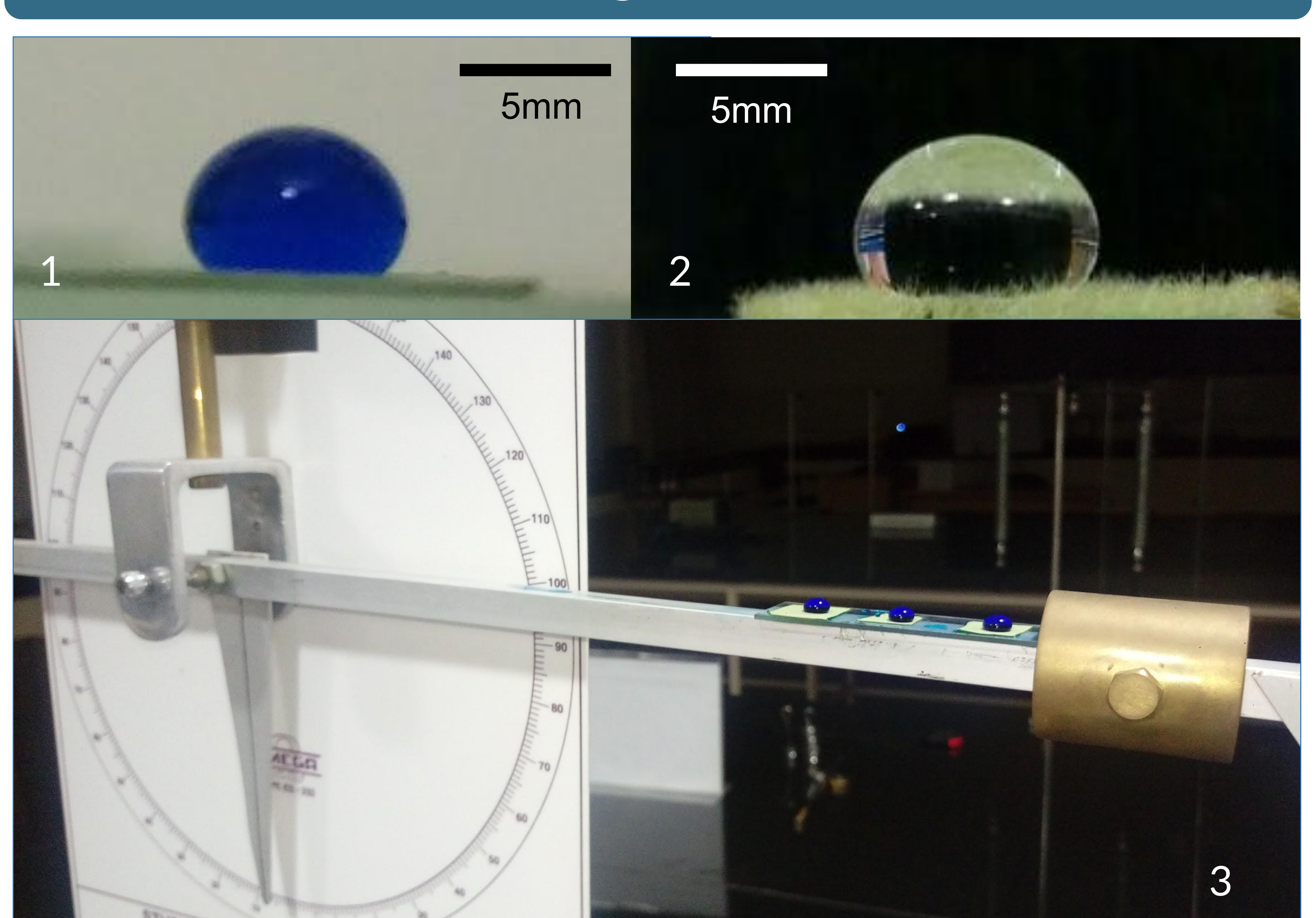
Introduction

- Superhydrophobicity is the property of solid surfaces that repel water strongly and leads to non-wettability of surfaces.
- Hydrophobic surfaces must exhibit Contact Angles (**CA**) between water and the surface, greater than 90°. If the contact angle is greater than 150° , the surface is said to be Superhydrophobic.
- Superhydrophobicity depends upon forces of adhesion between surface and water. Hence, surface roughness and structure forms a major factor for determining characteristics.
- The adhesion between the water droplet and dust particle is more than adhesion between hydrophobic surface and dust particle hence dust is picked up by rolling water droplet.

Experiment

- Measured CAs of 2 different leaves with distinct surface roughness, by dropping a standard sized water drop (50μL) and using ImageJ software.
- Fig.1 shows an experiment with dyed water drop on a surface with finer hair (Leaf A).
- Fig.2 shows contact angle experiment with a coarser hair structured surface and a clean distilled water drop (Leaf B).
- Different slide-off angles were measured for the 2 surfaces, corresponding to distinct types of Hydrophobicity[3]. Equipment used and design of experiment is shown below in Fig.3.

Figures



Observations

Leaf A

- Contact Angle : **136.32° ± 3.755°**
- Slide Off angle wrt Fresh Leaf : **12.33° ± 1.89°**
- Slide Off angle wrt Aged Leaf : **13.67° ± 1.25°**

Leaf B

- Contact Angle : **118.31° ± 4.806°**
- Slide Off angle wrt Fresh Leaf : **29.67° ± 0.47°**
- Slide Off angle wrt Aged Leaf : **33.00° ± 2.83°**

Significant variation in CA with aging (of 2 days) of the leaf, or with minor contamination(dyes) of solution was not observed.

Discussions

- Leaf A proves to be more Hydrophobic than Leaf B as observed from CA comparisons.
- Structure of Leaf A stays consistent even with 2 days of aging, while Leaf B loses consistency as reflected in increase of Slide-Off angle.
- Leaf A clearly shows Cassie's state and Leaf B shows Wenzel's state of Hydrophobicity as observed from the CA hysteresis and the Slide-Off angle comparisons of the 2 leaves.
- Self-cleaning effect is better observed in Leaf A due to the above mentioned reason.
- Surface of Leaf B is more adhesive to water droplets, than Leaf A.
- We conclude that finer sub-structure and lesser adhesion of the surface leads to better hydrophobicity and self-cleaning properties.

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References

1. Li et.al., Chemical Society Reviews, 2007
2. J. Bravo et. al., Langmuir, 2007
3. Wang & Jiang, Adv. Mater. 2007