Team First Report

Water Droplets on a Hydrophobic Surface

David Leng

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Flow Visualization

INTRODUCTION

The fluid phenomena of a water droplet on a superhydrophobic surface will be analyzed and discussed in this report. We see water around us in our daily lives, but very seldom do we see and analyze water on a hydrophobic surface. Team 2 of the Fall 2016 semester course Flow Visualization comprised of Sierra Castillo, Katie Gresh, and myself aim to photograph and analyze this phenomena.

"The superhydrophobic surface used was created using[Ref 1]:

-Isopropyl Alcohol 90%, a glass plate, ceramic dish, ceramic bowl, and a flame/heat source,

The process involves a flame, so safety glasses are recommended. The following steps were taken:

1. Fill the dish with a small amount of isopropyl alcohol.
2. Light the dish on fire.
3. Holding the glass from the bottom, wave it over the flame to begin coating it in the soot from the flame. Note: The glass used was thin, so to avoid cracking it we held the glass over the flame for 1 min and let allowed to cool for 10 min.
4. Repeat the process until the glass is black (about 4-5 min). During the cooling cycles, the glass was placed on the ceramic plate to avoid damaging the table the setup was resting on.

Finally, cool the glass to room temperature (approximately 15 min). The coated glass is now a hydrophobic surface "

Taken from Katie Gresh

Figure 1. Single drop on a superhydrophobic surface

The fluid interaction occurs between the surface of the water and the surface. The hydrophobic surface has a larger contact angle than its non hydrophobic counterpart. If the contact angle is larger than 90 degrees the surface is considered to be hydrophobic, and if the angle is larger than 150 degrees the surface is considered to be superhydrophobic[Ref 2]. Young's Equation gives us the contact angle as

$$\cos\theta = (\gamma_{SV} - \gamma_{SL}) / \gamma_{LV}$$

Where

γ_{SV} = Solid Surface Energy

γ_{SL} = Solid-Liquid Interfacial Energy

γ_{LV} = Liquid Surface Tension

Hydrophobic surfaces occur due to the lack of polarity of the surface. These nonpolar substances prevent the interaction of water molecules.

The visualization technique used to capture this image was to have a dark backdrop and photograph the difference between a hydrophobic surface against a non hydrophobic surface. Using water and various colored dyes gives contrast to the droplets allowing them the differences to be more easily visualized.

The image was created using a Nikon D3200 DSLR camera. Using an aperture of F4.8 with a 32mm focal length at ISO 1600 this image was captured at about 1.5 ft away from the lens. This gave me the ability to capture a field of view encompassing the hydrophobic and non hydrophobic surface. Using photoshop I increased the contrast a bit as well as increasing the exposure and shadows. I did this to bring out the vibrance of the droplets.

CONCLUSION

The image allows one to clearly visualize the difference between the two surfaces. As seen in the image the water droplets on the non hydrophobic surface seem to puddle and do not hold the “droplet” shape. The droplets on the hydrophobic surface can be seen to hold their shape more, the edges are sharper and more distinct. The image could be in better focus to more clearly display the non hydrophobic surface. The intent of the get wet project was fulfilled, but my curiosity is still piqued. I am curious as to how exactly the droplets transition from moving from the hydrophobic to non hydrophobic surface. Improvements would be to get better focus on the non hydrophobic side, better backdrop, and less soot on the hydrophobic side droplets.

REFERENCES

[1] Youtube. https://www.youtube.com/watch?v=HCGiwSghrqQ. [Online]. [Accessed: 10- Oct- 2016].

[2] Yuan, Yuehua and Lee, Randall. Surface Science Techniques. Springer Berlin Heidelberg, 2013. http://link.springer.com. [Online]. [Accessed: 22- Oct- 2016].