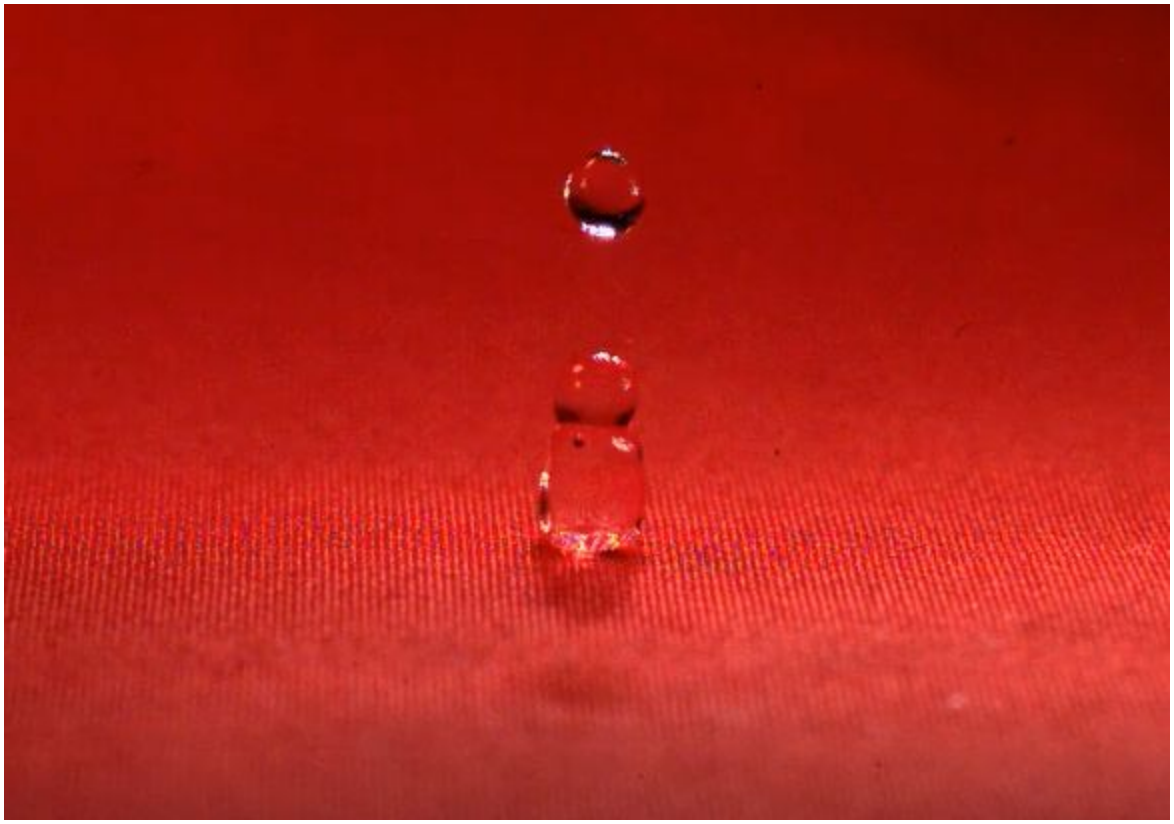
Team Second Report

Water Dropping on a hydrophobic Surface



David Leng

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Flow Visualization

INTRODUCTION

The fluid phenomena of a water dropping on a hydrophobic surface will be analyzed and discussed in this report. 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. Using a hydrophobic Gore-Tex jacket as our test surface, a 5mL syringe, and a high speed camera this phenomena was able to be captured. Professor Tadd Truscott recorded the original video using a Phantom V-Series high-speed camera.

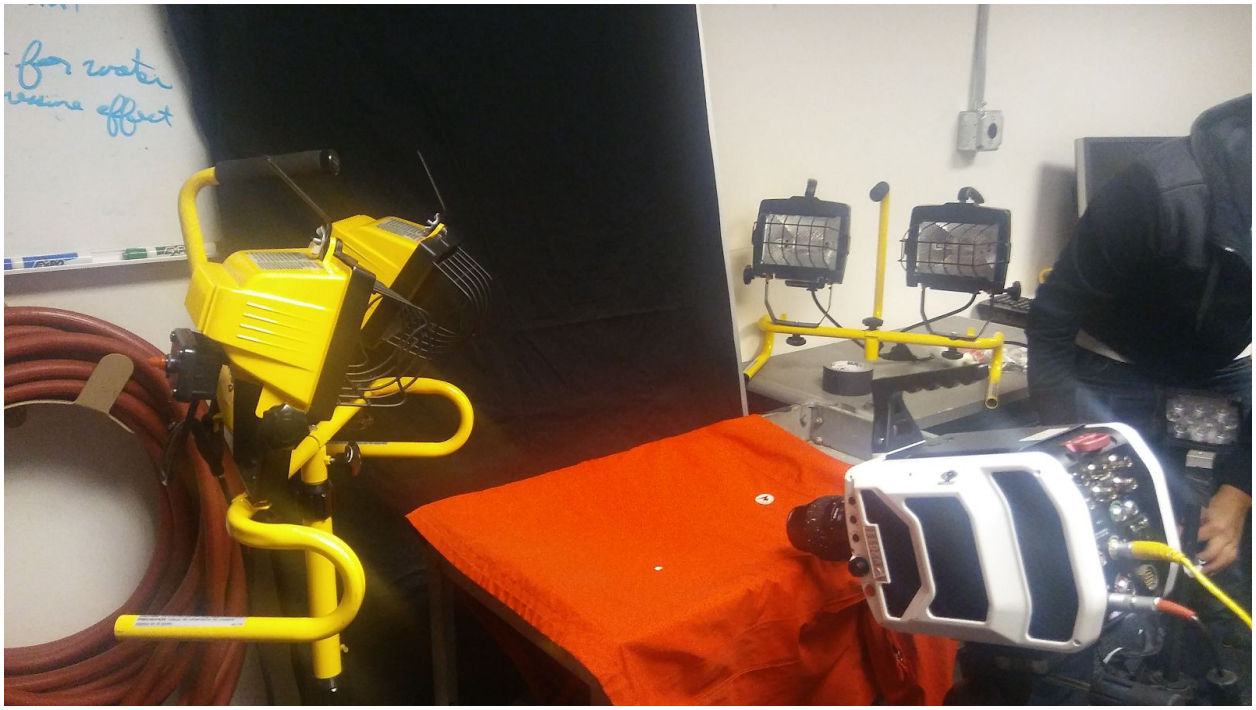

Figure 1. Setup Used

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

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

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.

Aside from the phenomena of water on a hydrophobic occurring, a Worthington jet was produced from a single drop. In the video it is seen that the Worthington jet split into two smaller droplets. Worthington jets occur when the falling droplet creates a crater and then the crater collapses resulting in the jet being formed from the leftover energy. [3]

The visualization technique used to capture this image was to have a high amount of lighting to really produce clarity in the water droplet. The high speed video camera is used to see frame by frame what is occurring. The image was created using a Phantom V-Series high-speed camera. The camera was set at 4000 fps with a resolution of 1280 x 800. Using Shotcut, a video editing software, I was able to bring down the brightness and increase the contrast as well as layer music on top of it. The music is used to add a more calming feeling to the video

CONCLUSION

The image allows one to clearly visualize a droplet falling on a hydrophobic surface. The video provides a step by step visual analysis of the phenomena. Surprisingly with the amount of energy the droplet had falling out of the syringe the droplet was able to form a Worthington jet. Nobody on the team suspected

this, but it was very interesting to see. This aspect is particularly interesting because Worthington jets are typically seen when a droplet falls into a pool of a much larger liquid. My curiosity leads me to question how much energy is required for a worthington jet to occur for a certain size droplet of water. Does it vary from surface to surface? Does it vary with contact area?

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].

[3] Liu, Jie. “Splashing Phenomena During Liquid Droplet Impact.” Department of Mechanical Engineering, University of California – Riverside (2009): 297-298.