TOUCHABLE BUBBLE ON A HOLIDAY SURFACE (FLOW VISUALIZATION FALL 2016)

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ABSTRACT

This paper describes the art and physics of the interaction between a touchable bubble and an ordinary surface. The experiment was performed for the Flow Visualization course at the University of Colorado at Boulder for the Fall 2016 semester. The project was performed as a team (Team 2) that includes: Sierra Castillo, David Leng, and Kate Gresh. On November 29, 2016 Team 2 met at the Integrated Teaching and Learning Laboratory at the University of Colorado at Boulder (Figure 8). Images were taken of a unique bubble product which forms bubbles that do not burst upon contact. The proprietary formula is a polymer solution manufactured by Unclebubble.com.

The image was taken using a Nikon D3200 SLR camera. The focal length was 48.0 mm. The ISO was 1600, aperture was 5.6, and the exposure was 1/100 second. Post-processing was performed using Photoshop and included cropping and editing to remove extraneous distracting elements.

INTRODUCTION

The third team image for the Flow Visualization course at the University of Colorado at Boulder was intended to capture a continuation of the theme of spherically shaped fluids. The other team projects captured spherically shaped water droplets by using hydrophobic surfaces. This project used a unique bubble solution manufactured by Uncle Bubble. The set-up included a black back drop, holiday light emitting diode (LED) light strings, and red and green fabrics (Figure 2) (Note: the fan pictured in Figure 2 was not utilized for the final image). The image shows a single bubble resting upon holiday fabric. The bubble did not burst upon contact with the fabric and a minute striation showing deformation of the bubble from contact can be observed.

Figure 1: Water Droplet on a Hydrophobic Surface- Created by Team 2

Figure 2: Set-up for Team Image

Camera Set-Up

The Nikon D3200 camera was set-up in the Integrated Teaching and Learning Laboratory (ITLL) at the University of Colorado at Boulder. The camera was provided by team member S. Castillo.

Several images were taken of both the bubbles floating in air and resting on surfaces (Figure 3 and Figure 4). The most challenging aspect of capturing the images was focusing on the bubble due to its clear, translucent nature. Another challenge included blowing the bubbles high enough in the air to allow for approximately five seconds of dry time. Bubbles which did not properly dry before contacting a surface, produced a shriveled polymer film which aesthetically were distracting to the images.

Figure 3: Team Member Image by S. Castillo

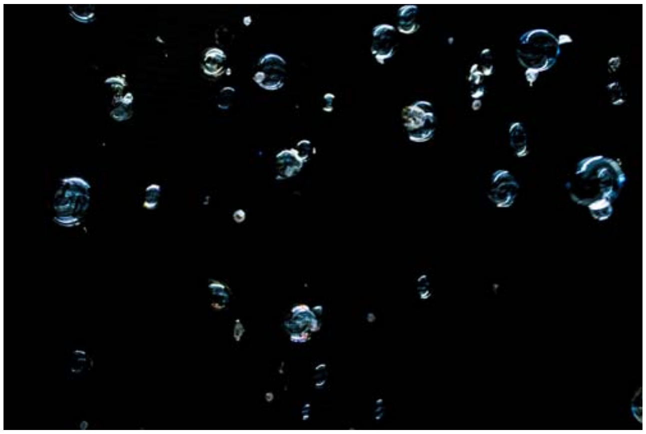

Figure 4: Team Member Image by D. Leng

Fluid Physics

Fluid physics of bubbles is a continuing area of research. Team 2 chose to investigate the fluid physics of bubbles due to the unique nature of the Uncle Bubble product. Bubbles were developed with soap in the 18th century as shown in paintings by Jean Simeon Chardin and Charles Vanloo [Ref 1]. Even today, typical bubbles consist of a soap and water solution. The Uncle Bubble product is a proprietary formulated polymer solution. Although the proprietary solution is unique, there are similar fluid physics. The primary physics of bubbles include: surface tension and pressure.

Pressure is necessary to form a bubble. The French National Centre for Scientific Research and the University of Rennes 1 conducted a study to research the formation of bubbles [Ref 2]. The study determined that the pressure necessary to create a bubble must be great enough to deform the solution into a hemispheric dimple by overcoming the surface tension of a solution. Surface tension can be estimated based on intermolecular forces [Ref 4]:

$$\gamma \approx U / 2a^2$$

γ = Specific Free Energy or Surface Tension
U = Cohesion Energy per Molecule Inside the Liquid
a = Molecule Size
a^2 = Exposed Area of a Molecule

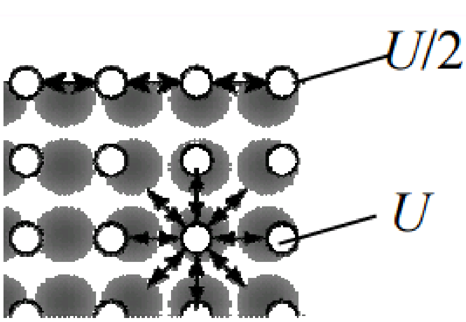

Figure 5: Cohesion Energy – U/2 Energy Shortfall At the Surface [Ref 4]

For a typical soap and water bubble, bursting occurs due to the evaporation of water and gravitational draining of liquid from the bubble walls causing thinning until rupture occurs [Ref 3]. Other polymer based bubble products prevent rupture by resisting evaporation. The polymer hardens after approximately four seconds and without disturbance can last up to ten days [Ref 1]. The Uncle Bubble product was similar and the polymer bubbles hardened and did not rupture upon contact. The striation most likely developed from the force upon contact because the bubble was not fully hardened when landing on the surface. Allowing enough dry time so the bubbles did not deform and shrivel in to a residue was a main challenge of taking the image. Other polymer bubbles which were allowed enough dry time did not exhibit striations.

Photographic Technique

The photographic technique included the following equipment:

-Nikon D3200 Digital SLR with the following settings:

-Aperture: 5.6
-Focal Length: 48.0 mm
-ISO: 1600
-Exposure: 1/100 second

Post-processing in Photoshop included:
-cropping
-editing to remove extraneous items

The original image size is 6016 x 4000 with a resolution of 240 pixels per inch.

Figure 6: Team 2 Project 3 Original – K. Gresh

The final image size is 4288 x 3728 with a resolution of 240 pixels per inch.

Figure 7: Team 2, Project 3 Final Image – K. Gresh

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