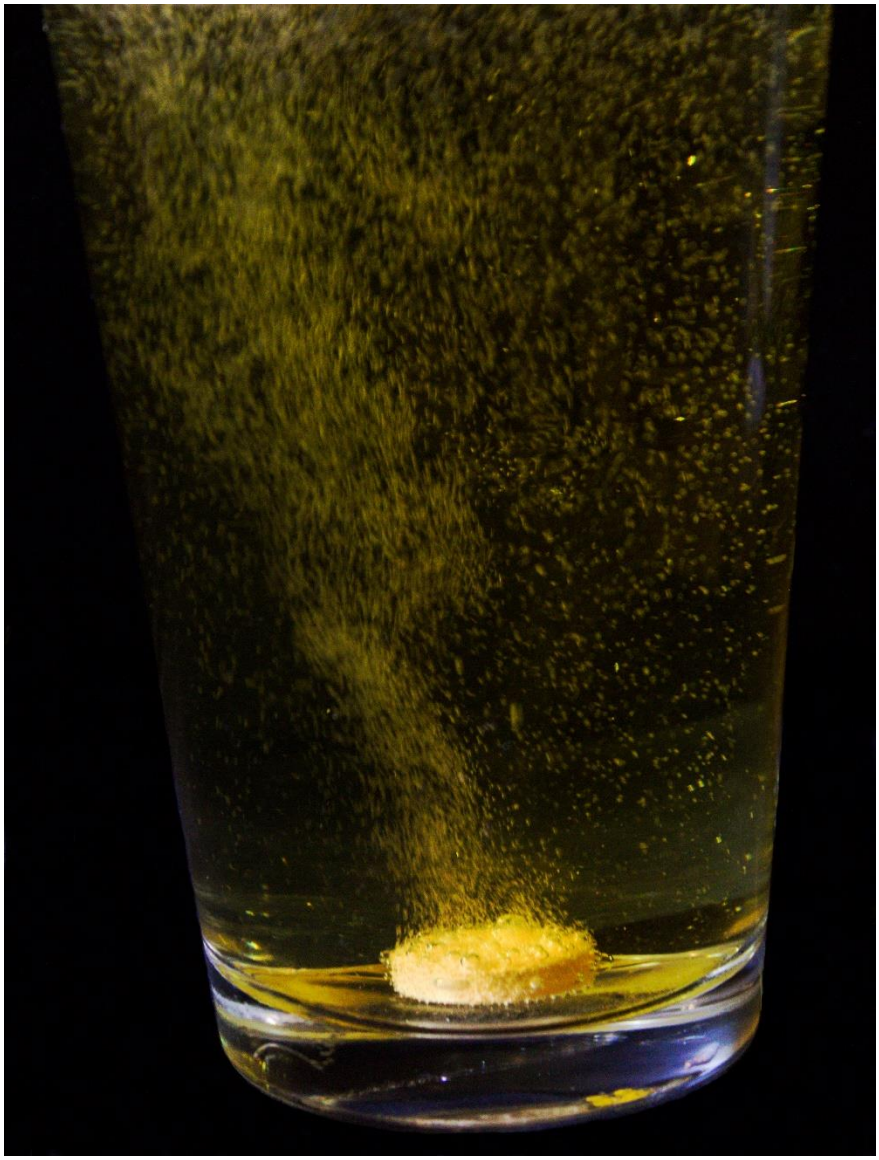

Effects of Dropping a Tum Tablet into Bud Light Lime

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Introduction

The second assignment that our team decided to explore was experimenting with beer, the college kid's favorite beverage. Beer is something that can be found in just about every college fridge. It's common that when your buddy tosses you a beer, it will foam up due to the carbonation contained within. Because of this, I personally decided to experiment with nucleation sites. This is a common occurrence with tablets such as Alka-Seltzer, I decided that I wanted to go a much less aggressive route with a Tum tablet.

Experimental Setup

The experimental setup can be seen in Figure 1. The background for this image was a black mini-refrigerator with a pair of black athletic shorts laid over the hardwood floor. This background was chosen because it provided a clean, matte-black plane that would contrast light yellow of the beer as well as the pink color of the tablet. The background choice ended up not being a super great choice due to the lighting required for the shoot. Because of this, I was required to do a large amount of post-processing to remove the distracting background that

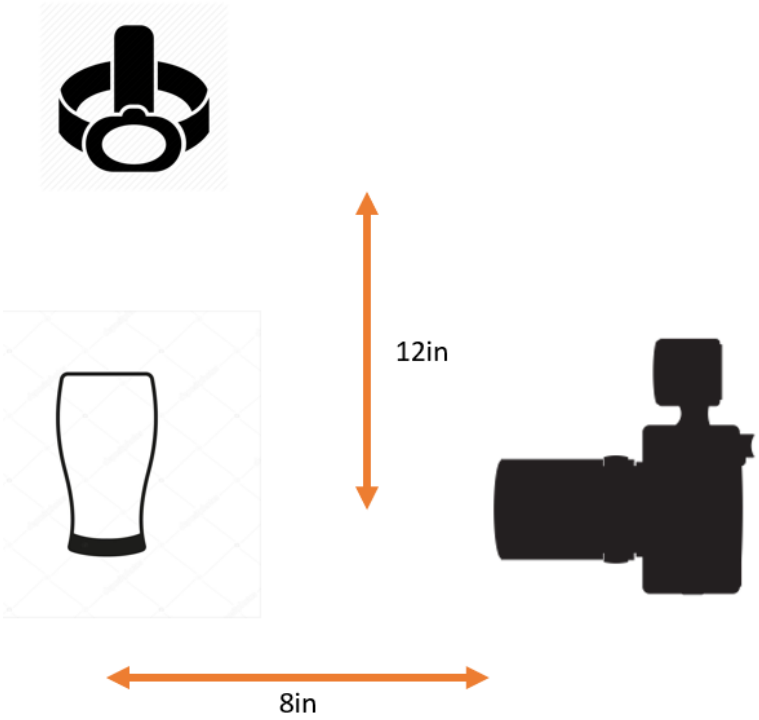

Figure 1: *Experimental Setup*

was captured. I chose to utilize a nice clear pint glass that would allow me to capture the entirety of the experiment. I decided to drop in a Tum tablet instead of an Alka-Seltzer tablet because of color. I was hoping that with the pink color of the Tum, it would provide a good contrast against the rest of the image; however, upon editing this was not the case.

Flow Physics

With help from Professor Hertzberg, we were able to identify some very unique physics within this image. The phenomena that occurs when a porous tablet is dropped into liquid and emits bubbles is called nucleation. During the production of beer, carbon dioxide is naturally produced along with ethyl alcohol as the yeast consumes sugar and additional carbon dioxide is added to keep the beer fresh[1]. Because carbon dioxide is purposefully put into the beer, many glass manufacturers will purposefully "nucleate" their glassware to intentionally allow for nucleation sites to form in specific patterns or in larger bubbles. A nucleation site is a small defect, or divot, that serves as a starting point for the formation of a carbon dioxide bubble. In this specific case, I decided to increase the number of nucleation sites possible by dropping in the Tum tablet. As shown in Figure 2, the divots on the surface of the tablet serve as nucleation sites for the carbon dioxide.

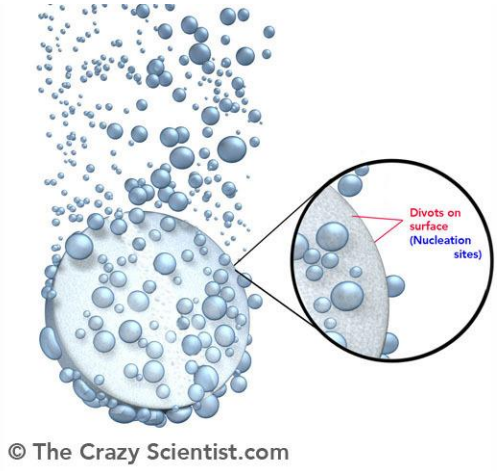

Figure 2: *Nucleation Sites on a Tablet*[2]

[1] "From Beer Bubbles to Nanoparticles: What Is Nucleation?" Sustainable Nano. September 27, 2018. http://sustainable-nano.com/2018/09/27/nucleation/.
[2] Wumanchao. "What Happened to Me When I Ate Diet Coke and Mentos Together???" A Bucket Full of Science. March 18, 2017. https://abucketfullofscience.wordpress.com/2017/03/18/what-happened-to-me-when-i-ate-diet-coke-and-mentos-together/.

The bubbles created by nucleation then would travel up the glass due to the buoyancy of the bubbles in comparison to the surrounding beer. Obviously, the density of Carbon Dioxide, 1.98 kg/m^3, is far less than that of beer, around 1060 kg/m^3. This density difference forces the beer to travel extremely quickly up the center of the glass. Velocity can be estimated using the shutter speed of the camera and the motion blur seen within the bubbles. As shown in the image, the motion blur of the bubbles is approximately 0.5mm. Using the following equation, the velocity of the fluid can be estimated.

$$Blur = v * T$$

where blur is the length of the motion blur captured from the camera, *v* is the velocity of the object and *T* is the shutter speed. Unfortunately, the picture was not completely time resolved, but this will allow us to estimate the bubble velocity. In this case:

$$0.5mm = v * (\frac{1}{50}\ seconds)$$

$$v = 25\frac{mm}{s} = 0.025\frac{m}{s}.$$

Additionally, the bubbles around the edge of the glass began to travel in a downwards direction. This is not captured within the image; however, it is a phenomenon that is extremely common. This is so common that many articles have been written on this, specifically in relation to Guinness beers. In Guinness, it is much easier to see this occurrence due to the contrast of colors against the dark beer background. As the bubbles begin to reach the surface, certain bubbles will not dissolve back into the liquid and the weight of the bubbles will bring the bubbles back to the bottom of the bottle[3].

Photographic Technique & Post Processing

The camera that was used to take this photograph was a Canon EOS Rebel T6. This experiment required a decently quick shutter speed (although I should have increased this), for this experiment I used a shutter speed of 1/50sec. Because this shoot was conducted inside, direct sunlight was not an option. To effectively light the fluid and tablet, I utilized a Black

[3] "RSC Press Release: Mystery of Downwards Guinness Bubbles Solved in Time for St Patrick's Day." Royal Society of Chemistry - Advancing Excellence in the Chemical Sciences. http://www.rsc.org/AboutUs/News/PressReleases/2010/GuinnessBubbles.asp.

Diamond hiking headlamp. This was positioned above the pint glass as seen in Figure 1. The ISO was increased to 1600 to obtain a bright image that wasn't grainy. The camera settings used were as follows:

Photo Dimensions	5184 x 3456 Pixels
ISO Speed	ISO - 1600
F-Stop	f / 5
Exposure Time	1 / 50 sec
Flash Mode	No Flash
Focal Length	45 mm

Table 1: *Camera Settings*

I was not pleased with the outcome of the raw image; however, I knew that I could make this image much better through post-processing. I preformed my post-capture editing through Gimp. Figure 2 shows the progression through the editing process. As seen in the raw image, the color contrast was extremely poor, and the background was extremely distracting. To resolve the issue of the distracting background, I utilized the clone stamp tool to paint around the glass in a dark black color. The image was then color corrected to drop out the dark pixels to a pure black and generate a much better contrast within the image. Finally, the image was cropped to focus on more of the subject of the picture.

Figure 3: *Image progression after editing. Raw file is shown on the left, final edited photo on the right.*

Note that in Figure 3, the raw file contains distracting elements at the top of the pint glass as well as around the glass. I utilized my editing skills to reduce the number of distracting elements in the image.

Visualization Technique

This image required no visualization techniques.

Results

Ultimately this image did not come out exactly how I was hoping it would. The contrast in the image was quite minimal. Additionally, the background of this image was extremely poor, because of this, a large amount of post-process editing was required. To capture a better image in the future, I would like to use a darker beer that allows the contrast of the bubbles to be seen much easier. Finally, the time resolution of this image was not great, I would like to increase the shutter speed next time to capture the bubbles better.