Mechanical Engineering
University of Colorado Boulder

Team Third Report

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1 Background

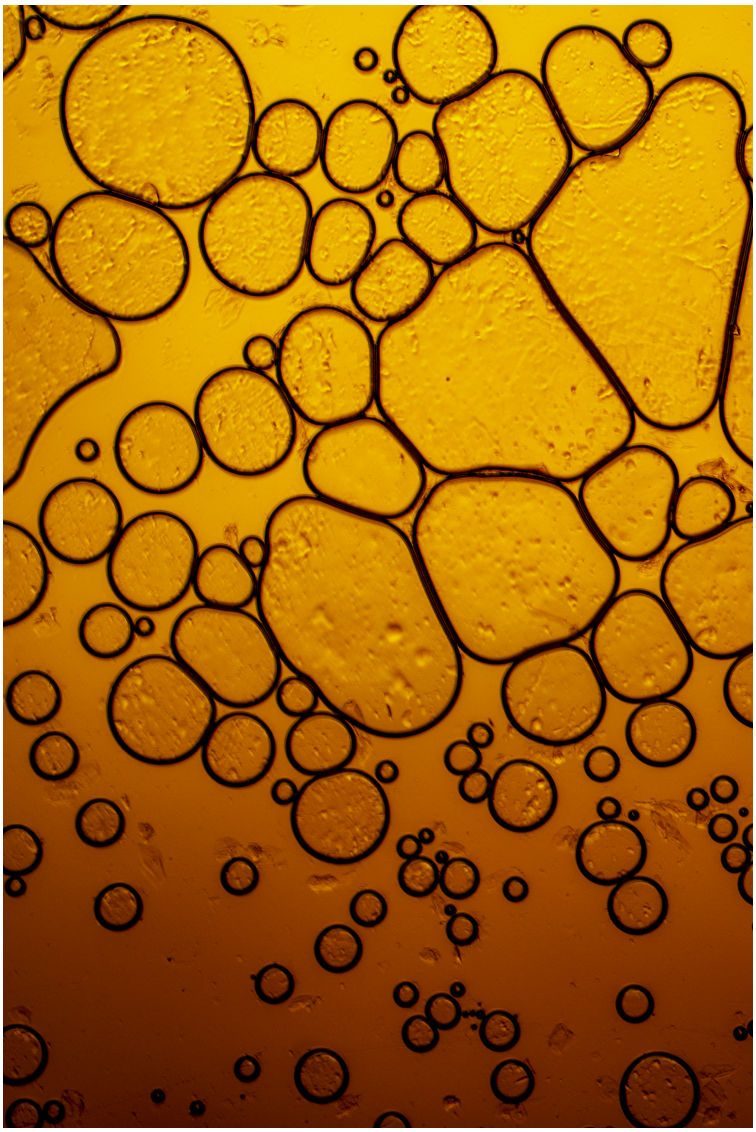

Figure 1: Team Third Submission.

The figure above is the final image that I submitted for the Team Third Assignment. My team wanted to capture coffee when viewed under a microscope. Aaron Zetley is taking a class titled Design of Coffee. He was able to arrange for our team to use the Olympus BX60 Compound Microscope in Prof. Borden's lab. We made regular black coffee and captured various images at different magnifications. The image I choose for this assignment was my favorite out of all the images we took. I liked the detail of the boundary layers and the coffee particles. My team for this project consisted of Aaron, Evan, Robbie, and Max.

2 Flow Apparatus and Flow Description

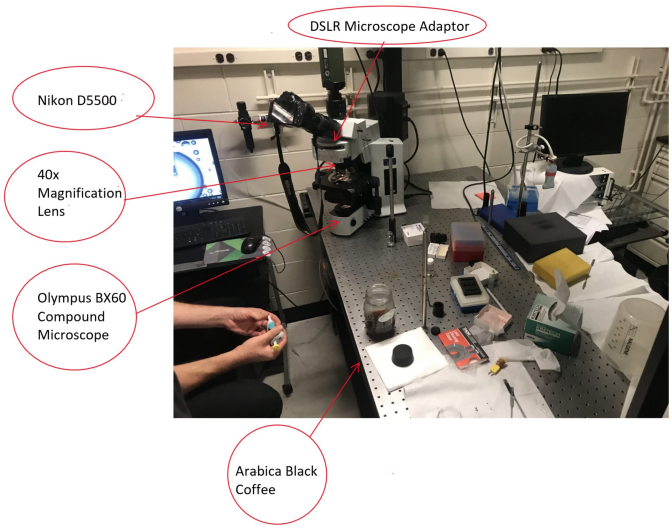

Figure 2: Flow apparatus.

In figure 2 you can find the exact set-up with which my image was captured. We used a Olympus BX60 Compound Microscope from Prof. Borden's lab. We also had to buy an adapter for the camera that attached directly to the lens of the microscope. We brewed fresh Arabica ground coffee minutes before this image was taken. The image was taken with a 40x magnification lens.

Coffee, in the form of a bean, grows inside the cherry of a coffee tree. The cherry growing in a tree has over 45 million individual cells[1]. When the bean is removed and dried, the tiny holes that are seen at a microscopic level are the remnants of what used to be a living cell. In figure 3 we can see a dried coffee bean that has been magnified 750x with a electron microscope. In it we can see the holes left behind by living cells.

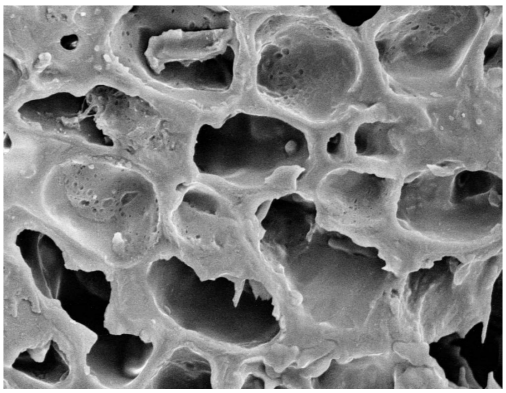

Figure 3: Dried coffee bean magnified 750x.[1]

After the bean has dried, the beans are then roasted. This is the process that gives the coffee bean its typical brown color that we see in our favorite stores and cafes. The process of roasting the bean fills the cells with CO2 gas and expands. Trapped within the walls of each cells are solubles. Solubles are substances in the coffee that can be dissolved with water. Figure 4 shows the four main categories of solubles found in a coffee bean. When water enters the bean's cells, it dissolves the solubles. This blend of solubles dissolved in water is what we know as coffee.

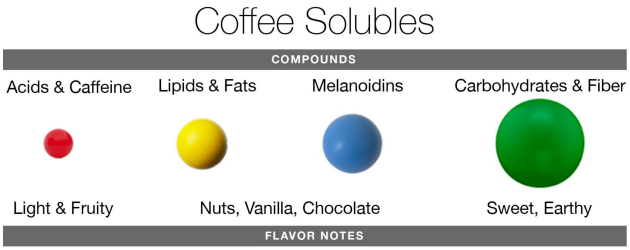

Figure 4: Coffee solubles.[1]

The image I captured for this assignment shows the solution of solubles dissolved in water. The circular blobs in the image are lipids. Lipids are natural fats and oils found in a coffee bean[1]. The oils are immiscible in water. We can see clear boundaries separating the two viscous fluids (oil and water). The water is everything but the circular blobs of oil. Moreover, we can also see crystals floating inside the oil and the water. These crystals are caffeine in pure form–caffeine crystals are white as pure crystals[2].

3 Photographic Technique

Table 1: Camera Properties

Property	Value
Camera Maker	Nikon
Camera Model	D5500
ISO-speed	ISO-400
F-stop	f/0
Exposure time	1/200 sec.
Flash	No flash

The field of view is 6014 x 4016 pixels. Table 1 breaks down all the properties that I used to capture this image.

Furthermore, I used photoshop to edit my image. The first change I made was to rotate the image counter-clockwise by 90 degrees. Then, I increased the contrast of the image by

manually changing the curve in the curves tool. I did this so that the molecules stood out more and so that the color gradient was more pronounced.

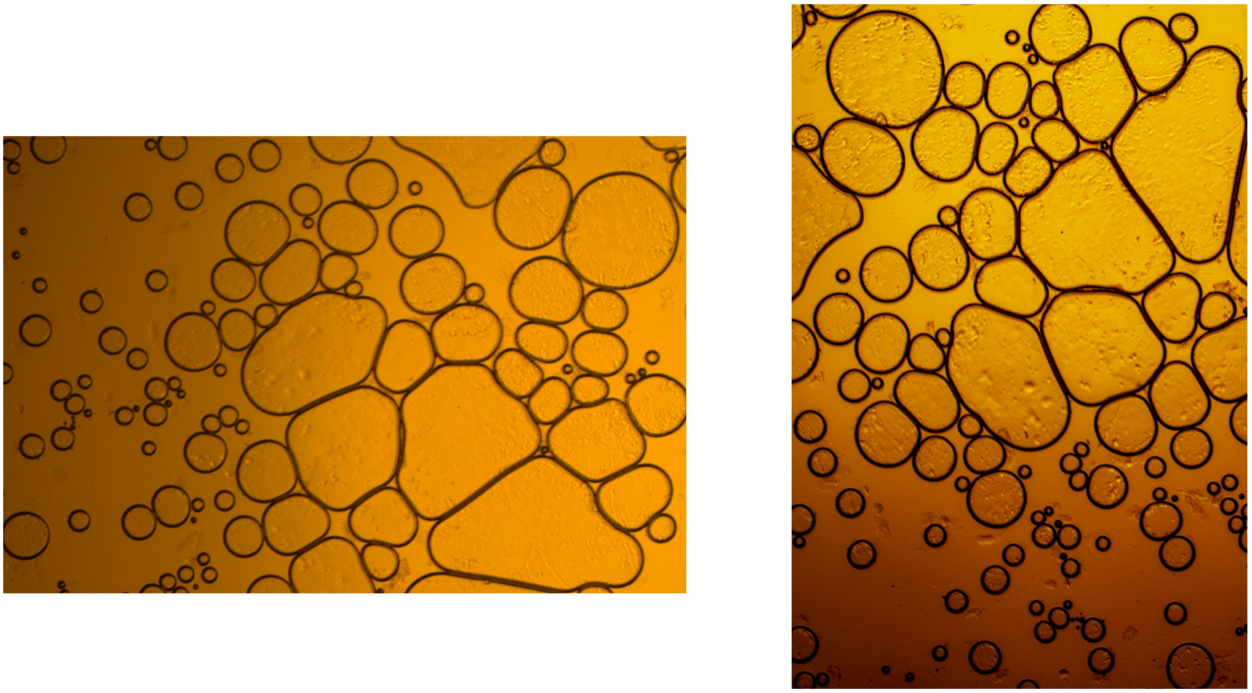

Figure 5: Original (left) and post-processed (right) image.

4 Conclusion

In conclusion, the image I submitted shows the fluid behavior of a coffee solution. I am pleased with this image because it captures micro-level behavior of a common fluid and it magnifies the beauty within. My intention was to explore a phenomenon that was unfamiliar. I achieved my intention with this image and I am motivated to continue my exploration of microscopic world of fluids. This course has given me the tools to continue exploring the physics of the world around me with added eye and appreciation for the beauty.

References

[1] Team Handground. *An Intuitive Guide To Coffee Solubles, Extraction And TDS*. Aug. 2016. URL: https://handground.com/grind/an-intuitive-guide-to-coffee-solubles-extraction-and-tds.

[2] Dave Mosher. *Crusty, dried-up coffee looks beautiful under a microscope*. Oct. 2016. URL: https://www.businessinsider.com/coffee-caffeine-crystals-microscopic-2016-10.