Austin Ruppert
Flow Visualization Project #4
Flower

For the third project I decided to image a Colorado Columbine flower. The plant tag is shown below.

Figure 1: Columbine Plant Tag

To image the flower we went to Mcguckin's nursery section at 2525 Arapahoe Ave # D1 Boulder, CO 80302. We took a small water bottle to create a mist on the plants but there was a little rain all morning so it wasn't needed for most shots. An image of the rain on the leaves of a Lupinus plant is shown below.

Figure 2 – Light Rain on Leaves

We were attempting to photograph the natural superhydrophobic properties demonstrated by some species of plants. The diversity of plant surface structures, evolved over 460 million years, has led to a large variety of highly adapted functional structures. The plant cuticle provides structural and chemical modifications for surface wetting, ranging from superhydrophilic to superhydrophobic features. The epicuticular waxes play an important role in surface structuring (1). An example of the cross-sectional layering of the plant surface is shown below

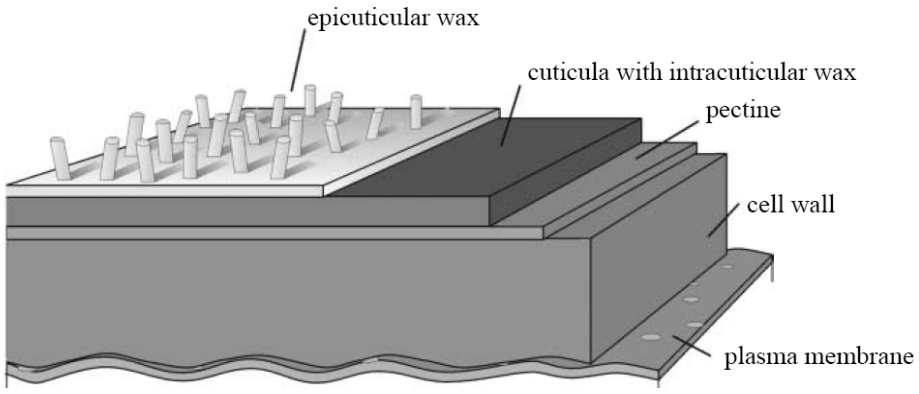

Figure 3: Epicuticular Wax Layer

These epicuticular waxes are sometimes visible as most readers will be familiar with as a white or bluish coloration of leaves and fruits, such as grapes and plums. Several reviews have addressed the chemical composition of plant waxes (2). The contact angle composition of plant waxes is highly variable among plant species but resemble the SEM micrograph below which shows the cell surface structuring created by epicuticular waxes

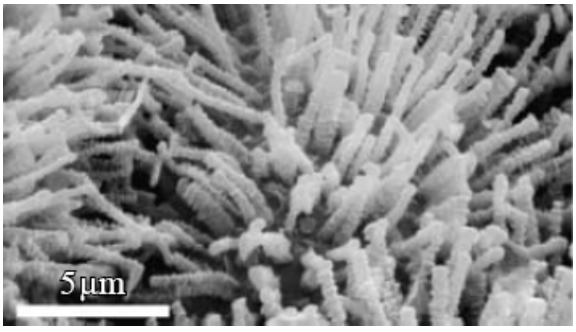

Figure 4: transversely ridged rodlets on a leaf of Sassafras albidu (XXX)

The contact angle measurement is the main method for the characterization of the wettability of surfaces, and the contact angle is the unit for the surface wettability. According to researchers (1)

"The contact angle of a liquid on a surface depends on the surface tension (molecular forces) of the involved liquid, the solid surface and the surrounding vapor. Thus, wetting depends on the ratio between the energy necessary for the enlargement of the surface and the gain of energy due to The wetting behavior of solid surfaces contact angle n be divided into four classes, defined by their static contact angle ".

A superhydrophobic surface has a static contact angle of more than 150 degrees. We conducted a quick experiment with our Columbine leaf to determine the contact angle as shown below

Figure 5: our contact angle image

We determine the contact angle to be around 140 degrees so just below the threshold for superhydrophobic properties but still very hydrophobic. The image I decided to use is shown below

Figure 6: Captured Columbine Image

All photographs were taken using an Olympus FE-370 8.0 megapixel digital camera. This camera has a focal length range of 6.3-31.5mm and an aperture range of 1:3.5-5.6. All photographs utilized the camera's "indoor" setting in conjunction with the "super macro" setting with the flash disabled.

:ColorSpace: 1
:ComponentsConfiguration (seq container)
:CompressedBitsPerPixel: 8/1
:PixelXDimension: 2304
:PixelYDimension: 3072
:DateTimeOriginal: 2009-04-25T10:43:17-06:00
:DateTimeDigitized: 2009-04-25T10:43:17-06:00
:ExposureTime: 10/500
:FNumber: 28/10
:ExposureProgram: 2
:ISOSpeedRatings (seq container)
:ExposureBiasValue: 0/10
:MaxApertureValue: 48/16
:MeteringMode: 5
:LightSource: 0
:Flash
:FocalLength: 79/10
:FileSource: 3
:SceneType: 1
:CustomRendered: 0
:ExposureMode: 0
:WhiteBalance: 0
:SceneCaptureType: 0
:Contrast: 0
:Saturation: 0

Figure 7: Image information

Bibliography

1. *Superhydrophobic and superhydrophilic plant surfaces: an inspiration for biomimetic materials.* **Koch, Kerstin.** s.l. : The Royal Society, 2009, Vols. 367, 1487-1509. 10.1098/rsta.2009.0022.

2. *1975 Ultrastructure and recrystallization of plant epicuticular waxes.* **Jeffree, C. E., Baker, E. A. & Holloway .** s.l. : New Phytol, Vol. 75, pp. 539–549. (doi:10.1111/j.1469-8137.1975.tb01417.x).