



# Unveiling the Mysteries of Chemical Gardens: Bubble Formation and Gas Composition

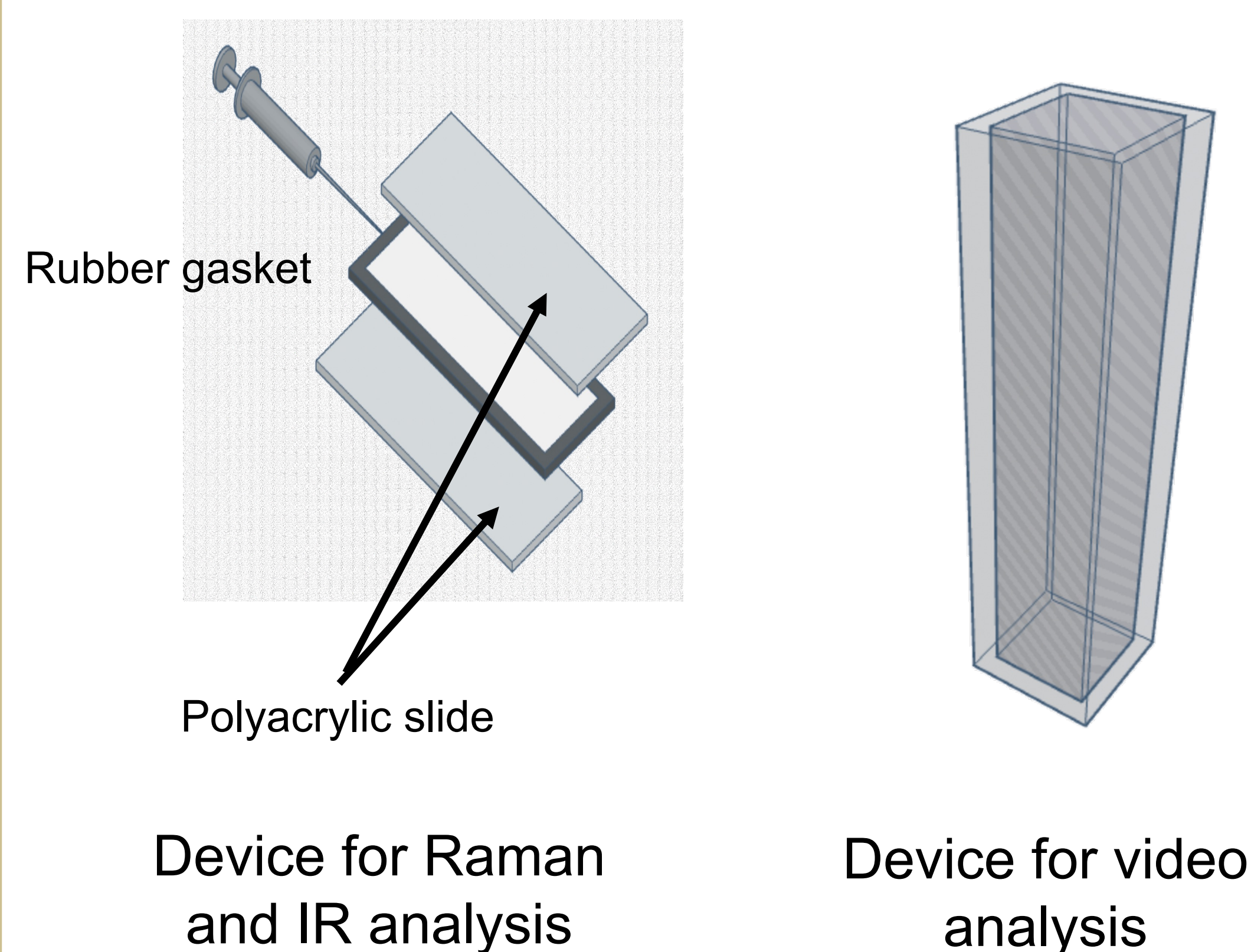


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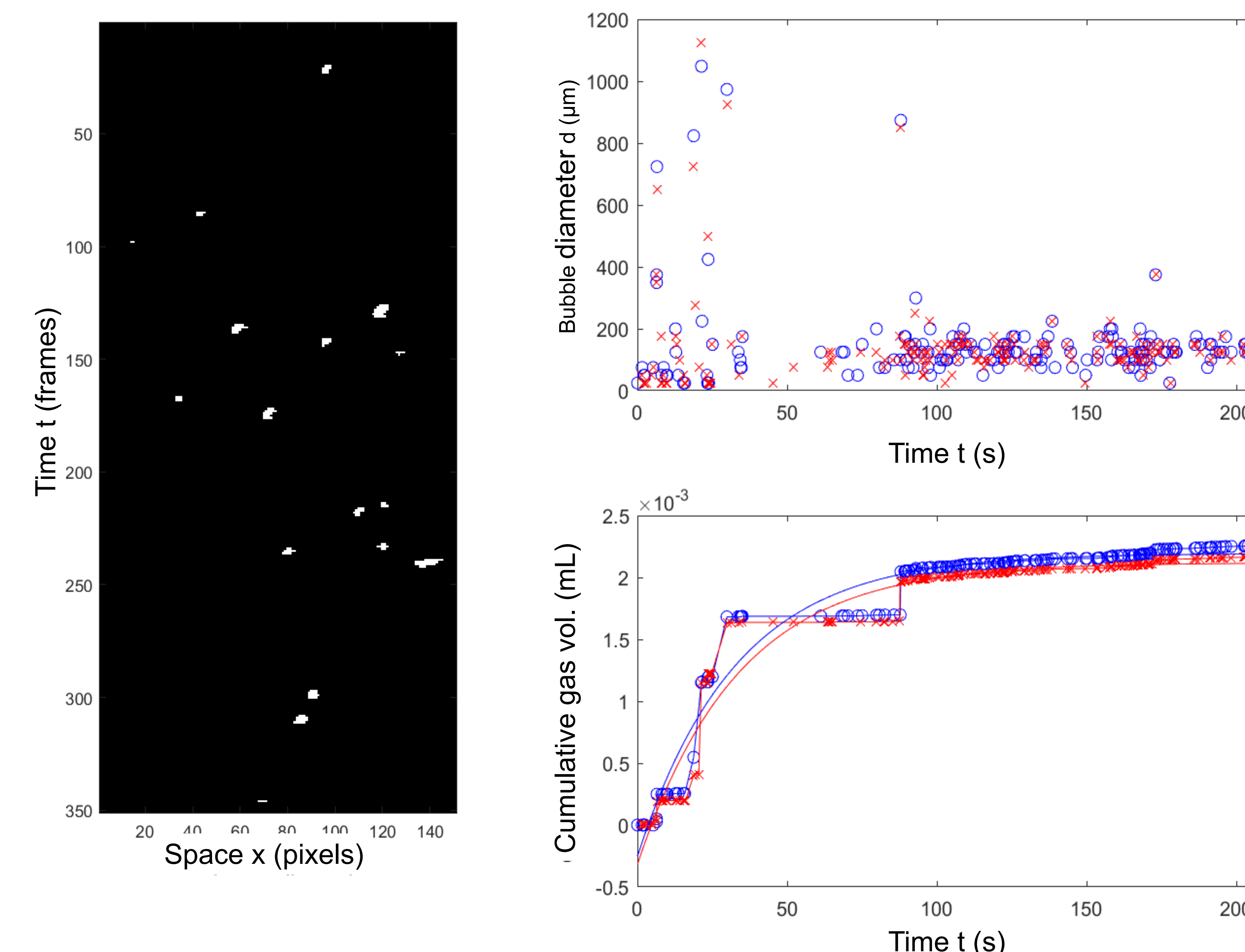
## Abstract

Chemical gardens are precipitate structures formed when a metal salt seed is placed into a sodium silicate solution. Often, the tube is guided by a bubble. Our studies focus on analyzing the gas bubble's composition through spectroscopy and optical analysis. The natural formation of chemical gardens can be seen in the deep ocean, an environment with ample dissolved  $\text{CO}_2$ . The addition of the metal salt seed acidifies the basic sodium silicate solution, lowering the solubility of  $\text{CO}_2$ , and forcing the gaseous  $\text{CO}_2$  out of the solution in the form of bubbles. Combining the silicate solution with a carbonate source can lead to a potential increase in total  $\text{CO}_2$  released during precipitation.

## Methods

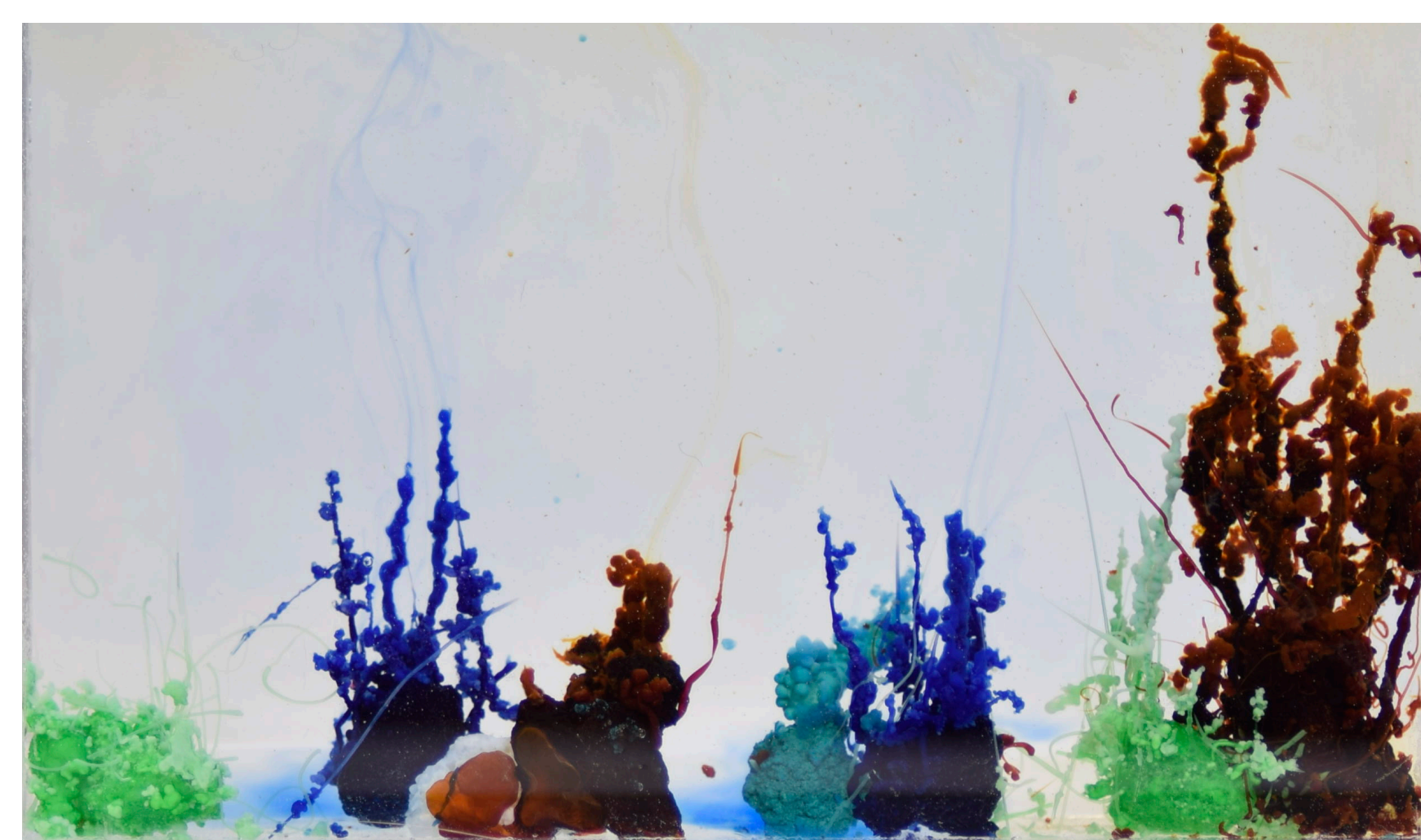


## Analysis

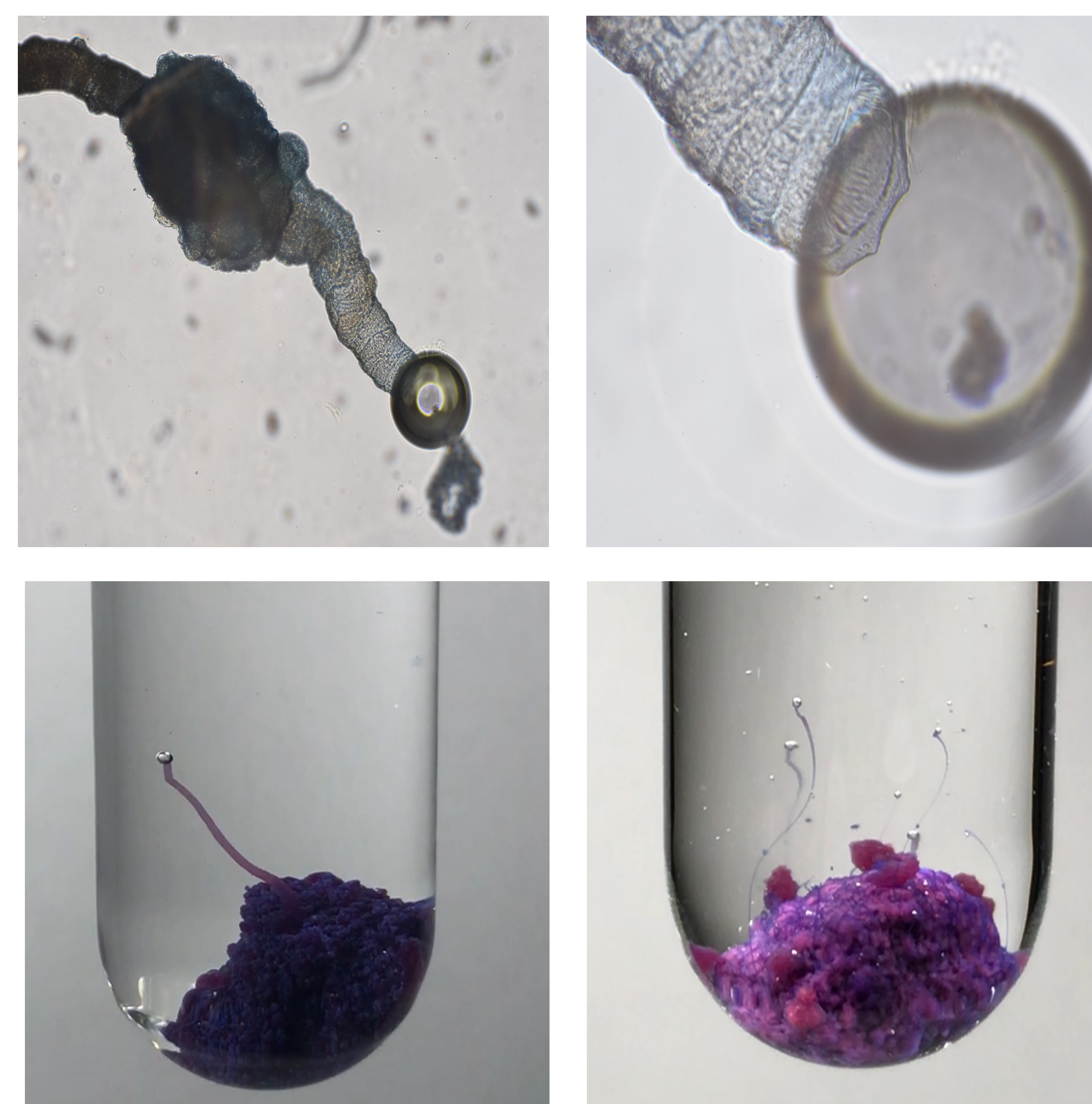


## Chemical Gardens

When a metal salt is introduced to a solution of  $\text{Na}_2\text{SiO}_3$ , a semipermeable membrane is formed around the seed. This membrane is created as the metal salt reacts with the  $\text{Na}_2\text{SiO}_3$ , resulting in the formation of a gel-like material that surrounds the seed. A concentration gradient is then formed between the inside and outside of the membrane. This pressure causes the solution inside the seed to burst out, driven by osmotic pressure. As the solution inside the seed bursts out, the metal ions that were previously dissolved in the  $\text{Na}_2\text{SiO}_3$  precipitates once they are introduced to the external solution.



## Bubble Leading Growth



## Future Work

In order to determine the composition of the gas bubble, we will purge our future solution with nitrogen gas. This allows us to eliminate the possibility of the bubble being dissolved  $\text{CO}_2$  from the original solution. Gas chromatography and FT-IR will be used to further characterize bubble composition.

## References

Barge, L. M., et al. *Chemical Reviews*, 2015, 115, 8652–8703.  
Nathan S. Jacobson, et al. *ACS Earth and Space Chemistry* 2020, 4, 2113-2120.