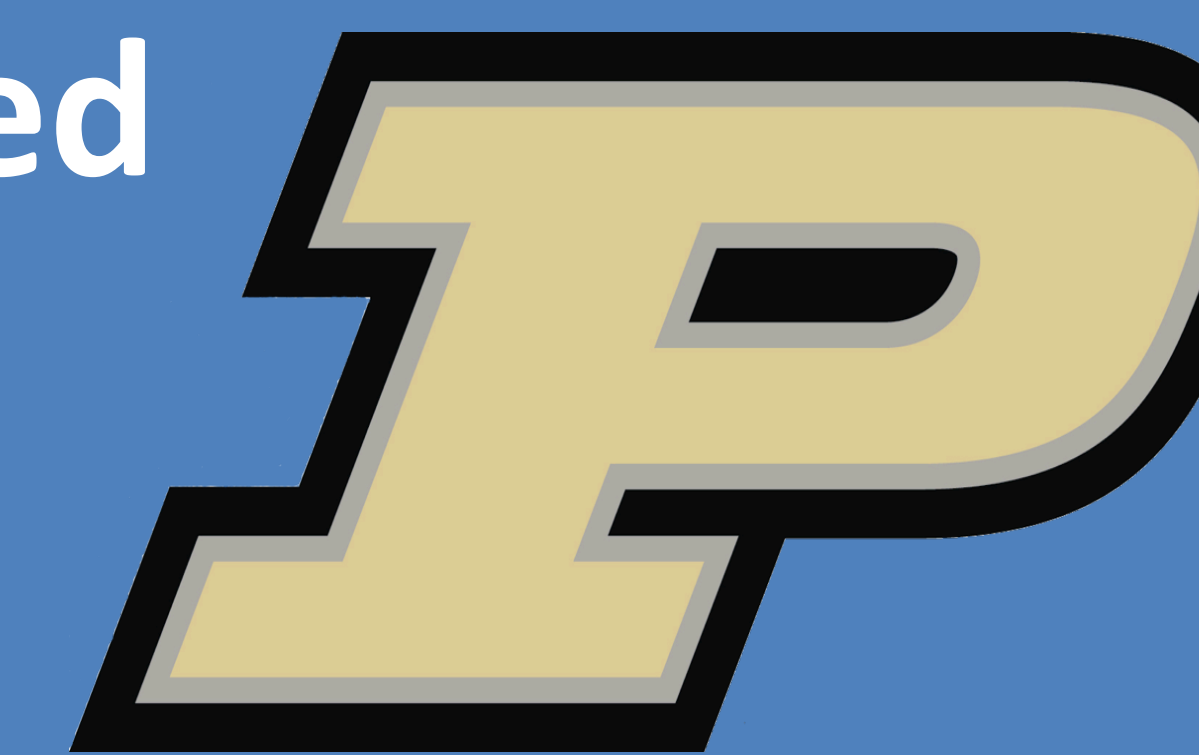


# Self Assembly of a Hexagonal Non-Close Packed Array at a Liquid-Liquid Interface

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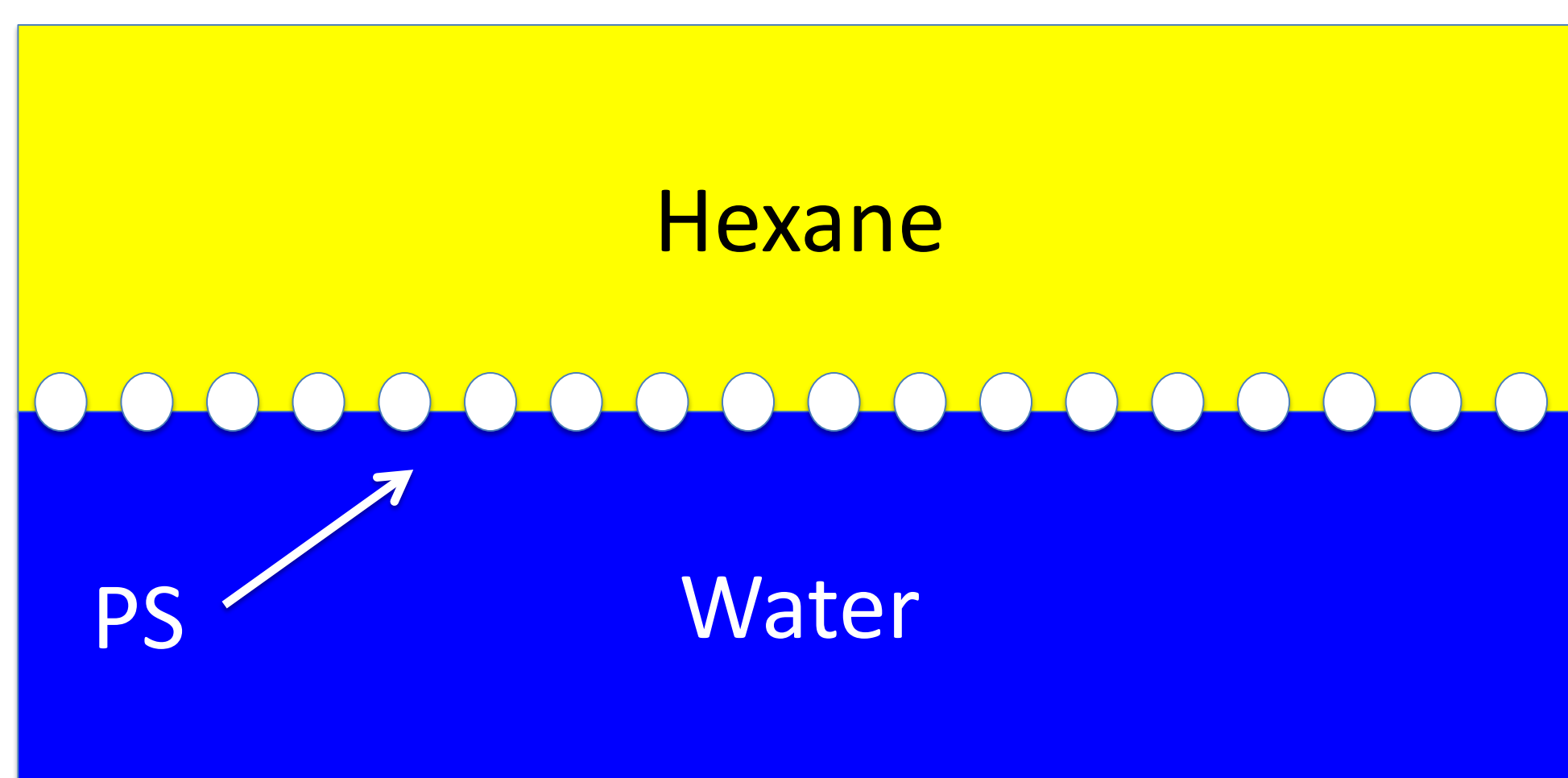


## A More Efficient Solar Panel

Thin film solar panels are cheaper to make, but they sacrifice light absorption efficiency.<sup>1</sup> Recent studies have shown that coating thin solar panels with metal nanoparticles can decrease this effect, making it an attractive option for decreasing the cost of solar energy.<sup>1</sup> One of the biggest challenges in this area is the precision with which the nanoparticles must be positioned. Great control over position and spacing is necessary to maximize the usefulness of the nanoparticles.<sup>1</sup> Methods have been developed to do this but are either expensive or difficult to do on a large scale.<sup>1</sup> This project sought to develop a simple method for arranging particles precisely<sup>2,3</sup> and apply it to metal particles.

## Particle Pattern Self-Assembly

Hexagonal non-close packed (HNCP) arrays of micrometer-sized amidine polystyrene (PS) beads as large as 15 cm<sup>2</sup> were formed at a water-hexane interface, and particle spacing could be roughly tuned by adjusting the number of particles used. Methods for depositing the particles onto a substrate were also investigated.



A side view of an array at an interface

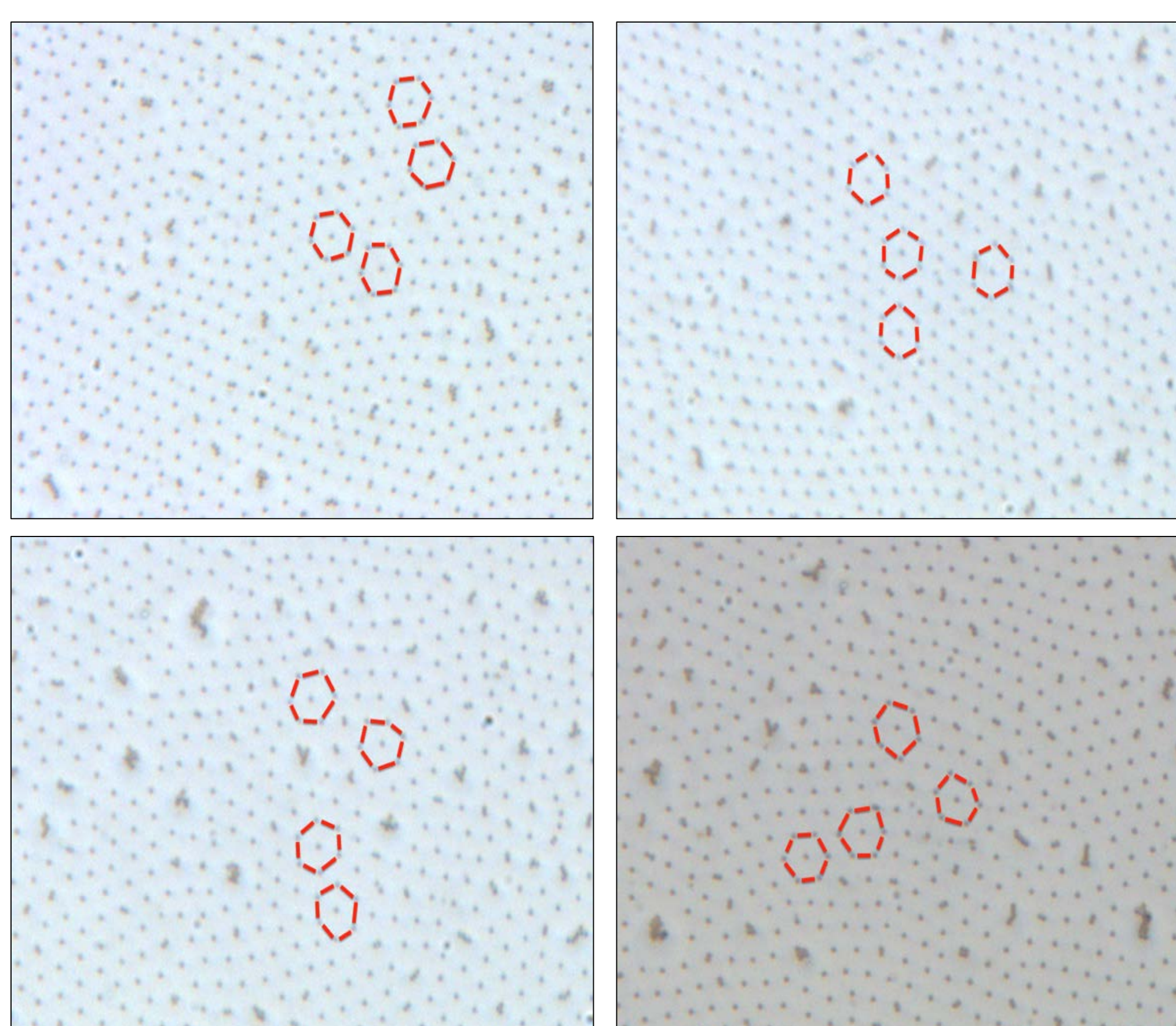
## Array Creation

Several factors were tested to determine the optimal method for creating the array. The following conditions resulted in the best pattern:

- Using hexane for the oil phase
- Injecting the particles at the water-air interface and then adding the hexane at an oblique angle to the interface
- Using amidine PS rather than sulfate PS particles
- Adding a small amount (.1 mM) of SDS to the water phase
- Using methanol as the solvent for the PS suspension

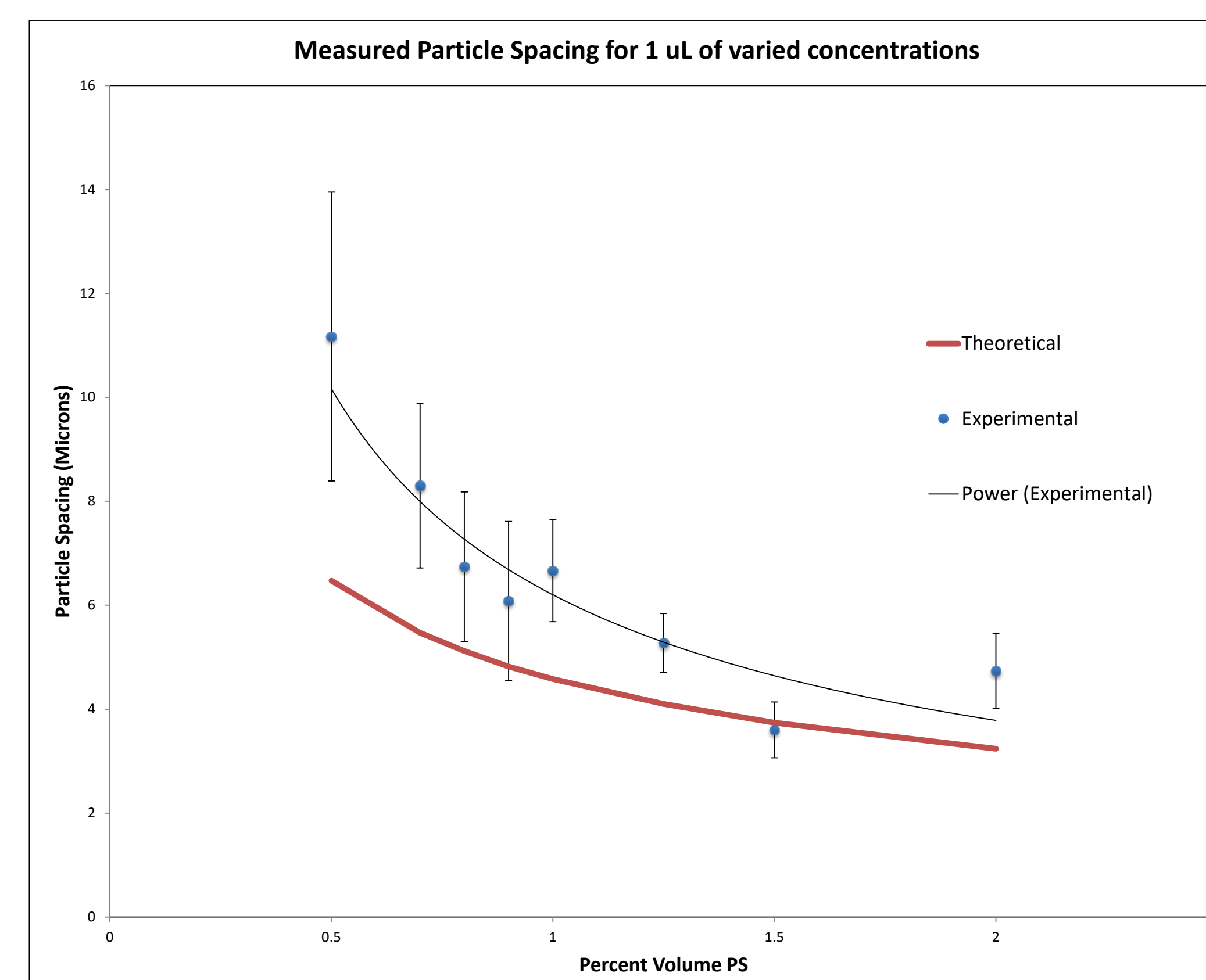
Under these conditions, a HNCP array with few flaws could consistently be formed

## Particles in an Array



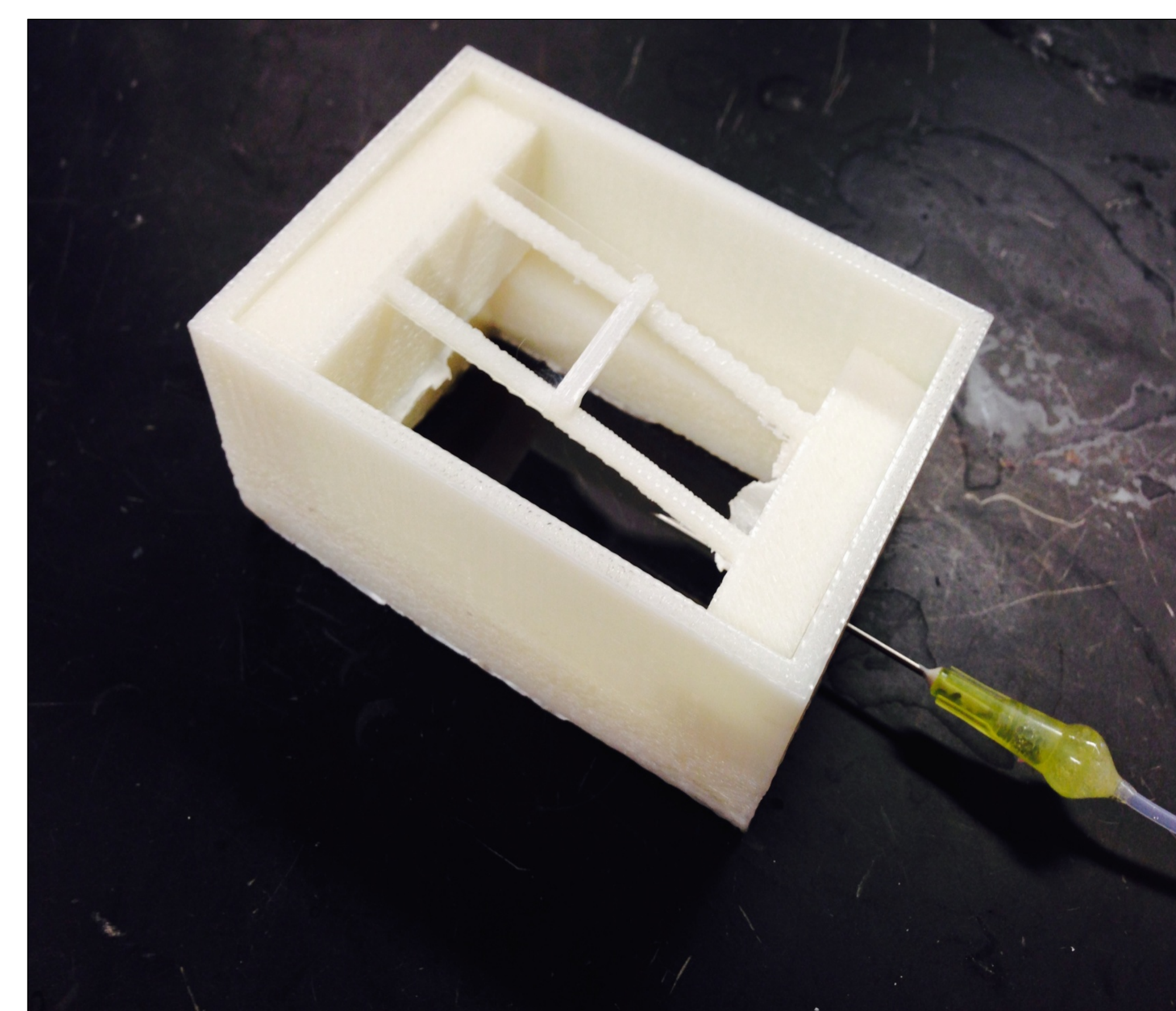
These photos taken under 40X magnification at various locations on a 15 cm<sup>2</sup> interface. The spreading of the particles was fairly uniform across the interface.

## Particle Spacing Control



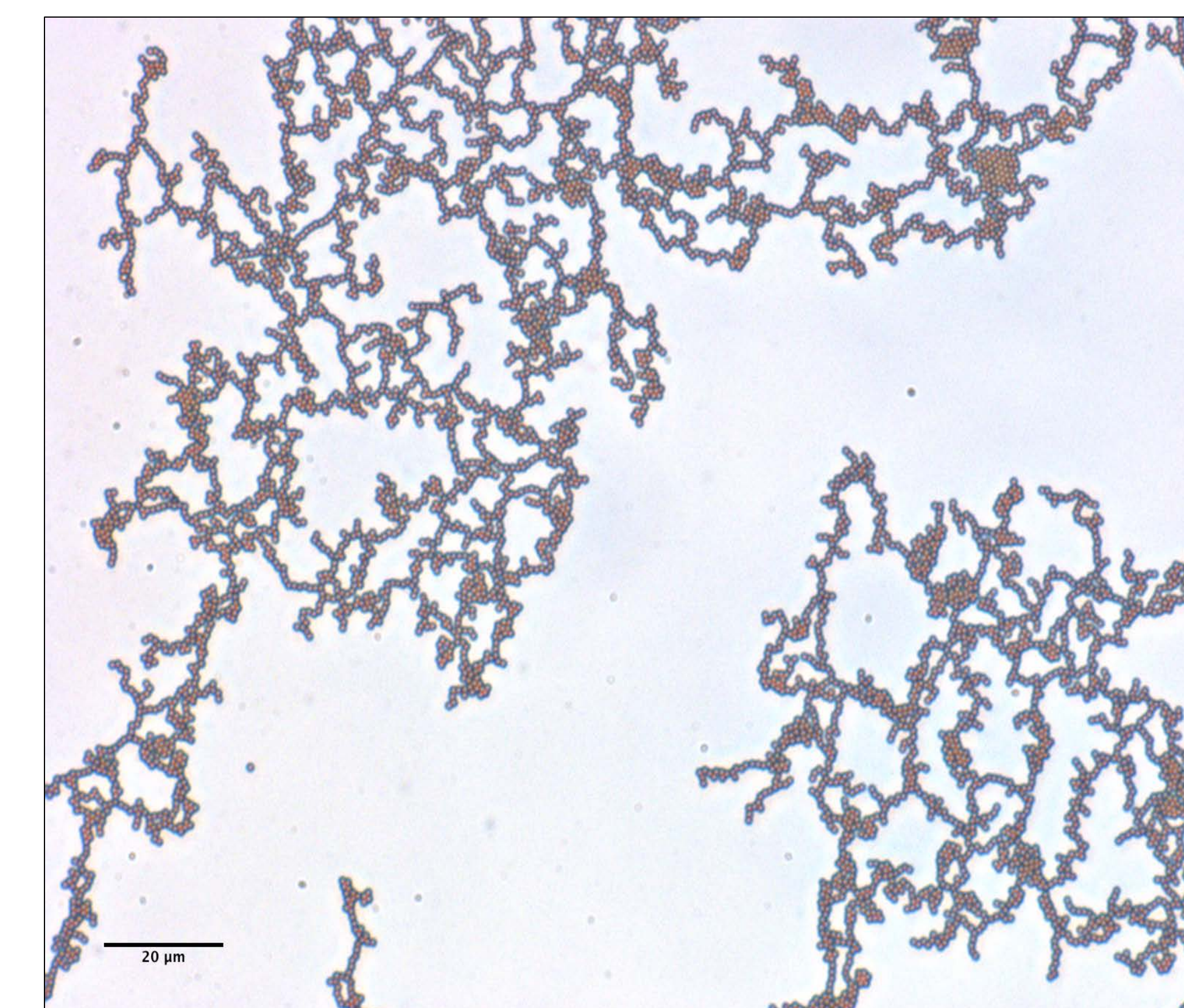
Experimental results showed that while the measured particle spacing did not match predictions, they followed the same general trend. In this way, particle spacing could be roughly tuned.

## Deposition on Substrates



One of the setups used to deposit particles on substrates. The needle inserted through a hole in the side of the container is attached to a syringe pump used to withdraw water and lower the interface onto the cover slip being used as the substrate. The parts were made via 3D printing.

## Particles on Substrate



Particles deposited on a PSS coated glass substrate. The particles were deposited by lifting the substrate a rate of 10 μm/s using an apparatus powered by a syringe pump.

## Next Steps

In this project, we have demonstrated the feasibility of creating an ordered array of micrometer-sized particles over a large surface area and have begun to develop a method to deposit the particles onto a substrate. Future goals are as follows:

- Increase pattern longevity of the arrays at the water-oil interface
- Perfect the substrate deposition process
- Switch from polystyrene particles to metal nanoparticles

The method presented here is versatile and simple. In theory, the self-assembly process can be applied to any charged particle. Additionally, the simplicity should aid in making this process industrially scalable.