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CH293

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Dr. Lockyear

Microfluidic Technologies Term Paper

**Introduction**

In the fall semester, I read academic journals and wrote an overall literature review on the entire scope of microfluidic technologies. With the necessary background information on this topic, I was then able to apply the knowledge I’ve gained into practice and experiments I will provide later in this paper.

**Prepping the Chip**

Prepping the chip requires the chip to be cleaned accordingly. With glass chips, a mixture of 1M of Sodium Hydroxide (NaOH), water, and 2.5mM of pH 9.2 Borate Buffer will successfully clean the chip. After cleaning the exterior of the chip, we then added water to the substrates and used a microscope to see the intersection and bubbles. Using a vacuum, we were able to eliminate the bubbles from the substrates inside the glass chip. With the PDMS chip, however, instead of using NaOH, we used 91% Isopropyl alcohol (IPA), water, and the same Borate buffer. Furthermore, instead of the glass chip where we inserted water into the substrates, we filled the substrates with IPA. However, I couldn’t see the channels with the microscope and the syringe was very difficult to use.

**Prepping the Capillary**

By learning the entire scope of microfluidic technologies, I recognized there are several ways to detect particles. Initially, when I had to prep and clean the chips as mentioned prior, that was a specific way to perform such endeavor. However, as I quickly learned, in research, anything can change; therefore, we had to figure out a new approach to detect particles: capillary electrophoresis. First, I had to prep the capillary. I inserted the capillary in the coiled wire, as seen in Figure 1. Then I gradually increased the power stat supply. As the power stat supply increases, I had to rotate the capillary to burn the polyimide that was coating the capillary—by doing this, we are able to see through the capillary. After the polyimide is burned off (which we can tell by the stickiness and discoloration) I turned off the power stat, remove the capillary from the coiled wire, and wiped the capillary off with IPA.



**Figure 1**

After successfully preparing the capillary, I learned how to prepare the slides. The slides were cleaned with water, and glue was added on each side of the slide so that the capillary would stay on the slide, provided by Figure 2.

**Figure 2**

**Preparation of Particle Solutions**

The particle used in the solution was Nucleosil 712650 300-5C8 Batch 26500011. This particular version is 5 microns wide in diameter, which means it can easily go through our capillary without avoiding any clogging. In our particular solution, I measured out .0094 grams of the Nucleosil since we needed less than .01 grams of the solid. Afterward, I added 1mL of IPA, then swished the mixture. Then, using a Class A volumetric pipette that was cleaned with IPA beforehand, I added 9 more mL of IPA. Now, this is our pure solution, so I had to make diluted solutions from this vile. How I did that was I extracted 1mL from the pure solution using a 100 microliter pipeter, and added it to 9mL of IPA. I repeated this step four times, however, with every repeated step, instead of going off of the pure solution, I extracted 1mL away from the diluted solution that preceded it. In short, each new vile was ten times more diluted than the precedent. After the solutions were made, I added a smidge of dodecyl sulfate (surfactant) [Aldrich Chem. Co., Milw., WI] in the diluted solutions; this keeps the solution from aggregating. After adding the surfactant we put the diluted solutions in the FS20H bath to help dissolve the surfactant since it is not soluble in water.

**Instrumentation**

In our research facility, we have a hand-made instrument that is used to detect the particles. The instrument consists of a voltage box, amplifier, photo multiplier tube (PMT), laser, the single-point laser apparatus, and the computer (The Lab View software program) which detects the particles. This instrument is used to detect Mie Scattering, which is the scattering of large particles with a large index of refraction. By hitting the capillary at a shallow angle (as placed on the single-point laser apparatus), Mie Scattering can occur.

**Application of Capillary on Laser Apparatus**

First, I used the vortex mixer to mix the particle solutions. Then, I taped the prepared capillary (that has been glued on the slide), and placed it on the microscope. Placing one end of the capillary in IPA and surfactant solution (pure solution) and suction syringe on the other, we were able to clean the capillary. The value of this step is that the IPA will eliminate whatever is in the capillary, whether it is any dust particles, bubbles, or any other form of particles. Evidence of solution passing through capillary was seen via microscope.

**Experimentation**

To begin, unlike cleaning the capillary where it requires the pure solution on one end of the capillary, we used the most diluted solution. Through several trials, we could not see any particles passing through the capillary. We noticed the lens on the microscope were dirty, so we ran the same experiment through the laser. With the same results, that is, no evidence of particles going through the capillary, we suggested to rearrange the laser apparatus to try to get Raleigh Scattering—laser is hitting the capillary at a steeper angle, in comparison to Mie Scattering—instead of Mie Scattering.

After rearranging the laser apparatus and taking the PMT apart, we unfortunately discovered there was a sticker blocking the opening of the PMT, which is why we could not ever get evidence of particle separation.

The following week, we put back the Dichroic in the optical train. The function of the Dichroic is to see the capillary image as well as optimizing the pre amp. We moved the stand with the optic mirror closer to the station so that we could get a better image. The capillary at this point was positioned at a different angle—since we attempted Raleigh Scattering—so we moved it back to its original position. Dr. Lockyear changed the sensitivity and filter frequency, which showed a successful lining of the image of the capillary to the PMT. After the rearranging, we applied amino acid and the same borate buffer solution into the capillary. We got a signal from the amino acid and Borate buffer solution at .901V.

From the signal notification we received, we decided to put an Fluorescein Isothiocyanate (FITC) amino acid and buffer solution into one end of the capillary, and while we are suctioning the other end, we took it out and replaced it with pure buffer solution to try to see a peak on the data collection; the peak will come from the bubbles from the removal of the FITC and buffer solution and insertion of pure buffer solution. The settings on the pre amp is as follows:

|  |  |
| --- | --- |
| Settings on Pre Amp | |
| Bias Voltage | POS, ON |
| Filter Type | Lowpass 128dB |
| Input Offset | POS, ON 2, X10, nA |
| Filter Fequency | 30 Hz |
| Gain Mode | Low Drift |
| Sensitivity | 5, X10, μA/V |
| Invert | Invert |
| Power | Line |

The evidence of bubbles is encouraging because it shows Mie Scattering. We ran this experiment twice, and saw peaks in both trials, as seen in Table 1.

**Table 1**

In attempt to get more data, we used the 4th diluted solution and ran it through the capillary. Because the data seemed to be inconclusive, Jacob realigned the PMT. After the realignment, we ran the capillary with the 3rd diluted solution, and it appeared there could be traces of particles. However, we could not replicate the results. It was suggested to remove the pin hole from the PMT; this allows more light access in addition to receiving all data from the capillary rather than parts.

It was suggested that instead of using the surfactant solution, we should use a solid that has a larger particle diameter because it was hypothesized the particle diameter for surfactant is too miniscule to detect Mie Scattering.

**Conclusion**

To further this investigation, we need a larger particle that can be detected through the single-laser apparatus. We currently do not have a particle that meets our standards in regards to diameter size. We tried to use a different form of Silica (particle diameter is about 65 micrometers with that mesh count) with a different mesh count; however, the particles were too big for our capillary. The capillary’s diameter is approximately 75 micrometers. Next semester, I will investigate finding a particle with a larger mesh count. The larger the mesh count, the smaller the diameter of the particle.