Optimizing the Stöber Process to Create Monodisperse Silica Nanoparticles

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Introduction

Silica Nanoparticles are biodegradable, can passively accumulate in tumors and are easy to functionalize . Our lab's research is focused on creating a silica nanoparticle that uses both a fluorescence marker and a radio label to locate cancer. The goal is to make a biodegradable and trackable multimodal nanoparticle-based contrast agent.

- Silica Nanoparticles are formed using the Stöber process.
- The Stöber process uses water and ethanol to condense TEOS into our Silica Nanoparticle.
- Our lab is optimizing the Stöber process to make approximately 100 nanometer particles.
- Unlike metal-based nanoparticles, silica particles are biodegradable and can be eliminated by the body.

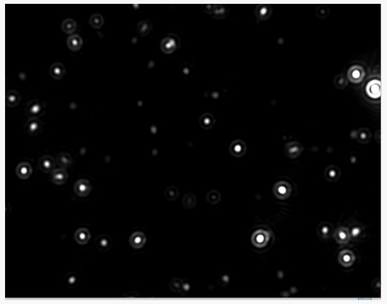


Figure 1. Silica Nanoparticles flowing through the Nanosight NS300.

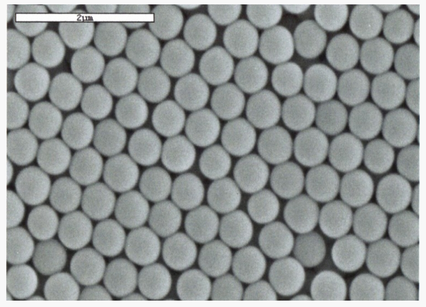
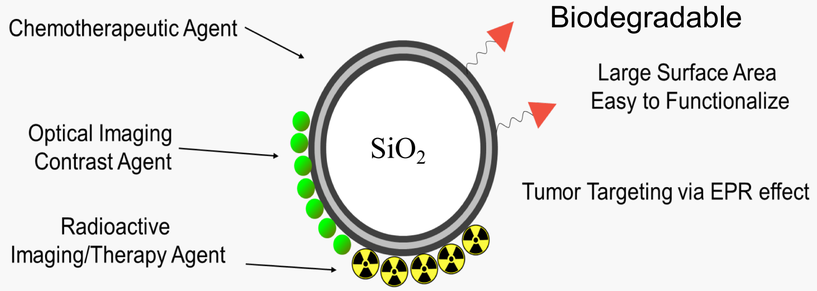


Figure 2. Silica Nanoparticle SEM image.

Objectives & Impact of Professor's Research

Our lab primarily focuses on developing new nano-based contrasting agents for cancer detection and localization.

- The lab also focuses on imaging tools for surgical image guidance and early cancer detection.
- Examples of many ways the nanoparticles can be functionalized.



Methods

- Ethanol, Ammonia, and Milli Q were added to a 50 mL tube and sonicated to mix.
- TEOS was then incorporated. The solution incubated for 1 hour before centrifugation.
- Solutions were spun at 2500-7000 RCF for 4 minutes, checking to see if supernatant is foggy or clear.
- Pellet was washed with ethanol twice then resuspended in 1mL of Milli Q.

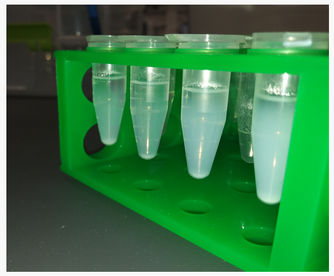


Figure 3. TEOS, Water, Ethanol mixture, centrifuged for 8 minutes at 5000 RCF. We see a small decrease in size of cell pellet and cloudiness of the supernatant.

- After making Silica Nanoparticles, the Nanosight NS300 was prepared to analyze our particles.
- The Nanosight was flushed with two mL of water in order to remove any nanoparticles.
- Inject 0.1 mL- 0.3mL of the solution into the machine until nanoparticles were visible. Settings were optimized and nanoparticles counted.
- A script to collect data that Nanosight produced was created. Finally we exported the data for analysis.

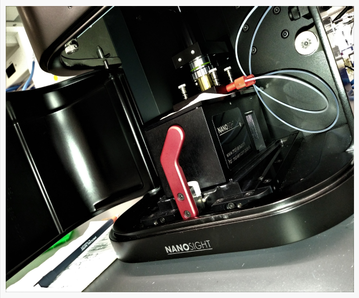


Figure 4. Inside the Nanosight NS300

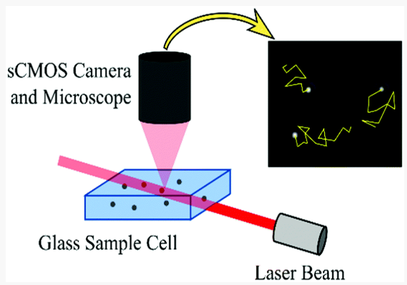
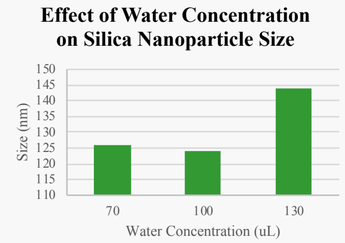
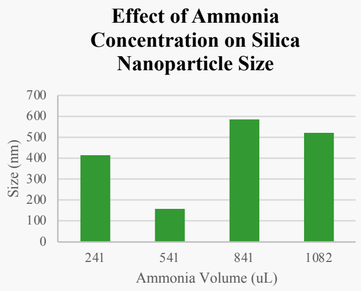


Figure 5. Nanosight NS300 using NTA to track and size nanoparticles

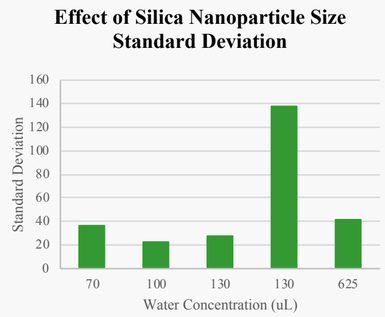
Results



- We want to see the effects on nanoparticle size based on water concentration.
- However, there is not a clear trend in this graph.
- I believe that the size will increase minimally as water concentration increases.



- We observed the change in size of our nanoparticles based on changes in ammonia concentration
- We do not have a distinct trend in our results, however.
- This might be a mistake from the process of making the particles. For example, adding too much or little of a volume into the tube



- We ran our silica nanoparticles and observed how the water concentration affected the standard deviation of the nanoparticles formed.
- We observed a low standard deviation from most of our water concentrations.
- An error occurred with the 130 uL trial resulting in high standard deviation, or polydisperse particles

Conclusion

In conclusion, we saw that the effect of ammonia concentrations can differ the size of the nanoparticle. With more Ammonia added, the greater the size of the nanoparticles, as shown by the graphs. Additionally we have created very monodisperse nanoparticles. We created nanoparticles with a low size standard deviation, which is vital for creating monodispersed particles. In the future we hope to use particles in cancer detection. Hopefully creating particles that are biodegradable, fluorescent, and detectable in vivo in patients.

Acknowledgement

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