Observation of Acid Penetration of Nano-gold Doped Sol-gel System

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Background:

Currently, the drug delivery technology utilizes sophisticated systems, which allows specific drug delivery along with persistent or controlled release of drugs. Exceptionally, silica gel based materials are bioactive and is regarded to be an accurate drug delivery in the biomedical and dental field. However, many drugs cannot be able to go through the gastrointestinal tract due to their poor physicochemical properties, a high first-pass metabolism in the liver, or degradation in the acidic environment of the stomach. Our research team attempt to design a silica Sol-Gel material with a sensitively controlled diffusion rate parameters. To probe the peptide dynamics in the gel matrix, ThT is encapsulated into a sol-gel matrix and subject to fluorescence and lifetime decay assays at different pH levels to determine both the solvent diffusion rates and the peptide fibril formation. In addition, different sizes of gold nanoparticles ranging from 10nm-100nm would be added into the gel to observe their effects.

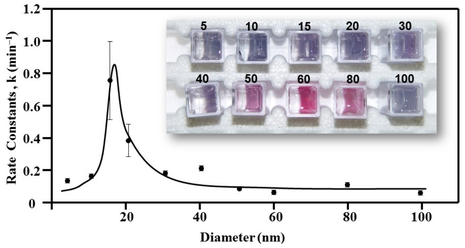


Figure 1. Rate Constant Determination using Absorption Spectroscopy

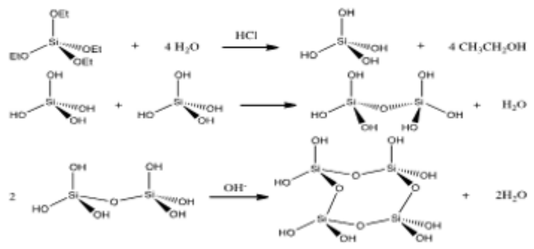
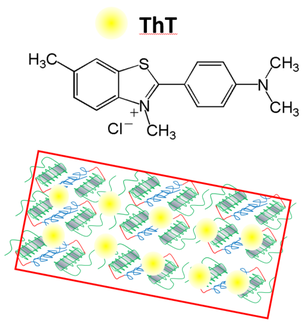


Figure 3. TEOS hydrolysis and polymerization



ThT assay sensitively probing formation of aggregate (β-sheet) in water.

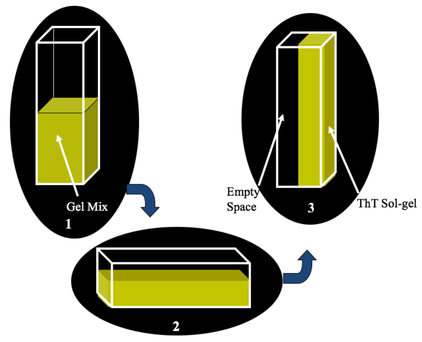
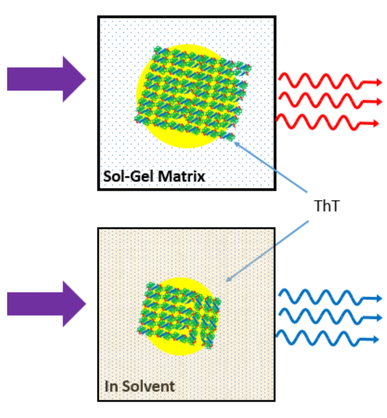


Figure 4. Experimental procedure

Experimental:

To prepare the sol-gel matrix, a precursor must first be made. This is done by hydrolyzing 2.0mL Tetraethyl orthosilicate (TEOS) with 3.34µL of 0.1M HCl and 0.63mL water as shown in **Figure 1**. This is then combined with pH 9.18 buffer, water, and ThT **(Figure 2**) to create the sol-gel as shown in **Figure 3.** Next, the gel is subject to fluorescence assays after treatment of either 0.1M NaOH (basic conditions) or 0.1M HCl (acidic conditions) by injecting either the acidic or basic solvents next to the gel to observe the solvent diffusion rate into the sol-gel matrix **(Figure 4**)**.** Various parameters have been studied such as adding gold nanoparticles from 10nm-100nm when creating the gel, or replacing ThT. Analysis of the assays can be seen in the results section.



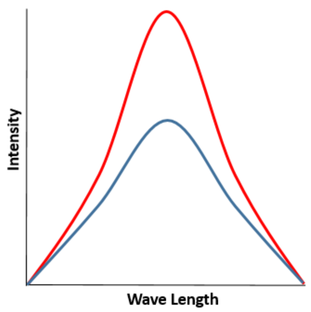


Figure 5.Fluorescence Emission Approach

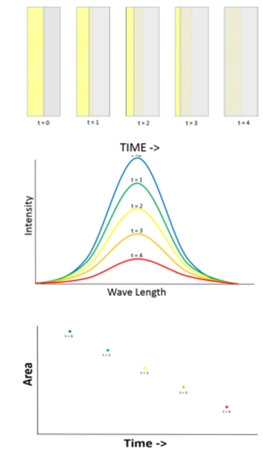


Figure 6. Rate of diffusion of Sol-Gel Matrix

Results:

The Nano-size dopant dependent diffusion rates were remarkably different between HCl and NaOH insertion as seen in Figures 7 and 8. Also, the effect of peptides were clearly confirmed in which the rates were slowed down for most of the cases.

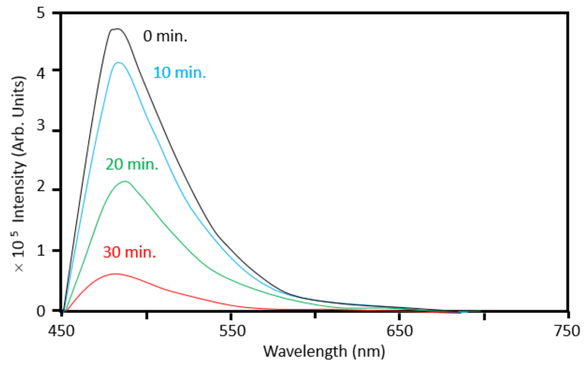


Figure 7. ThT assay of Sol-Gel under basic conditions

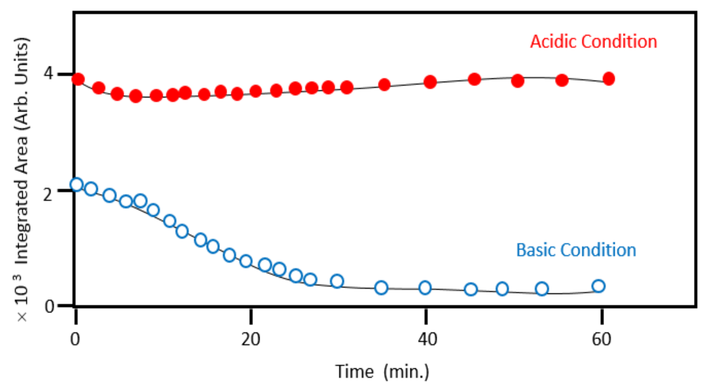


Figure 8. Rate Fluorescence Intensity Change as a Function of Time

Discussion:

The results indicate that the fluorescence intensity of the ThT in a sol-gel matrix slowly decays over time in acidic and basic conditions, while the fluorescence lifetime is virtually unaffected. Low fluorescence intensity resulted from acid/base diffusing into the gel to block the fluorescence emitted by ThT. Additionally, the solvent flow channels were blocked by the aggregates of the Amyloid beta peptides. To our surprise, the solvent diffusion process in the sol-gel matrix monitored by ThT exhibited different properties under acidic and basic conditions. Under basic condition, rate of diffusions were constantly occur respect to its time; whereas, there were almost no change under acidic condition. This may be the result of an intrinsic ThT structural change observed while probing under basic conditions that was not detected under acidic conditions. The next step to take is to add different sizes of colloidal gold particles to the ThT sol-gel to see if it alters peptide structural conformations or solvent diffusion rates.

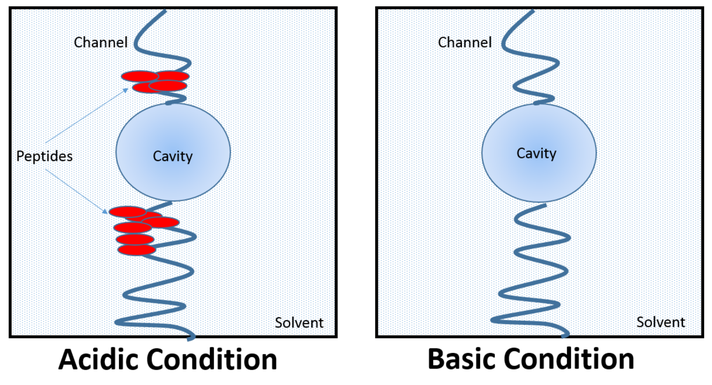


Figure 9. Comparison of Sol-Gel Matrix Under Acidic and Basic Condition

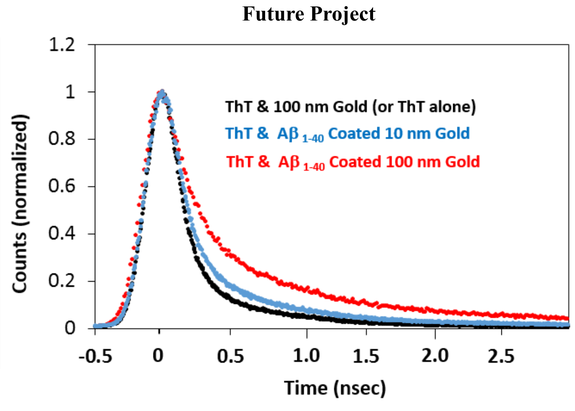


Figure 10. Gold colloidal size dependent fluorescence decay time for future study

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References:

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