Microsphere Surface Functionalization with Click Chemistry

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Introduction

PDMS microspheres (MS): promising drug delivery tool

- Biocompatibility (inert in the cell)
- Ease of fabrication
- Capacity for controlled drug release

However, the potential of PDMS MS is limited.

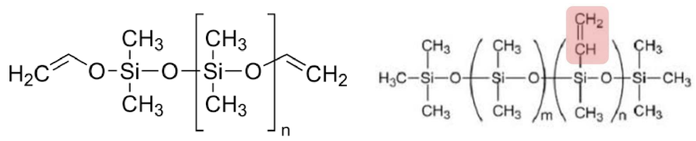
- Lack of robust click reaction protocols for **tailoring MS surface chemistry**.
- Surface chemistry is a critical factor that dictates cellular interactions and targeting efficiency.

Addressing this limitation

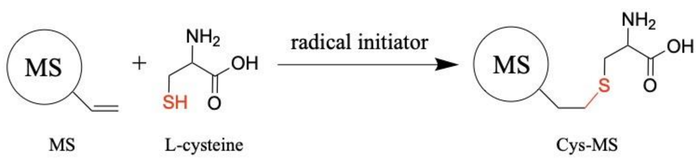
- We developed a novel method for amino acid surface functionalization of PDMS MS using thiol-ene click chemistry.

Methods

- PDMS-co-PVMS base polymer was used to provide vinyl groups for thiol-ene click of L-cysteine to the MS surface.

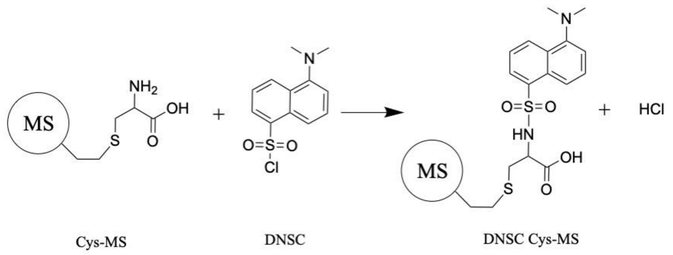


PDMS PVMS-co-PDMS



MS L-cysteine Cys-MS

Scheme 1. MS surface functionalization click reaction



Cys-MS DNSC DNSC Cys-MS

Scheme 2. Dansyl chloride (DNSC) reaction

Characterization

- FTIR analysis was used to characterize the functionalization protocol's success.
- **Key:** The disappearance of the S-H peak after the reaction

Summary of Experimental Design

1. Synthesize MS with PDMS-co-PVMS (Figure 1)
2. Functionalize MS with L-cysteine (Scheme 1)
3. Confirm functionalization of Cys-MS with FTIR (Figure 2)
4. Attach the fluorescent probe DNSC (Scheme 2 & Figure 3)

Results

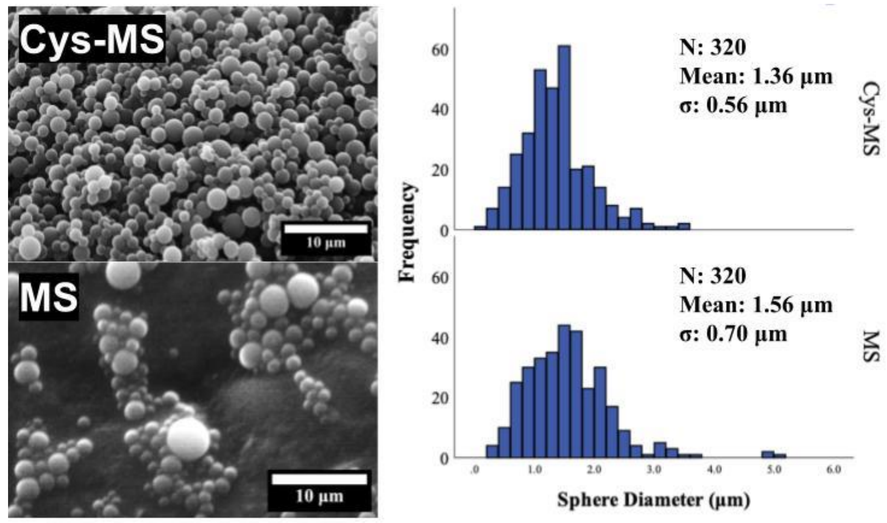


Figure 1. SEM images of Cys-MS and MS

- Sphere morphology and size are similar for Cys-MS and MS.

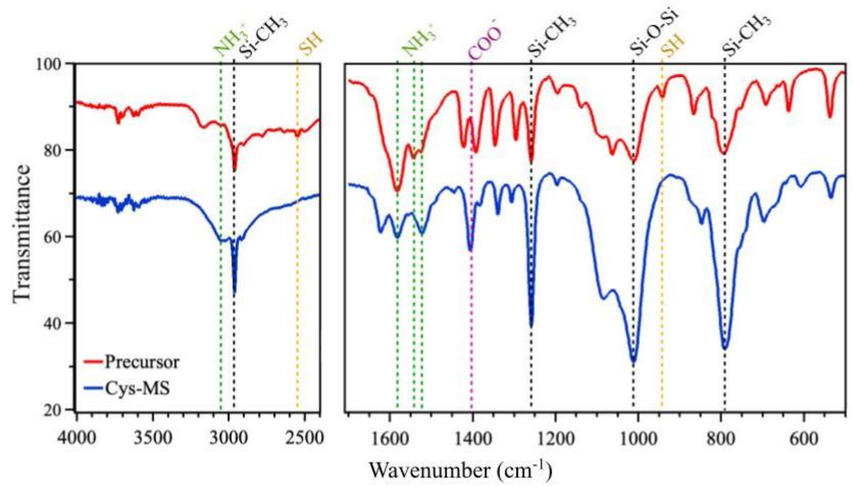


Figure 2. ATR-FTIR spectra of **precursor** and **Cys-MS**

- The disappearance of the thiol peaks (2550 cm^{-1} and 943 cm^{-1}) confirm the covalent attachment of L-cysteine to the microsphere surface.

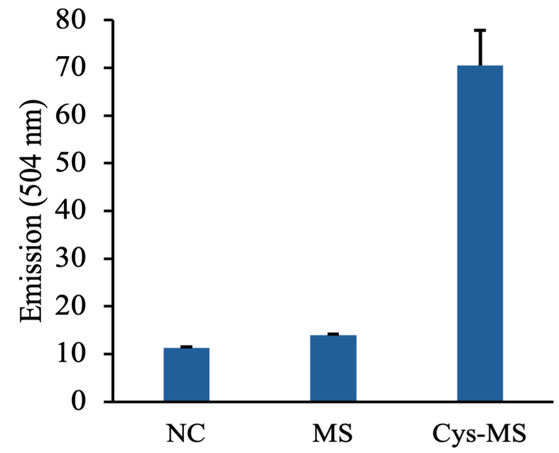


Figure 3. Dansyl Chloride Assay

- NC (negative control), MS (control) & Cys-MS
- Excitation: 340 nm, emission: 504 nm
- Cys-MS vs MS ($p = 0.016$)
- Cys-MS vs NC ($p = 0.015$)
- MS vs NC ($p = 0.005$)

Discussion

We hypothesize that this simple and efficient method can be directly extended to conjugate more complex biomolecules, such as peptides and proteins.

- This work establishes a foundational strategy for customizing the surface of PDMS microspheres.
- By enabling precise control over surface chemistry and characteristics, our functionalization protocol paves the way for developing directed drug delivery vectors with enhanced cellular uptake and reduced off-target effects.

References

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Acknowledgements

A special thanks to Dr. Jen Baldwin for her guidance and mentorship through the project, and to my supportive peers Summer Jensen and Tia Gonzales. Thanks to the Chemistry department at Luther College for providing this research opportunity.