Enhancing Drug Delivery Targeting and Efficiency: Controlled Delivery with Specific Biopolymer Coated Mesoporous Silica Nanoparticles

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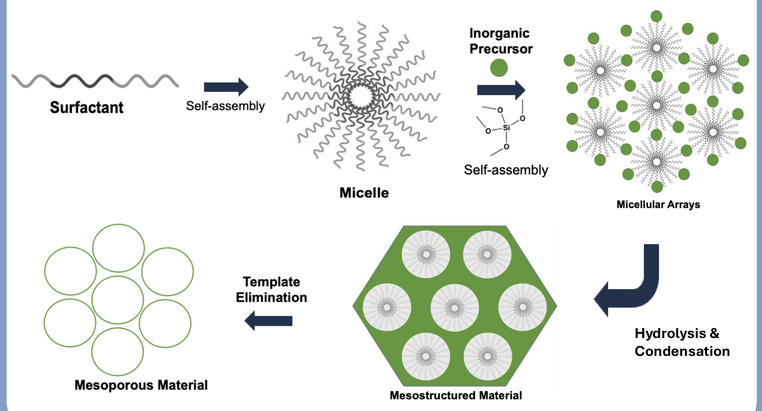
Abstract

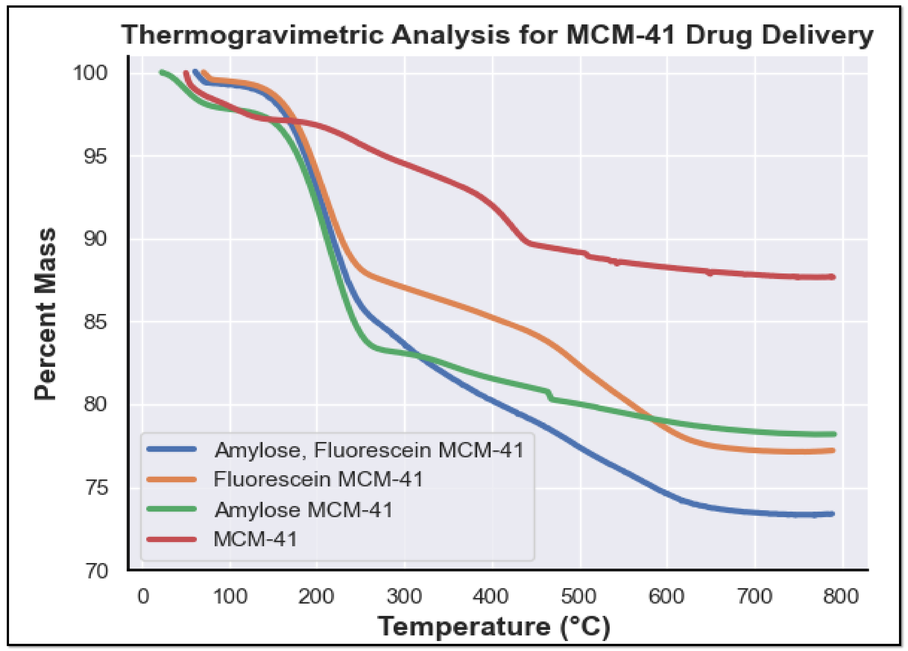
Traditional drug delivery methods face significant challenges such as non-target site exposure, adverse effects, environmental impact, and high costs. This study reports the initial findings and characterizations of an Amylose coated mesopore silica nanoparticle (MSN) drug delivery system capable of the uptake and sustained release of drug surrogate molecules, mediated by concentration gradient, pH-dependent electrostatics, and biopolymer hydrolysis. Amylose exhibited suitable surface interactions with bare MCM-41, achieving effective pore coverage. A 90% dimethyl sulfoxide solution (DMSO) with water was found to be sufficient for amylose coating of MCM-41 due to amylose solubility in DMSO. Nitrogen adsorption determined the pore volume, BET surface area, and size distribution of synthesized MCM-41. Thermogravimetric analysis (TGA) was conducted on bare MCM-41, MCM-41 loaded with drug surrogate molecules, amylose-coated MCM-41, as well as surrogate loaded amylose-coated MCM-41 to calculate weight percentages of our product. Further testing will determine drug release rates of the amylose-coated MCM-41.

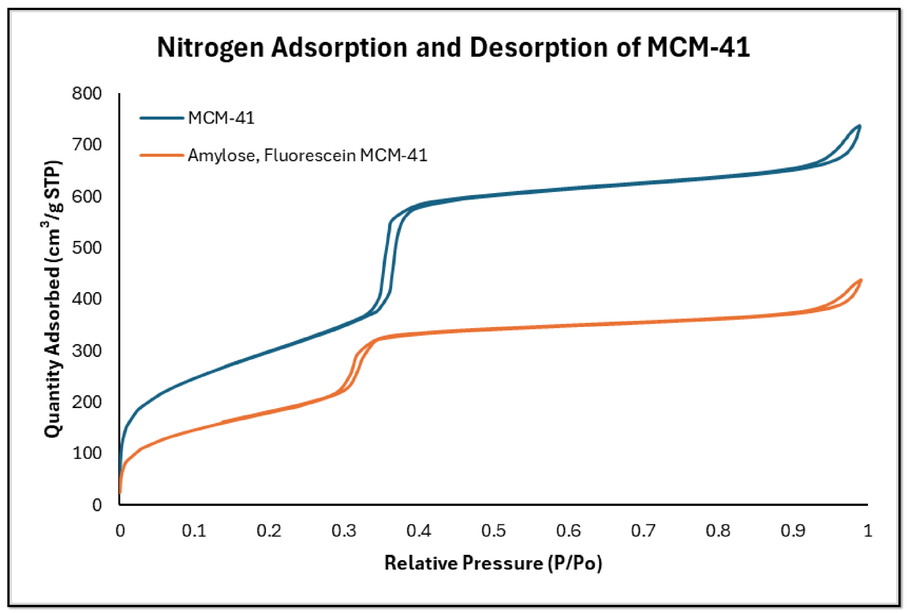
Hypothesis

Amylose can effectively coat and encapsulate drug surrogate molecules (fluorescein) within MCM-41 mesoporous silica nanoparticles (MSNs), providing sufficient pore coverage and allowing for biochemical-mediated release.

MSN Synthesis





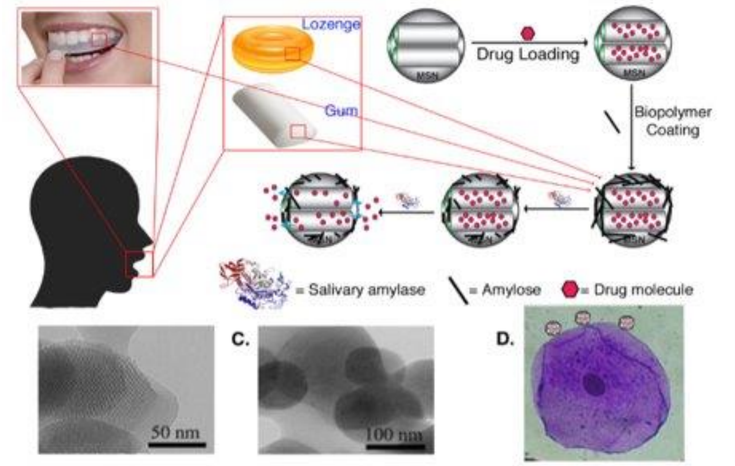


Conclusion

With successful creation of MCM-41, as seen in the adsorption and desorption curves, mesopore characterized pores, as well as the reduction in surface area and pore volume after loading with fluorescein and coating with amylose, suggest the coating applied successfully covered the surface area of the MCM-41 pores.

Future Work

This project aims to tackle the specific goal of drug diffusion characteristics of amylose coated MCM-41 in the presence of digestive enzymes via biopolymer hydrolysis. Further techniques will be used to refine the coated product as in lyophilization to further remove DMSO from our amylose coated MCM-41. Further repeated coating of amylose MCM-41 will be explored to expand the biopolymer thickness. Diffusion testing will be conducted in varying buffer solutions to model biochemical conditions of saliva.



	MCM-41	Amylose, Fluorescein MCM-41
BET Surface Area (m^2/g)	1059	696
Pore Volume (cm^3/g)	1.09	0.62
Pore Size (nm)	2.8	2.6

References and Acknowledgments

- Harget, M. C. (2022). *Biopolymer coated mesoporous silica nanoparticles for controlled therapeutic delivery: Battle for bioavailability* (Master's thesis, Colorado School of Mines). Colorado School of Mines. https://hdl.handle.net/11124/176620
- Wang, Chen *et al*. *Inorg. Chem. Front.* **2018**, 5, 2183-2188.

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