Responsive Silk Protein Plastics for Controlled Drug Release

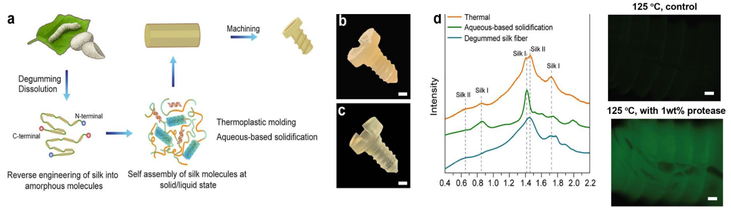
Kareen A. Fajardo Cortes[1], Edward Gordon[1], Mariah Arral[1], Aaliyah Abel[1], Julia D Rivera [1], Bipro Dhar[1], David Kaplan[1]
[1] Department of Biomedical Engineering, Tufts University, Medford, MA, 02155

Goal

Novel approach for silk processing via thermoplastic molding promotes controlled release through tunable enzymatic degradation in silk plastics.

Background

Silk reservoirs can efficiently encapsulate bioactive molecules using beta-sheet inducing methods such as thermoplastic molding and water vapor annealing.[1,2,3]



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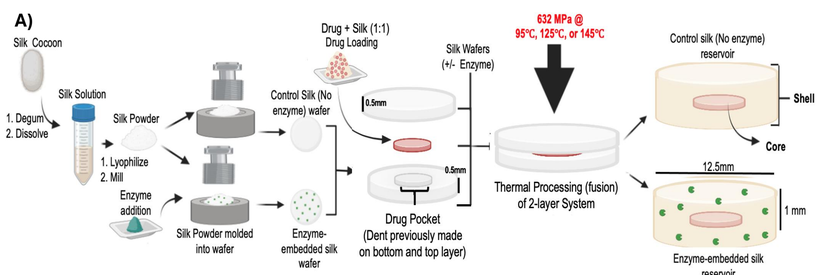
The Design and Methods

A two-layer wafer system made from 1w/v% silk amorphous nanopowders can efficiently encapsulate small molecule or enzyme-based active pharmaceutical ingredients.



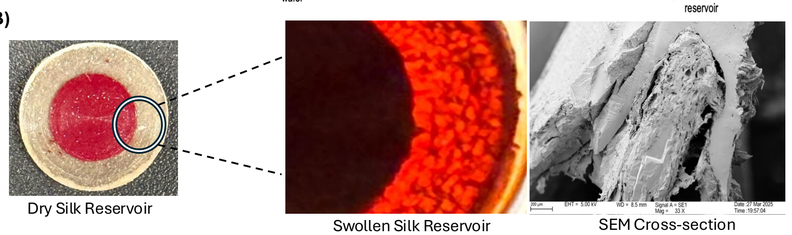


Figure 1: A) Synthesis of dense bulk silk fibroin drug delivery reservoirs (two-layer wafer system) blank or embedded with enzymes. B) Digital image of 12.5mm x 1mm, and SEM of system's cross section

Mechanisms of Release & Results

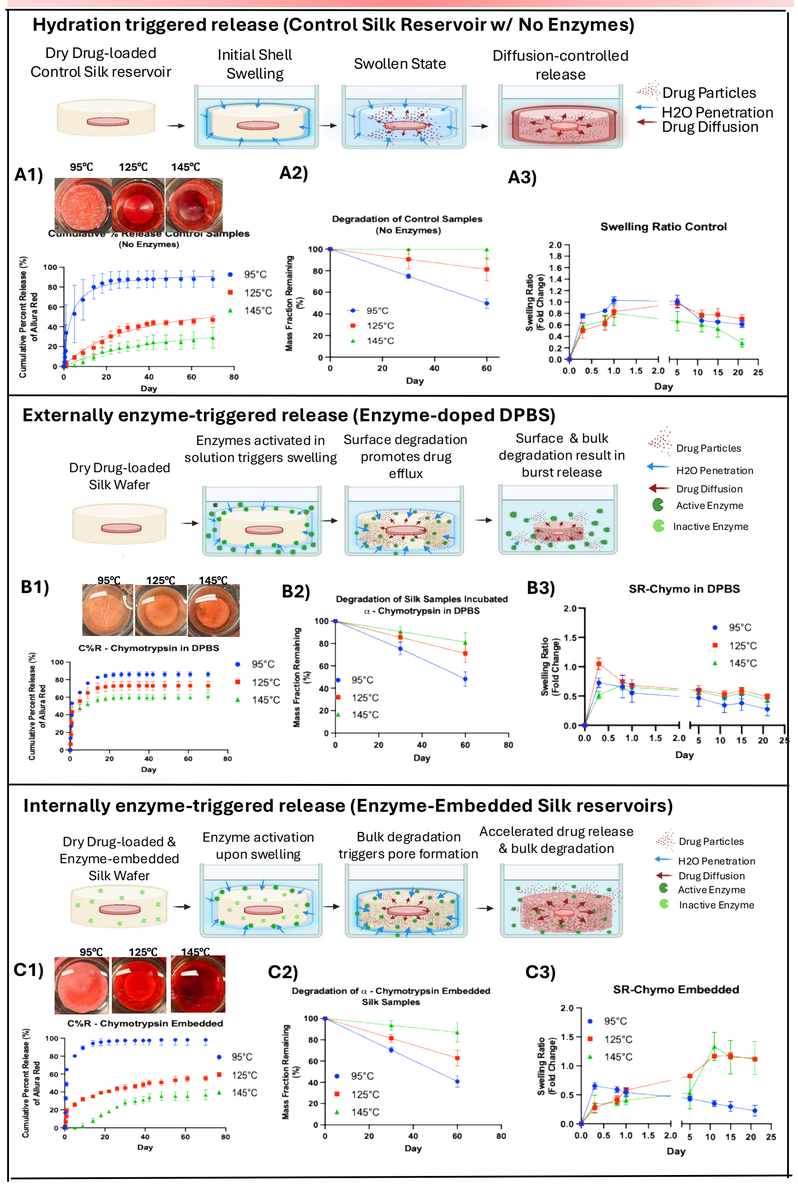


Figure 3: Cumulative release of fluorophore (A1,B1,C1) Degradation profile (A2,B2,C2) and swelling profile (A3,B3,C3) over time at different processing temperatures for (A) Control samples, (B) α-Chymotrypsin-embedded designs, (C) Silk designs in α-Chymotrypsin doped in DPBS.

Protecting Enzymatic Activity

Thermoplastic molding processing temperatures impacts silk fibroin material properties.

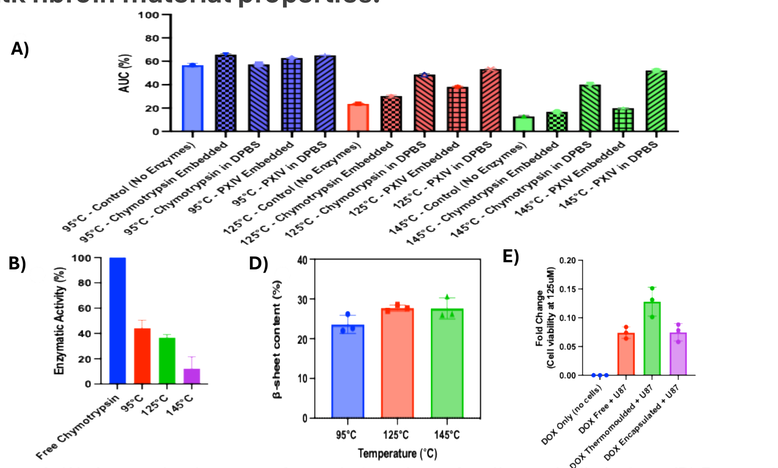


Figure 4: (A) Area under the curve of cumulative release for all tested silk designs. **(B)** Enzymatic activity of enzyme-embedded designs vs. fresh enzyme. (C) Beta-sheet content under processing temperatures. (D) Doxorubicin stability after exposure to heat at IC50 dosage.

Conclusion

- Higher beta-sheet content enhance controlled, sustained, and delayed release profiles.
- Enzyme-embedded silk reservoirs show initial bolus release and accelerated pharmacokinetic properties in response enzymatic activation.
- Enzyme function decreases with higher processing temperatures.
- Thermoplastic molding protects small molecule and enzyme drug.

Next Steps

Evaluate the pharmacokinetic profile of 1- 30w/v% silk formulation and the thermal effect on high crystallinity formulations.

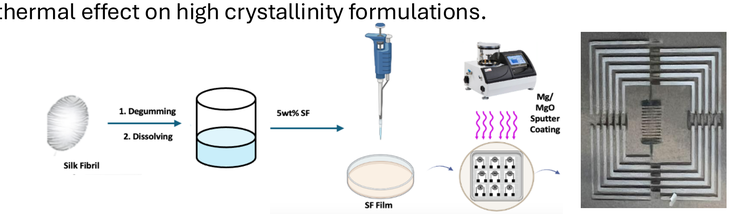


Figure 5: Schematic of antenna fabrication.

Acknowledgements

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