Characterization of Soft Gel Materials Under Dynamic Loading Conditions

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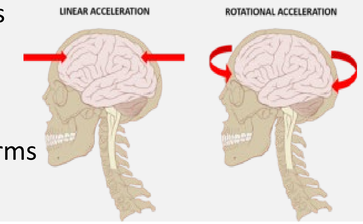
Can Soft-Gel Materials be Characterized using Dynamic Mechanical Analysis?

Motivation

The use of soft-gel materials as tissue surrogates in material characterization is crucial for better understanding of the body's response to potentially traumatic stimuli. Much is yet to be learned, especially regarding traumatic brain injuries (TBIs) and their related forms of injury mechanisms.



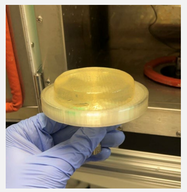
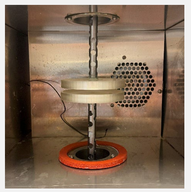
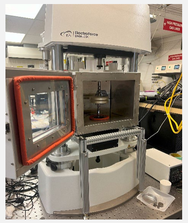
Methods

Sample Preparation

- Samples were made by dissolving various powders of agar, Agarose, Gelatin A, and Gelatin B; of various concentrations, in DI water. Then the mixtures were poured into molds and set overnight.

DMA

- The tests were done with the TA ElectroForce DMA 3200 at various frequencies, and the resultant load-displacement data was used to determine the storage and loss moduli.

Figures

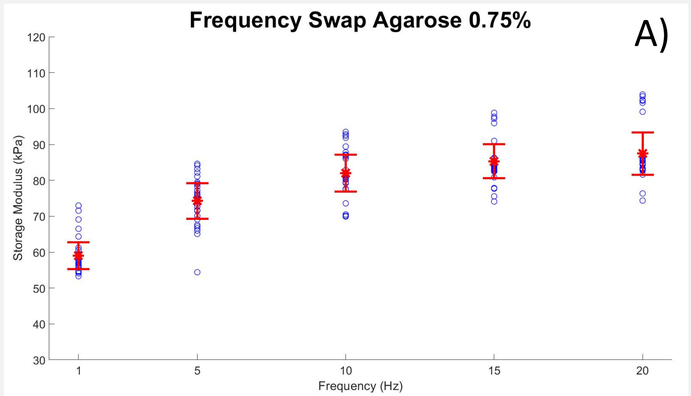


Figure A shows the combined results from frequency swap tests done on agarose hydrogels, which depict strain rate stiffening with a higher storage modulus.

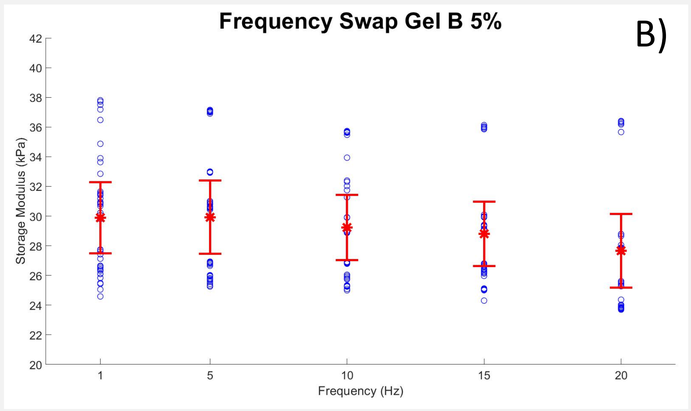


Figure B shows the combined results from frequency swap tests done on gelatin hydrogels, which shows no strain rate dependent effects.

Key Findings / Future Work

Key Findings

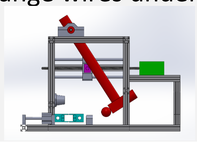
- Due to their viscoelasticity, the stress-strain relationship in soft gels is inherently non-linear.
- Agarose / Agar's behavior is highly frequency/strain rate dependent, while Gelatin A / B is not.
- Using DMA on soft gels can prove challenging due to the delicate nature of the materials, however, adverse damage can be mitigated. For example, syneresis tends to occur in lower concentrations of Agar & Agarose, which can be reduced by lowering the strain rate.

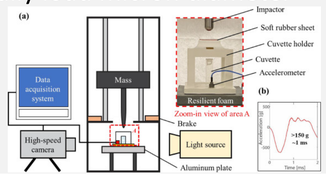
Future Work

- Further dynamic testing with these soft gels is needed to understand their elastic behavior fully.
- The drop tower multiple impact test is important in characterizing how these soft gels behave with TBI-type stimuli.

Related Work

- Development of a new instrument to axially load micron diameter range wires under high strain rates.





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