

Optimizing Biocompatible Implant Coatings Via Contact Angle & Viscosity of Sol Gel systems



Adwita Goyal, Biomedical Engineering (BSE)

Mentors: Dr. Vincent Pizziconi, Ph.D., Erwin Kruger, MD

School of Biological Health and Systems Engineering (SBHSE), Mayo Clinic

Introduction

Sol-gel: A process where a liquid (sol) transitions into a solid network (gel) through chemical reactions → thin, uniform coatings

Hydroxyapatite (HAp): primary mineral component of human bone; is ideal as a biocompatible orthopedic implant coating

Research Question: *Can contact angle measurements serve as a reliable indicator of optimal gelation time for hydroxyapatite sol-gel coatings on orthopedic implants?*

Methodology

Sol-gel Stoichiometry:

$10 \text{ Ca(NO}_3)_2 + 6 \text{ TEP} \rightarrow \text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2 + \text{byproducts}$

Contact Angle Measurement: Droplets deposited on cleaned quartz substrates via 1mL needle. Angles were measured via ImageJ analysis.

Viscosity Measurement: A Brookfield LVT viscometer was calibrated & used to measure viscosity at 12, 30, & 60 over 36 hours.

Results

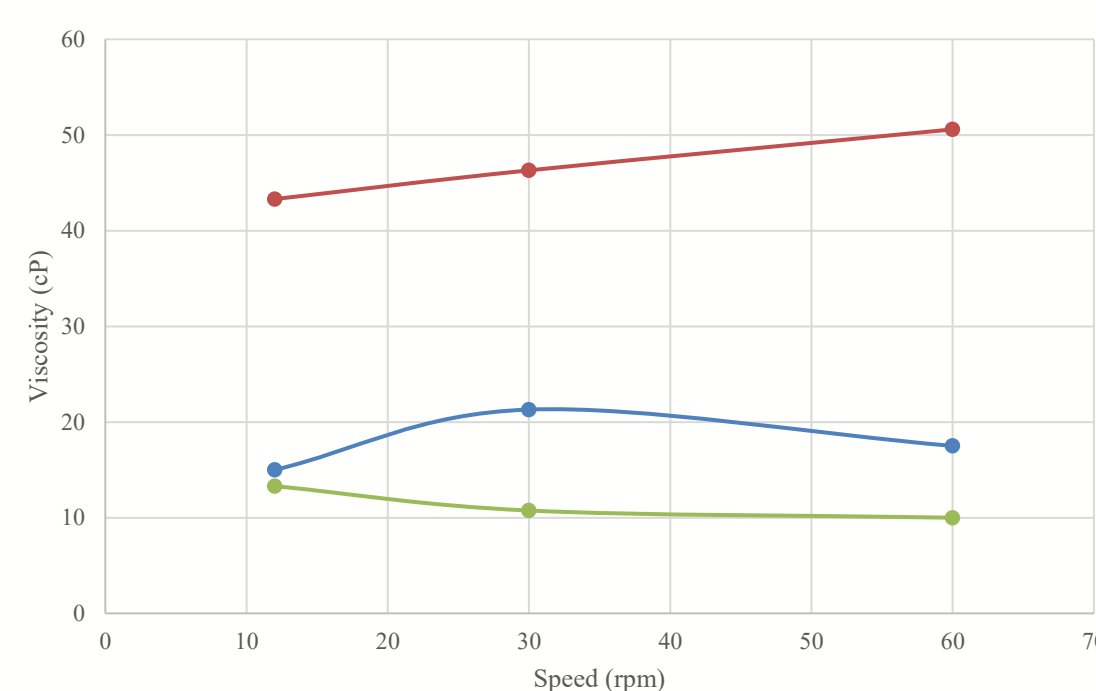


Figure 1: Relationship between viscosity and speed → sol-gel is a thinning non-Newtonian fluid

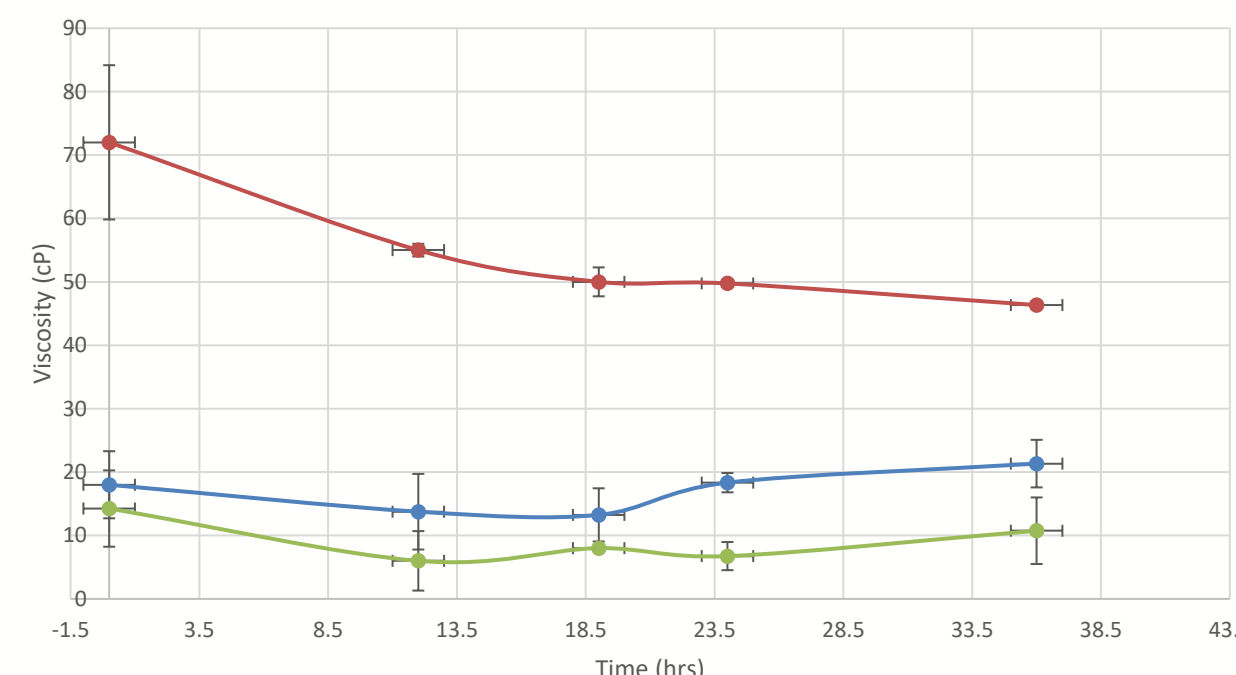


Figure 2: Relationship between viscosity and time → early hydrolysis stage

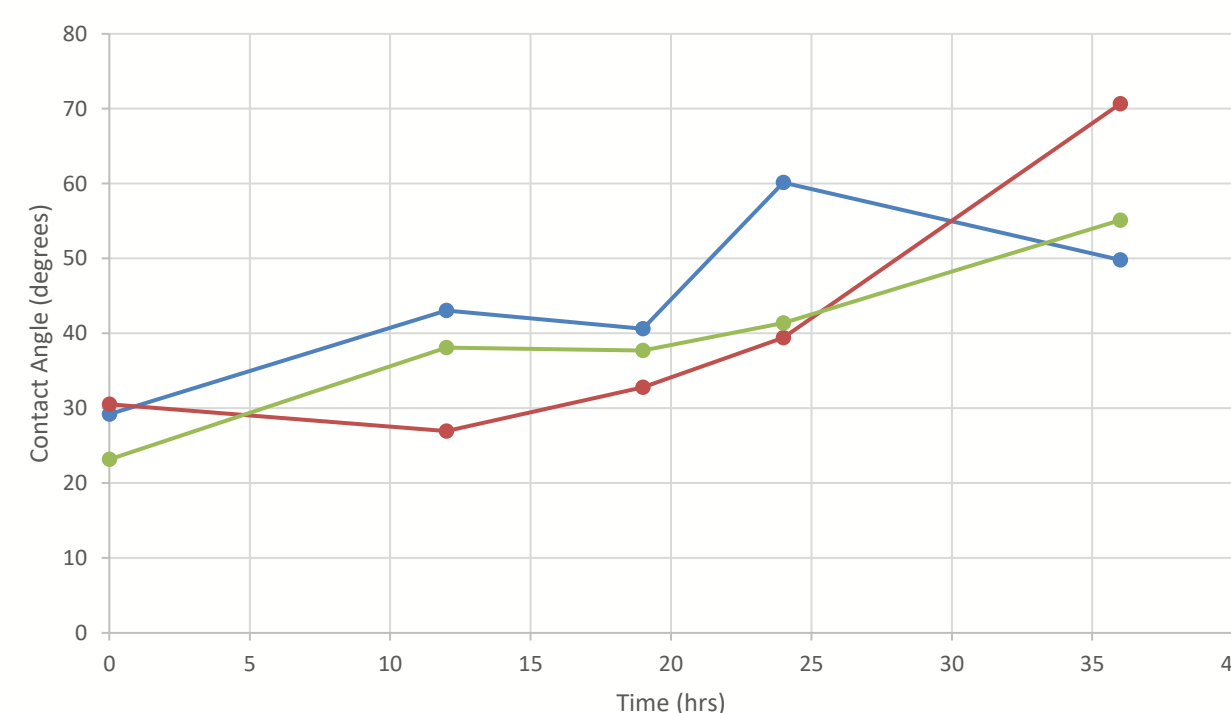


Figure 3: Relationship between contact angle and time → impact dip coating process

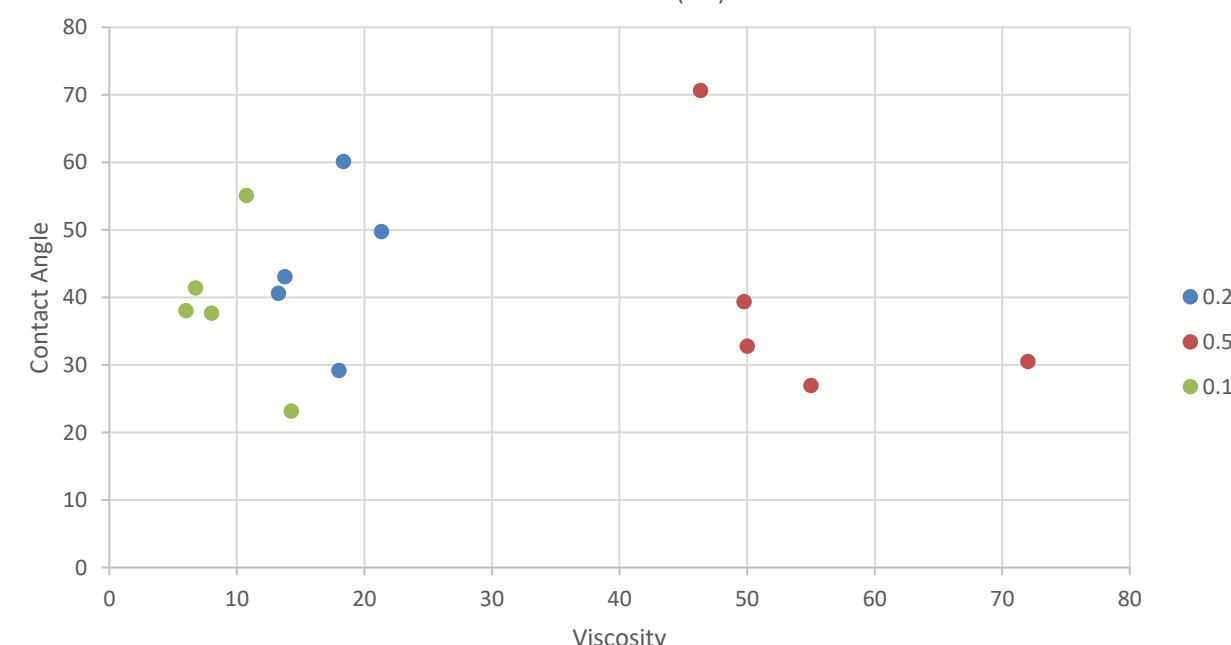


Figure 4: Relationship between contact angle and time.

Sol-gel Synthesis:

0.2 M – 04/01/26

0.5 – 10/29/25

0.1 – 02/11/25

Discussion

Viscosity & Gelation

- Viscosity decreased then stabilized, consistent with network formation; 0.5M shows concentration ∝ rpm (non-Newtonian)

Contact Angle & Wettability

- CA increased in all concen. → surface becomes less hydrophilic/ wettable as gel network develops

Correlation

- Viscosity and CA has no apparent correlation, but the time period was during the preliminary stages of sol gel gelation.

Errors

- Insufficient time points + limited replicates reduce statistical confidence
- ~1970s Brookfield LVT viscometer has mechanical inconsistencies w/ occasional polar readings

Acknowledgments

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