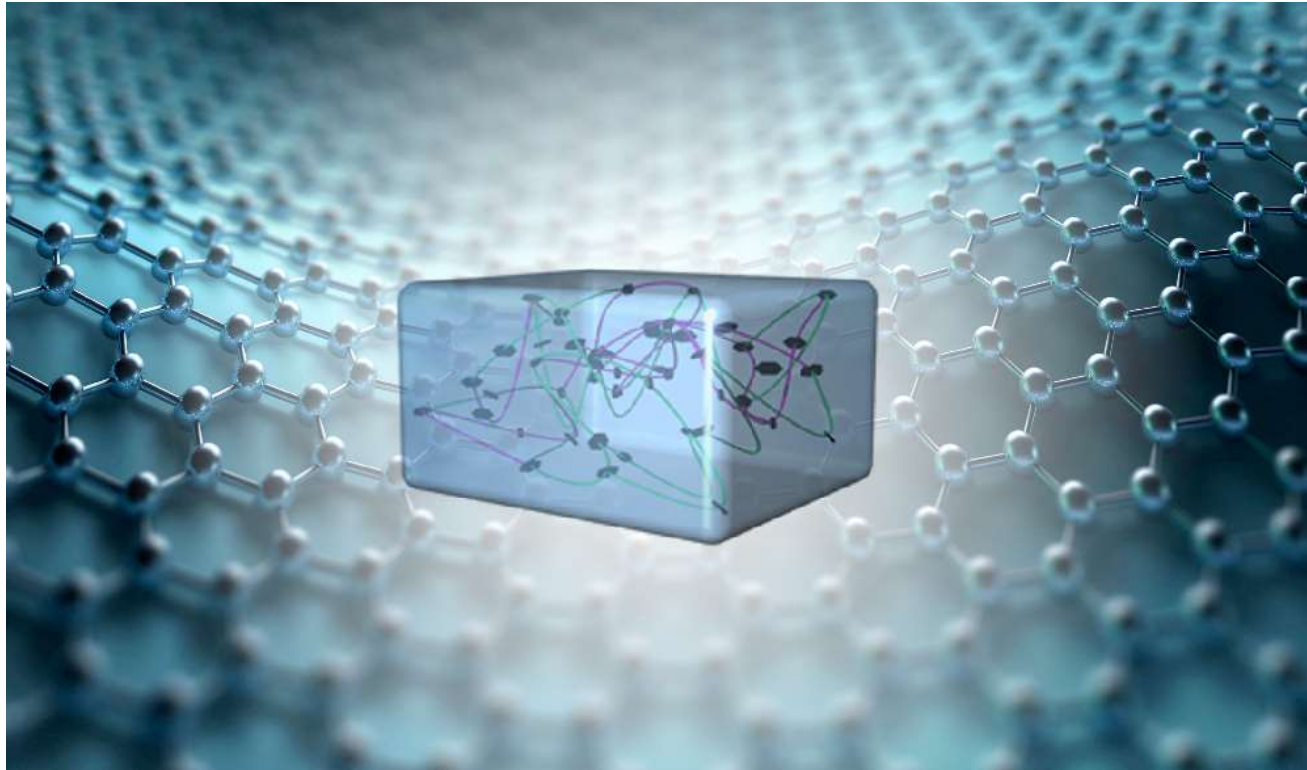# Sound Waves and Hydrogels

By: Ashmita Pyne

George Washington Department of Mechanical and Aerospace Engineering

Dr. Sarkar's Lab

- Contrast ultrasound, drug delivery, tissue engineering, computational modeling
- Biomedical acoustics

Hydrogels

- a three-dimensional (3D) network of polymers that can swell with water

- hydrogels hold a large amount of water while maintaining the structure due to chemical or physical cross-linking of individual polymer chains

- Ex: hydrogel dressing, contact lens, Orbeez

Wet

Dry

Gelatin methacryloyl (GelMA)

- Gelatin-methacryloyl (GelMA) is a semi-synthetic hydrogel consisting of gelatin derivatized with methacrylamide and methacrylate groups

- Used widely in biomedical research and application due to its highly tunable properties

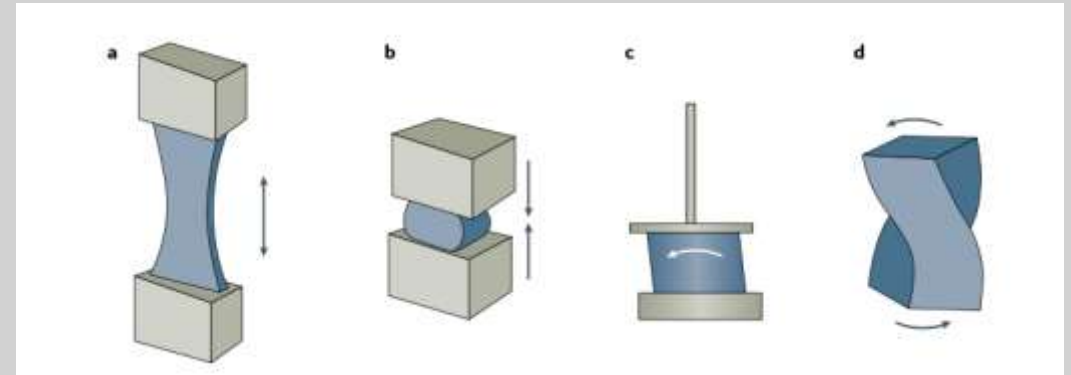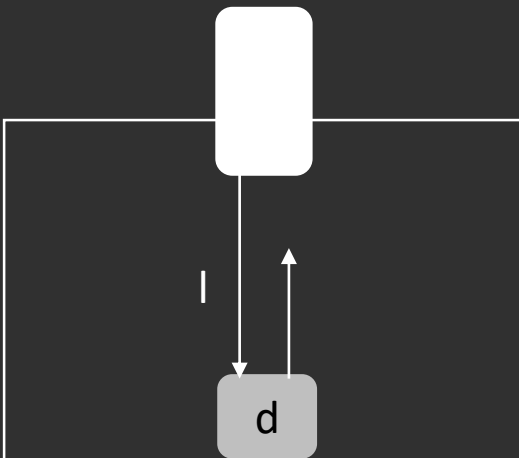- Many different additives → nanoparticles, graphene oxide
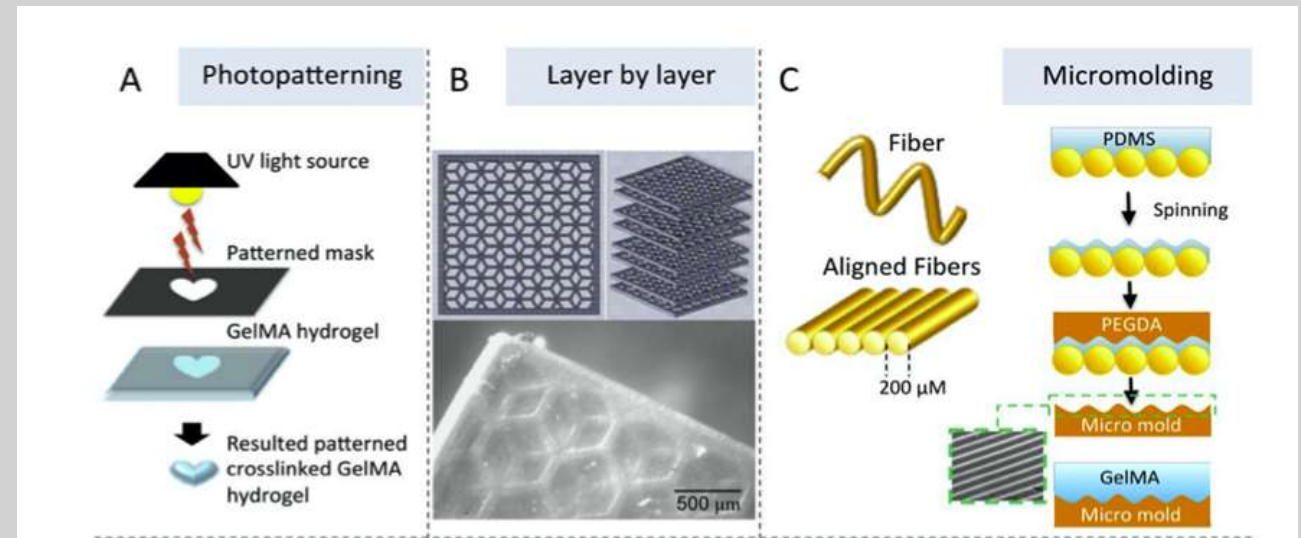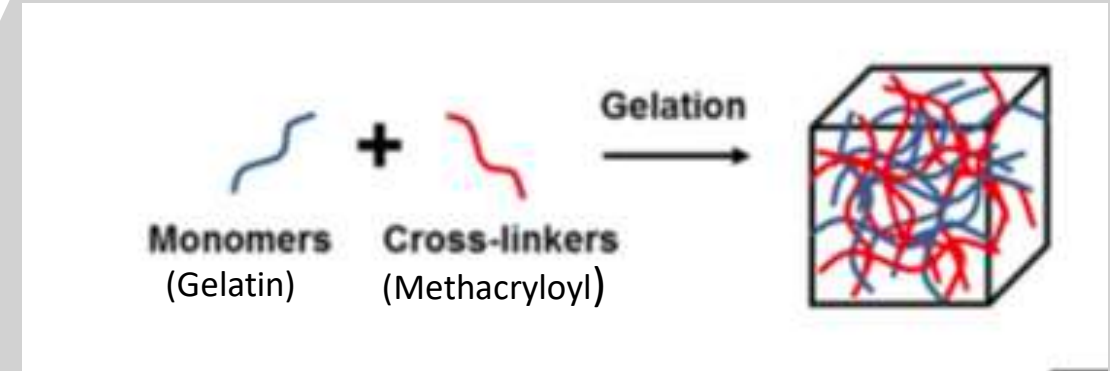
Synthesis, properties, and biomedical applications of gelatin methacryloyl (GelMA) hydrogels
By Kan Yue

Speed of Sound

- Non-destructive way of testing materials

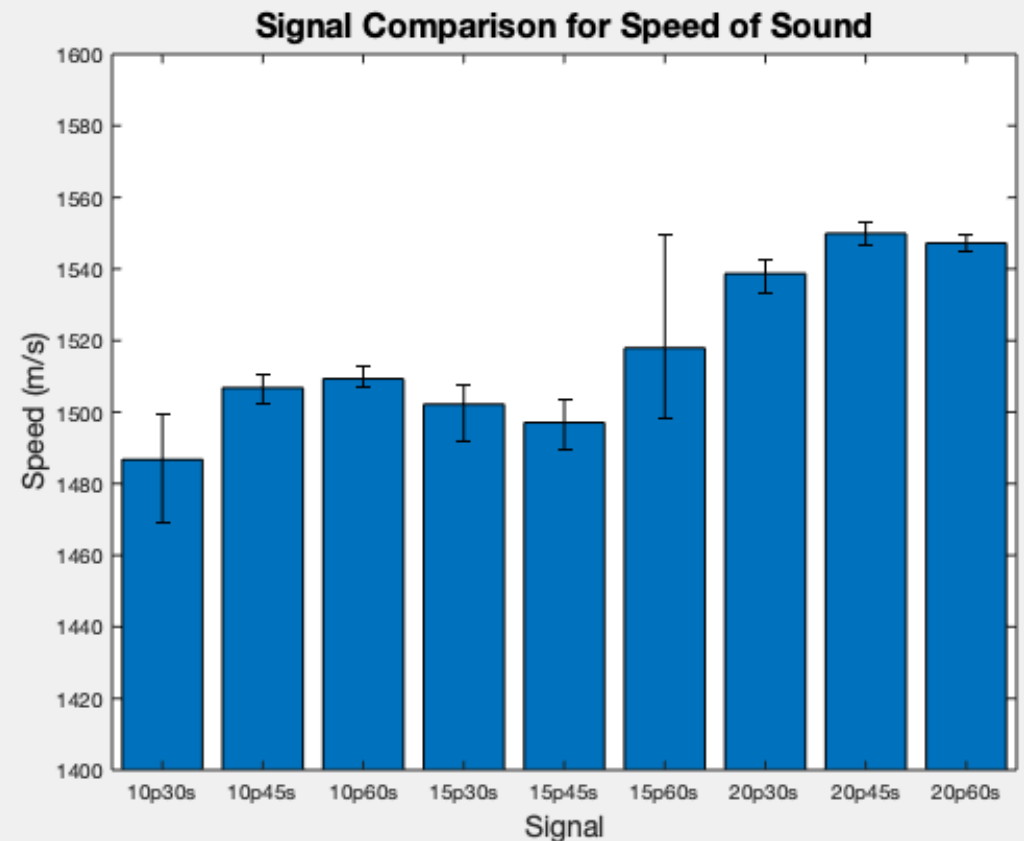- We want to see if percent gel and allotted time affects the speed of sound

The stiffness of living tissues and its implications for tissue engineering By *Carlos F. Guimarães*

$$C_{sample} = \frac{2d}{\Delta t + \frac{2d}{C_{water}}}$$

Results

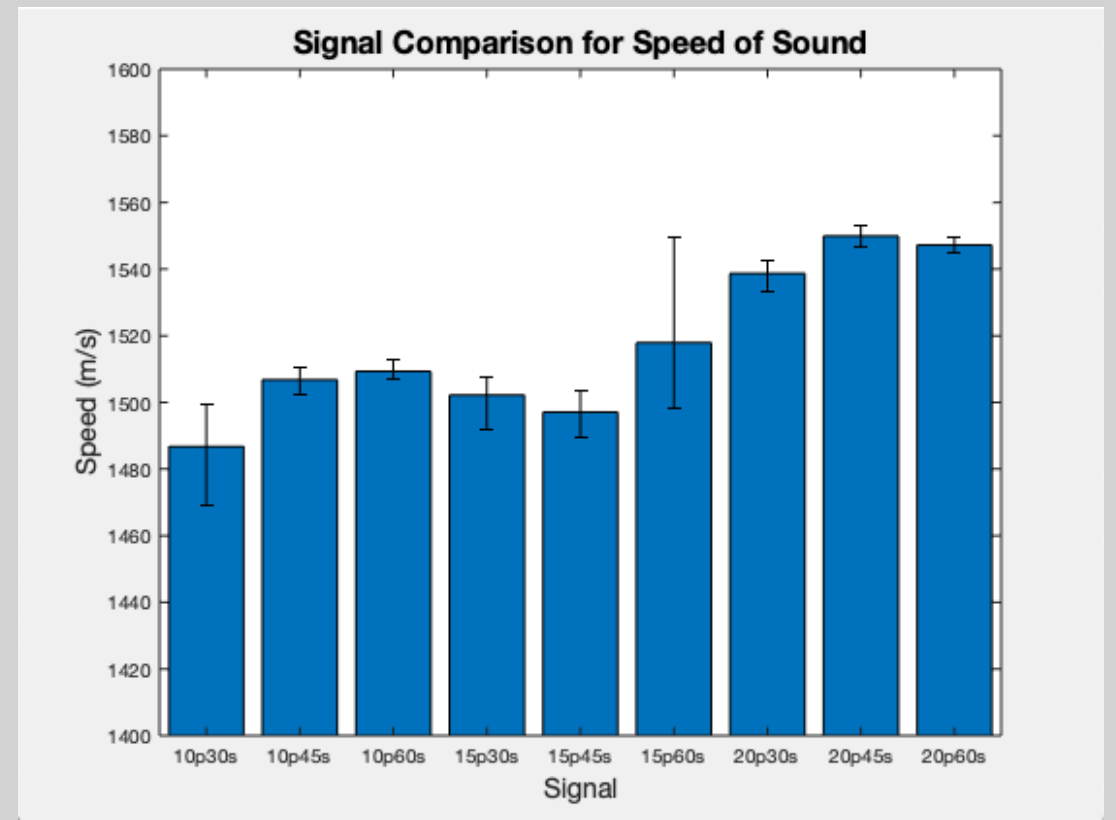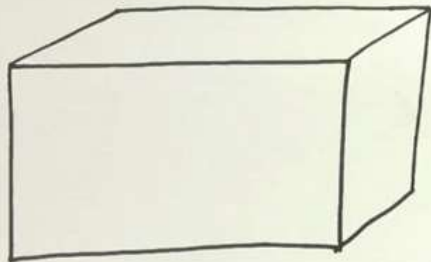| Signal Name	Average (m/s)
10p30s	1486.7
10p45s	1506.8
10p60s	1509.3
15p30s	1502.2
15p45s	1497.1
15p60s	1517.9
20p30s	1538.7
20p45s	1549.9
20p60s	1547.2

GelMA concentration and cross-linking time affects speed of sound

- Speed of sound is dependent upon GelMA percentage and time allotted for cross-linking because both factors affect the density of the material and how sound will travel through the scaffold.

stiffer medium = faster sound waves

Applications

Material	Speed of Sound (m/s)
Water	1480
Brain	1550
Kidney	1570
Muscle	1575-1590
Liver	1590
Skin	1730
Bone	2800-4080

Source (2)

Basics of Biomedical Ultrasound for Engineers by Haim Azhari

Signal Name	Average (m/s)
20p45s	1549.9
20p60s	1547.2

Lessons Learnt:

- Better understanding of the Matlab Interface
    - Two signals on the same Graph
    - Error Bars
- How to effectively read Scientific Writing
    - Literature Review
- Ask for help
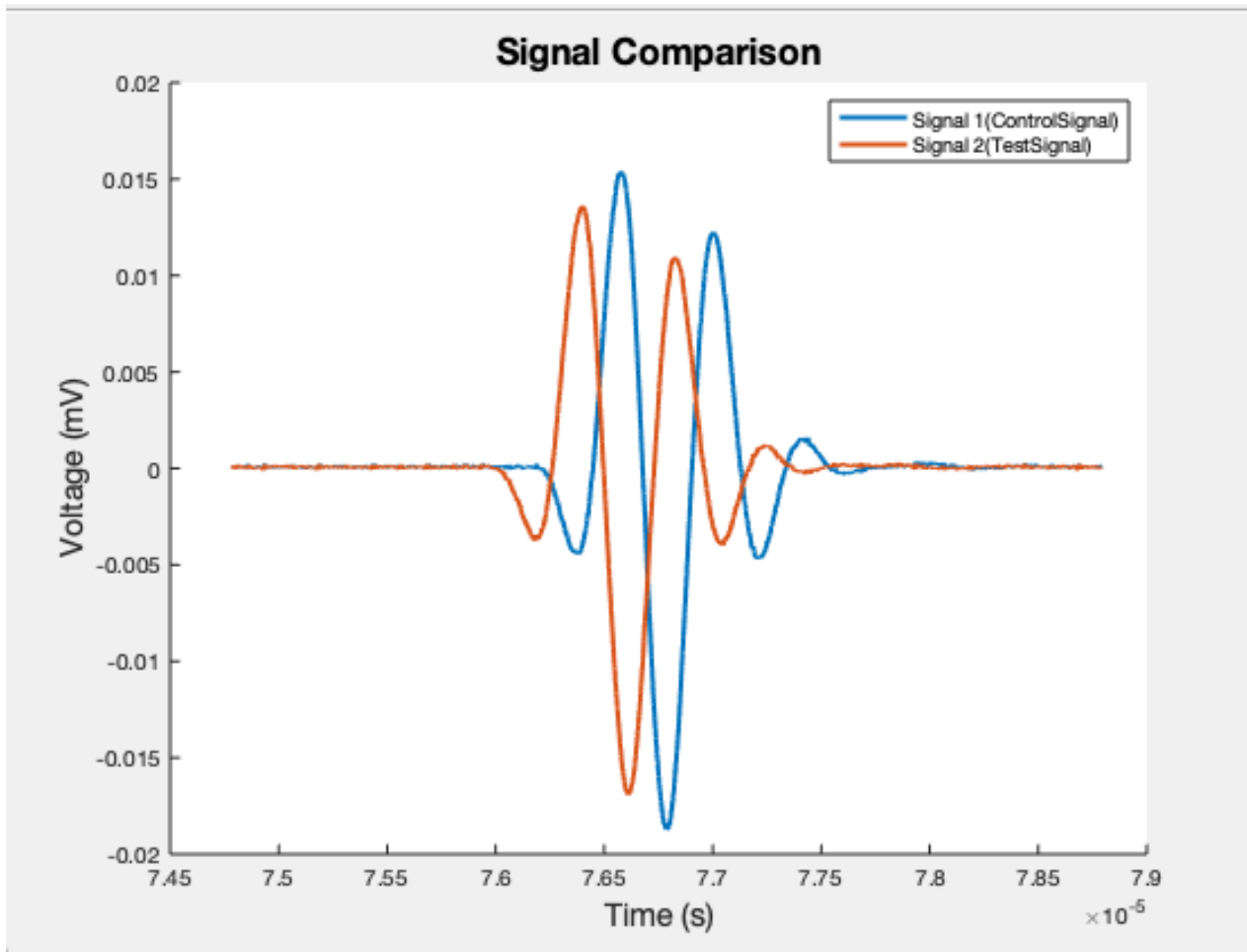
Thank You

Megan Anderson

Dr. Kausik Sarkar

Dr. Krug

My family