Bioscaffold Synthesis for Musculoskeletal Tissue Engineering

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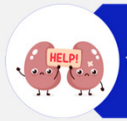
I. Introduction

Background Motivation

1 in 2 adults will suffer from a musculoskeletal disorder in their lifetime



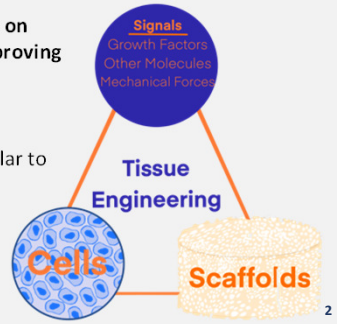
110,000 people are on the transplant waiting list in the US

Tissue Engineering Infographic[1]

- Organ shortage crisis
- Limited tissue regeneration abilities of the body
- Inadequate current treatments

Tissue Engineering

Tissue engineering (TE) focuses on **restoring, maintaining,** and improving **damaged tissue and organs.**



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Bioscaffold Requirements:

- Mechanically properties similar to target tissue
- Cells
- Growth Factors
- Biocompatible

Bioprinters

The purpose of using bioprinters is to be able to control the parameters of the scaffold.

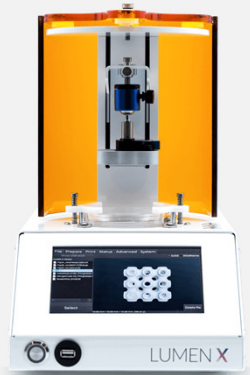
LumenX:

- Digital Light Projection (DLP)
- 405 nm crosslinking light
- 50µm resolution

Bioink Components:

- Photoinitiator (PI)
- Hydrogel
- Photoabsorber (PA)

Goal: To develop a bioink for the LumenX in order to print bioscaffold who's properties act as growth factors for tissue regeneration, and benchmark to graphene foam.



Cellink LumenX bioprinter available in the ANML lab[3]

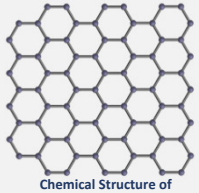
II. Graphene Synthesis

Why Graphene?

Nanomaterials such as graphene can be introduced to bioinks in order to utilize its mechanical and conductive properties. Previous work has focused on using graphene foam by itself as a scaffold, where bioprinting could give more control over scaffold parameters.

Graphene Foam Synthesis

Graphene is a single carbon layer arranged in a hexagonal structure and is synthesized via Chemical Vapor Deposition (CVD).



Chemical Structure of Graphene[4]

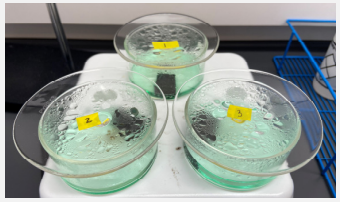
Nickel Foam

1. Nickel foam is placed in the furnace where it is heated in a vacuum and exposed to methane gas.

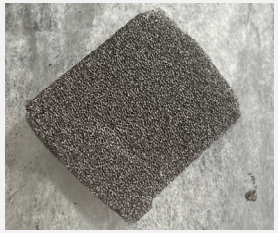
Chemical Vapor Deposition (CVD)

2. Methane is used to deposit carbon on the nickel foam.

Graphene Foam in HCl



3. HCl is used to selectively etch away the nickel and leave only graphene foam.



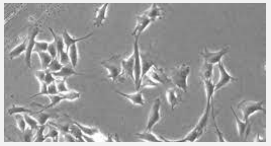
Graphene Foam

III. Future Work

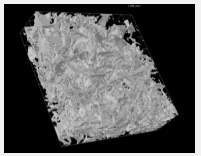
Cell Culture

C2C12 Cells

- Mouse Myoblast Cell Line
- Muscle tissue regeneration



C2C12 Cells[5]



Micro CT of graphene foam[6]

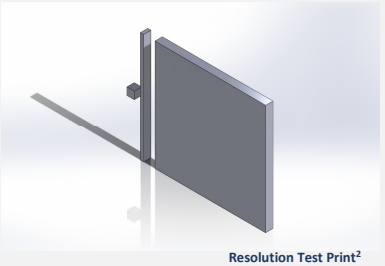
+ Cells

Micro CT of graphene foam with cells for 3D microstructure analysis

Developing Bioinks

Goal: To functionalize a bioink that can be printed as a scaffold on the LumenX while controlling the properties using CAD design software.

- Test different formulations of bioinks with different concentrations of PI, hydrogel, and PA.
- Measure rheological properties and resolution of the inks
- Incorporate conductive nanomaterials into inks



Resolution Test Print[2]

IV. Acknowledgements and References

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