

DESIGNING AN ORTHOGONALLY NON-EXPANDABLE METAMATERIAL

Mariela Cruz-Suarez, Zhao Research Group Lincoln High School, class of 2024 USC Viterbi Department of Aerospace & Mechanical Engineering, SHINE 2023



INTRODUCTION & PURPOSE

Metamaterials: Engineered materials with unique properties due to specific structures



Orthogonal metamaterial: designed with perpendicular and right angle features

PURPOSE

conform & deform

OBJECTIVES

RESULTS



METHODS

1. Design: create a unit cell in SolidWorks & repeat it to develop a rectangular material



3. 3D print: Print design using resin



2. Simulate: import design into abaqus to evaluate Poisson's ratio & functionality of design (ability to expand/extend)

Enhances healthcare technology by enabling

it to function on diverse textures, surfaces,

and stiffness levels, thanks to their ability to

Create a design that doesn't shrink when force is applied by utilizing angles

 $\leftarrow \text{ faces against force } \quad \swarrow \quad \rightarrow \text{ force (pull)} \rightarrow$



4. Test: Using a material testing machine, we can determine the materials displacement capacity before cracking from applied force (pull) and generate a plot



The **displacement curve plot** allows us to calculate the young's modulus & indicates that the material is **brittle** due to it's straight-line behavior. Brittle Materials have a **higher Young's Modulus** indicating greater resistance to deformation. They also exhibit controlled fracture behavior but have limitations such as low impact resistance due to the inability to absorb enough energy.

ACKNOWLEDGMENTS

Big thanks to **Steve Dorfman** for sponsoring my full scholarship, giving me this amazing opportunity. Also, thank you to the **shine staff** and **Liangshu Liu** for their support, shared knowledge, and time. Also thank you to my lab partners for their kindness & assistance.

When tested, the material

fractured towards the end

instead of in the middle.

This points to structural

flaws that occurred during

the 3D printing process like

the presence of air bubble.s

CITATIONS

SKILLS

Technical: SolidWorks for

Soft: I had to create multiple

iterations of my design with varying techniques that required

for running simulation

flexibility and creativity

designing 2D & 3D parts, Abagus

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5179975/#:~:text=Brittle%20materials%2C%20such%20as%20ceramics,loading%2C%20and%20shock%20or%20impact.

https://www.sciencedirect.com/science/article/abs/pii/S2214785321074435