“3D-Printed Auxetic Metamaterial-Integrated FBG Sensor: A Wearable Health Monitoring Approach”

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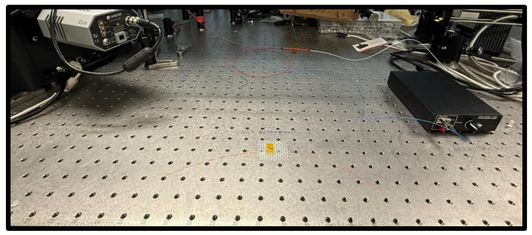
INTRODUCTION

Wearable sensors often face challenges with flexibility and inefficient strain transfer, leading to reduced sensitivity. This study presents a 3D-printed TPU-based auxetic metamaterial characterized by a negative Poisson’s ratio, the auxetic structure enables superior lateral expansion and strain amplification, improving overall sensing performance

RESEARCH OBJECTIVES

This study aims to design an optimized re-entrant auxetic structure for efficient strain transfer. An embedded FBG sensor enables optical strain sensing for physiological monitoring. Different auxetic geometries are analysed to compare their strain amplification and sensing sensitivity.

EXPERIMENTAL SETUP



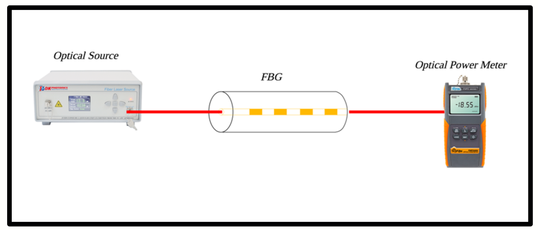
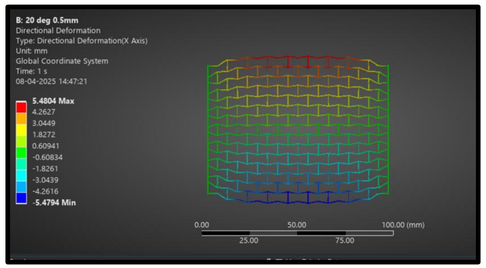


Fig 1: FBG Sensor Integration

RESULTS



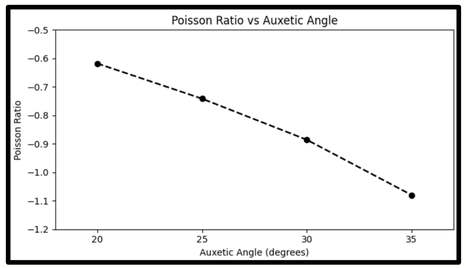


Fig 2: FEA results show that increasing the auxetic angle increases the negative Poisson’s ratio

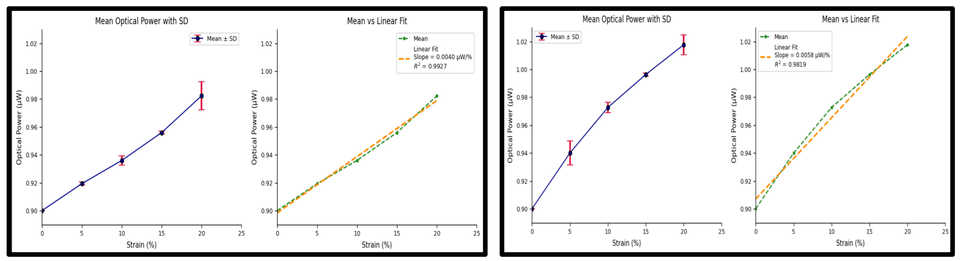
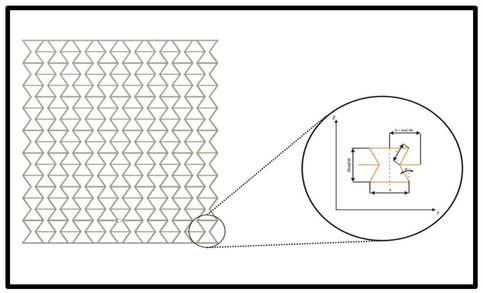


Fig 3: Error bars indicate strong repeatability and low variation across tests, confirming reliable sensor performance.



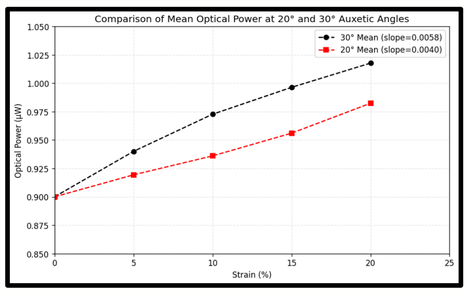
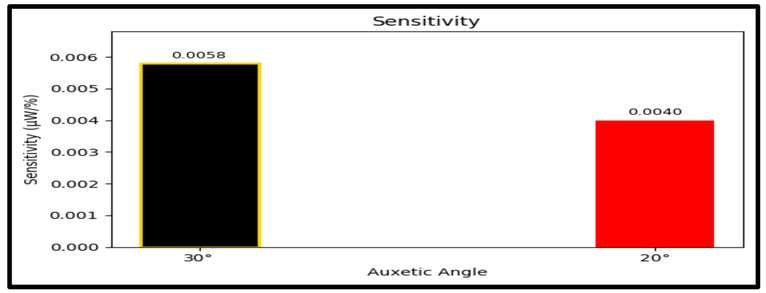


Fig4: Sharper auxetic angles lead to greater strain amplification and optical sensitivity

CONCLUSION

Sensitivity = ΔOptical Power/ΔStrain (%)
Observations:

- **30° auxetic angle** shows higher sensitivity: **0.0058 μW/%**
- **20° angle** shows lower sensitivity: **0.0040 μW/%**



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