Exploring the Potential of Recyclable PDMS-Based Polymers for Self-Healing, Flexible Sensor Applications

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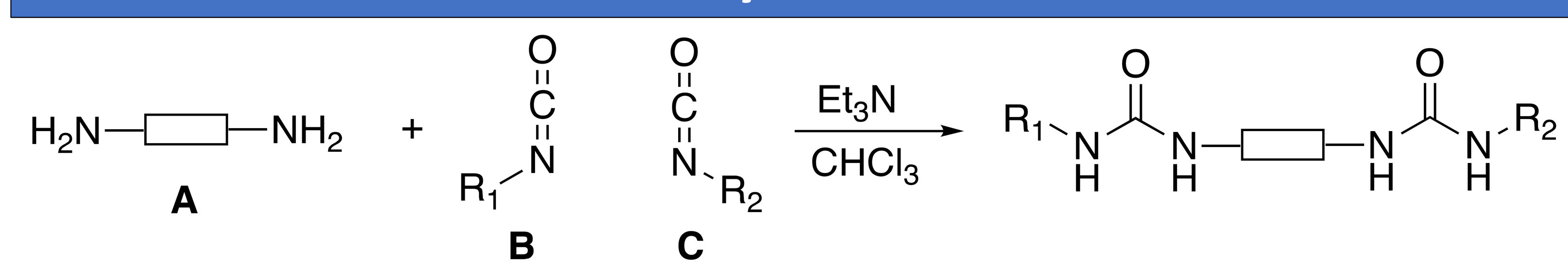
Introduction

Self-healing polymers have gained much attention in recent years for applications that range from coatings on aircraft to medical devices. The nanomaterials lab at Embry Riddle Aeronautical University has created a novel polydimethylsiloxane (PDMS) based material that can intrinsically heal at room temperature. The mechanism that allows for intrinsic self-healing is attributed to urea moieties, a functional group that exhibits both strong and weak hydrogen bonding. The reported self-healing material allows for small holes and rips to be repaired in approximately 24 hours. This material also demonstrated excellent stretchability allowing for a high elastic limit, where the material can return to its original length, as well as begin able to extend over 1200% before failure. Utilizing the flexible characteristics of this material a graphene based flexible stretch sensor was produced.

Synthesis



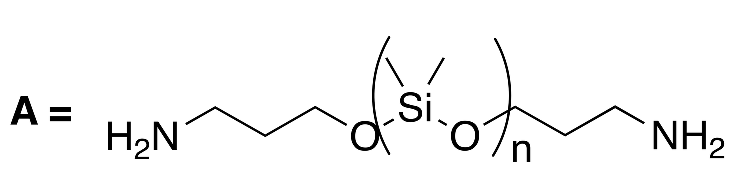


Figure 1: Synthesis of PDMS based polymer

Self-Healing

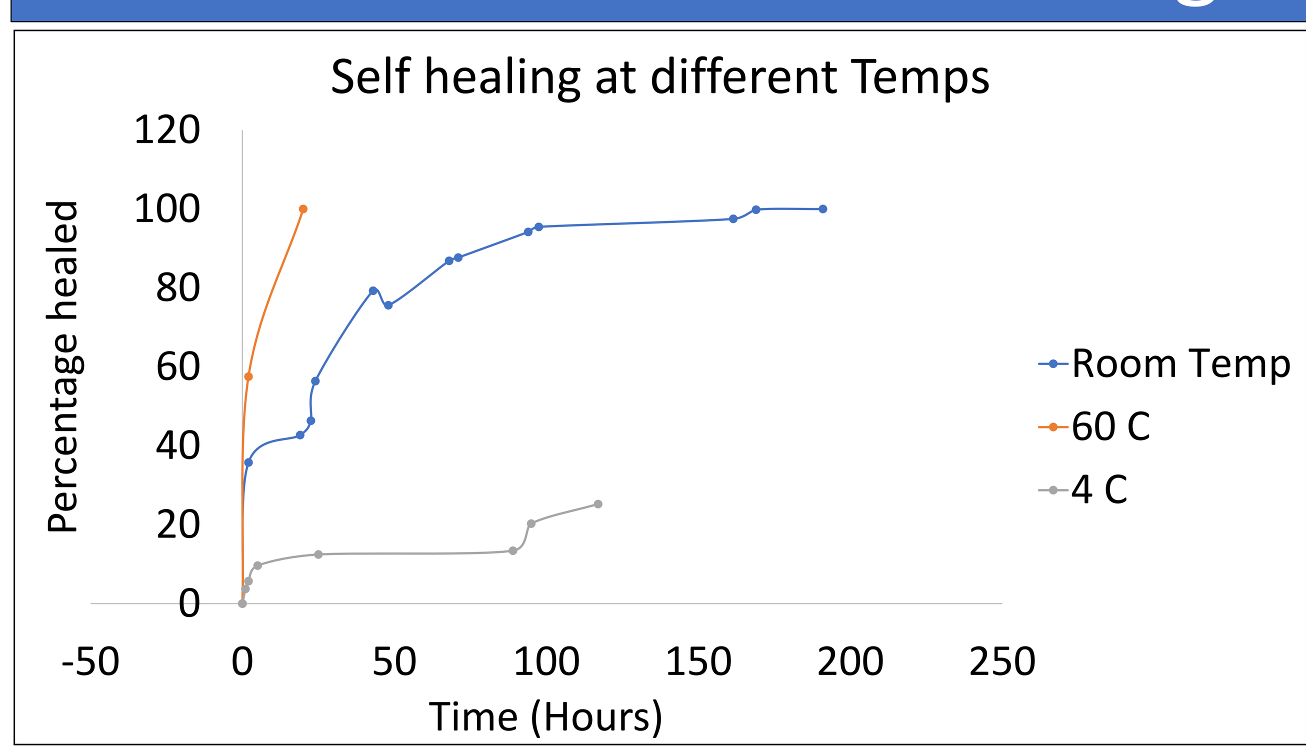


Figure 2: Self healing at different Temperatures with an average 0.4mm thickness.

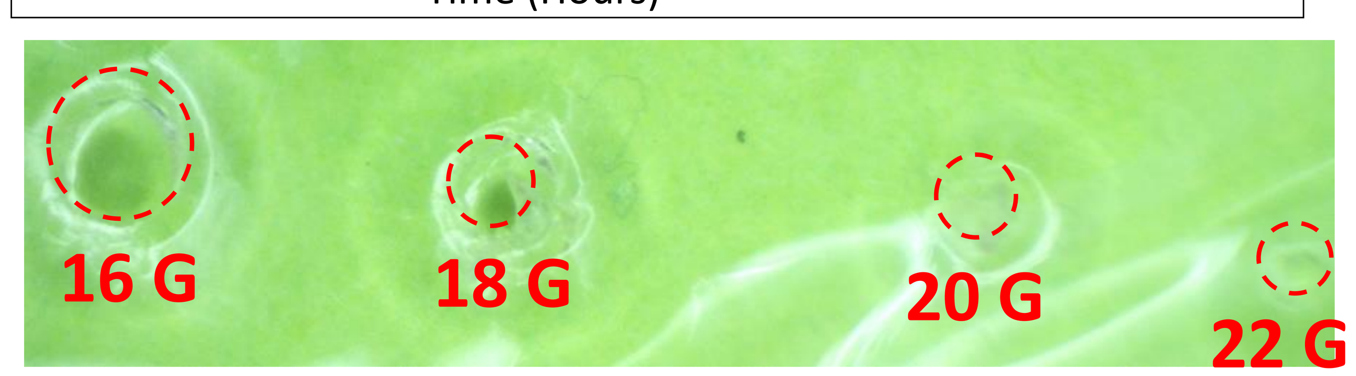


Figure 3: Initial image of damaged polymer with different gauge needles.

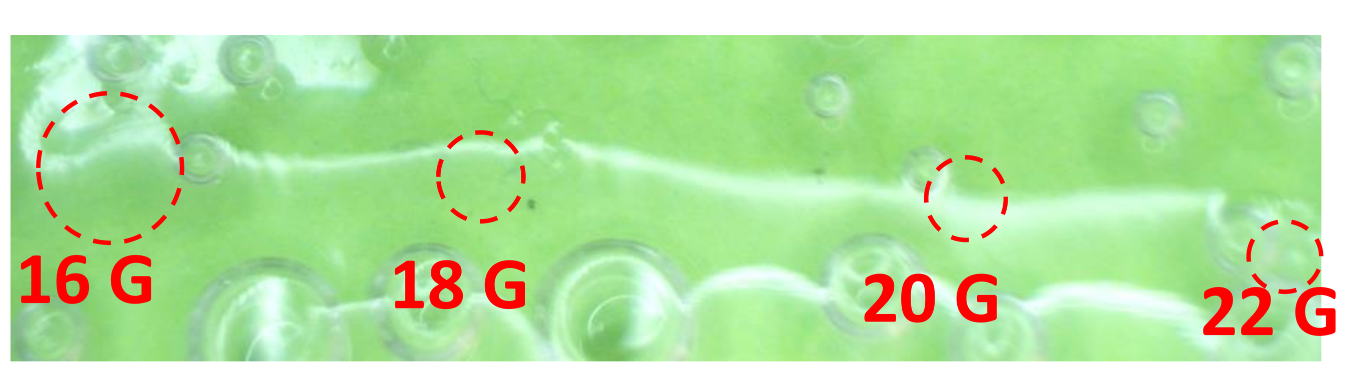
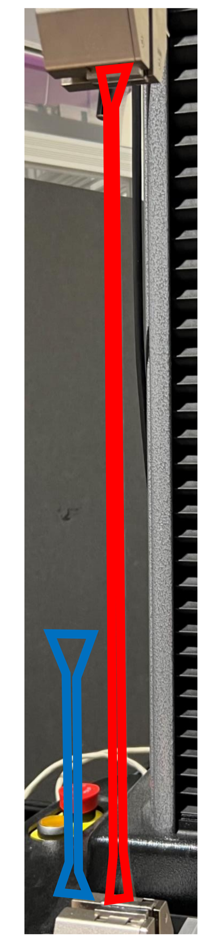


Figure 4: Self healing after 68 Hours

Tensile Testing



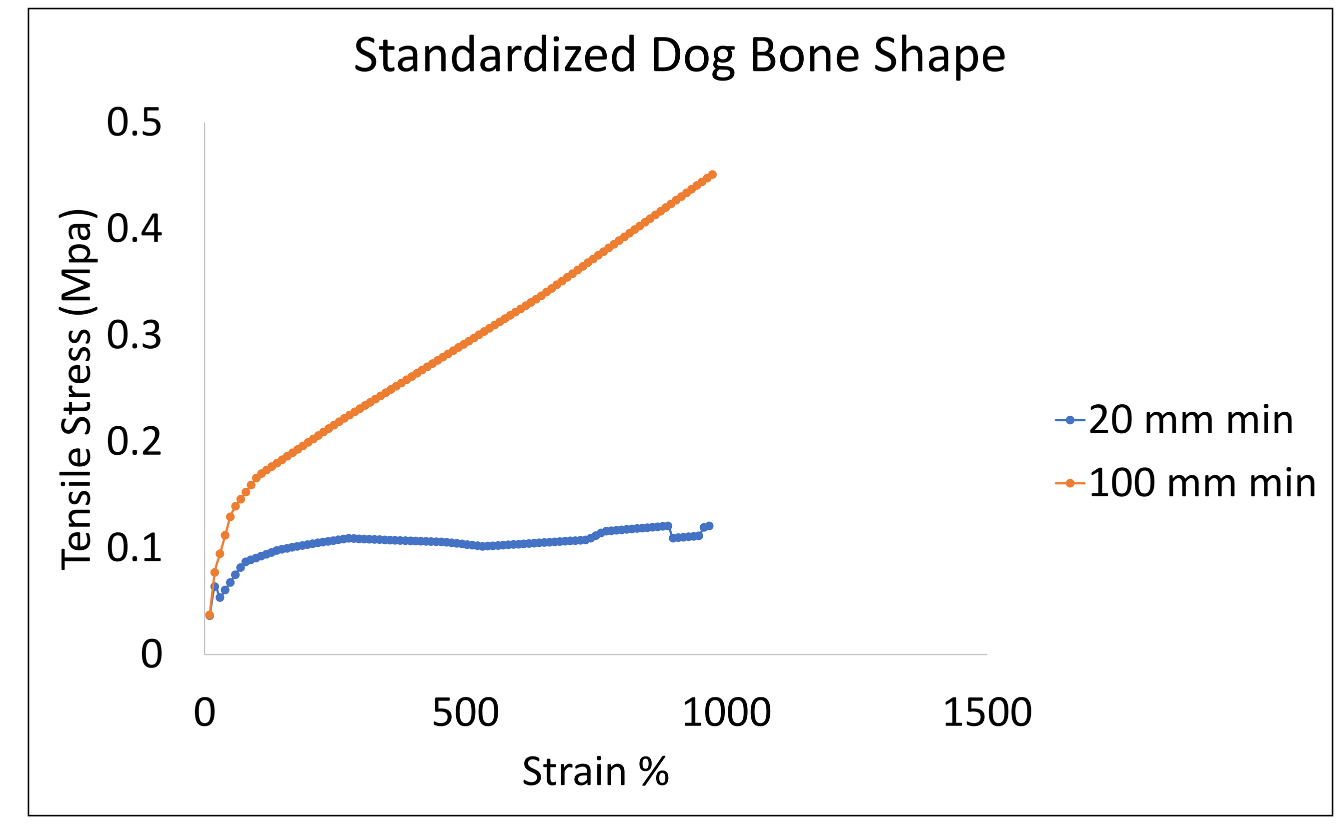
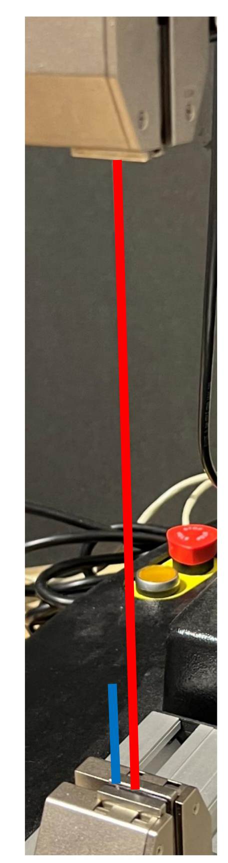


Figure 6 (right): Image with before outline in blue and after in red.
Figure 7 (above): Test with the standardized shape



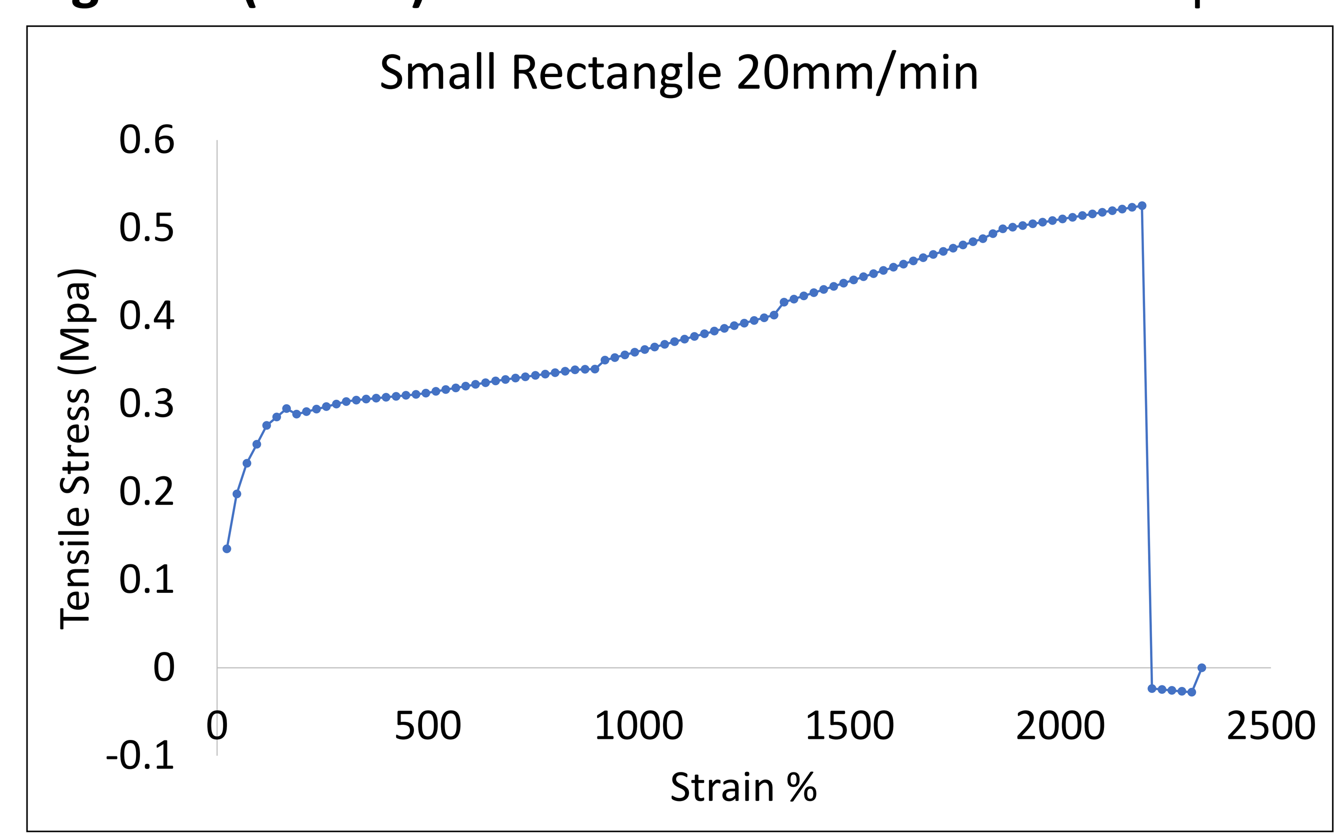
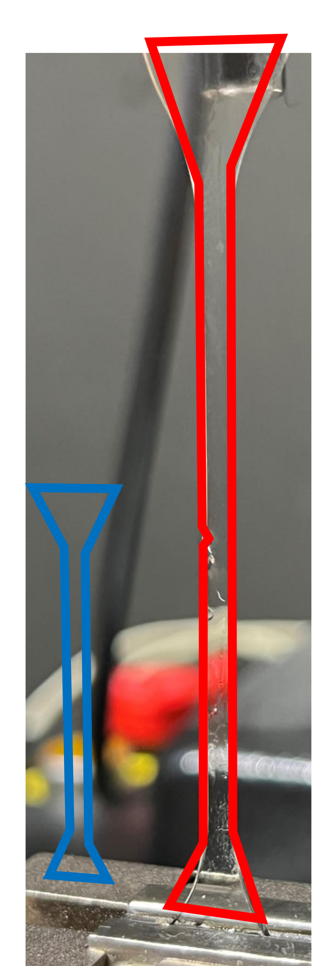


Figure 8 (right): Image with before outline in blue and after in red.
Figure 9 (above): Test with the rectangle shape



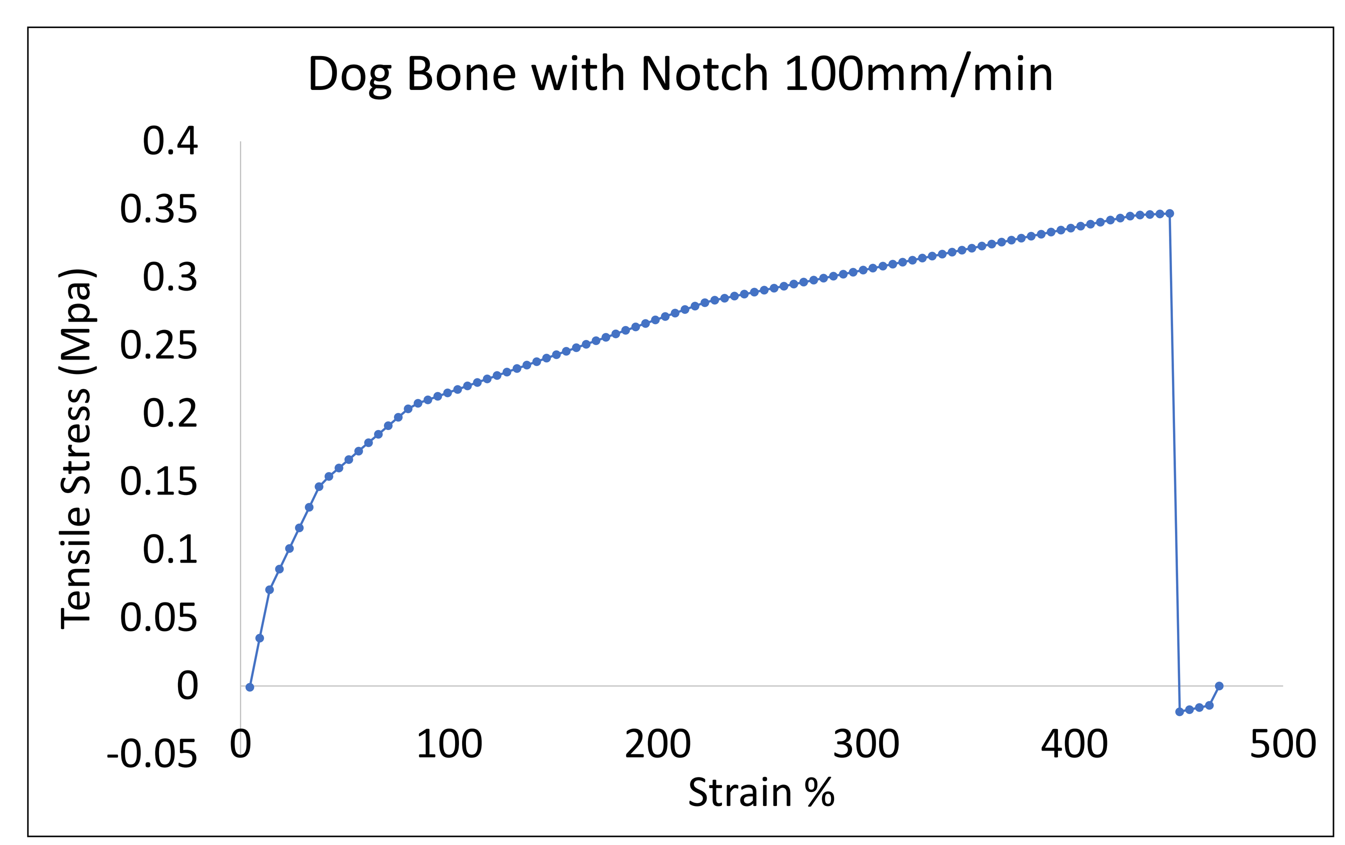
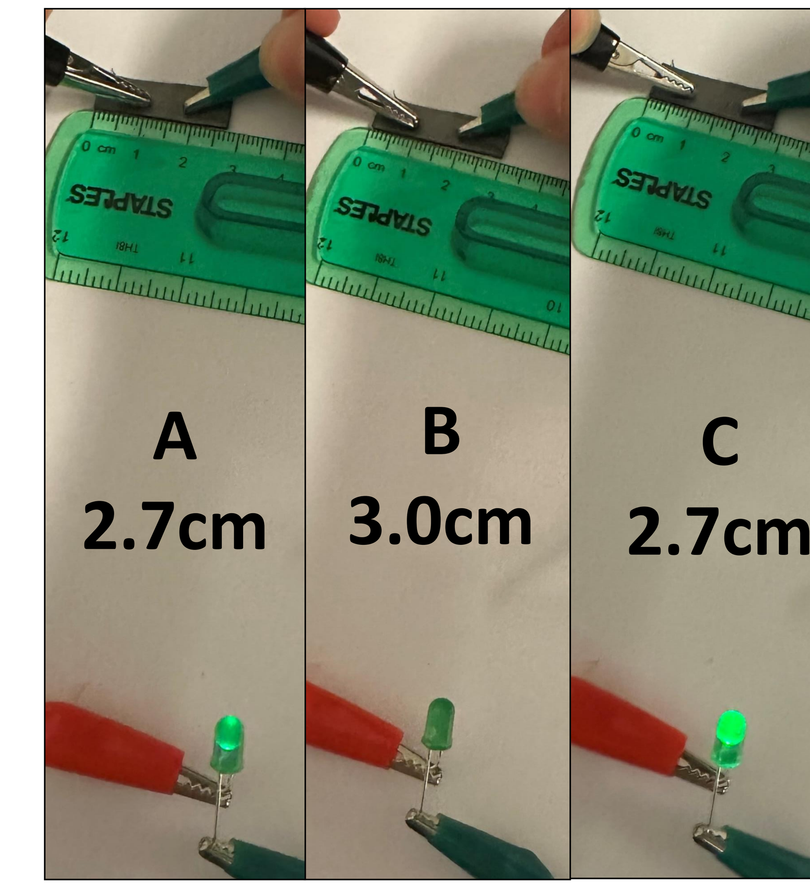


Figure 10 (right): Image with before outline in blue and after in red.
Figure 11 (above): Test with the standardized shape

Graphite Flexible Sensor

Figure 12 A: Initial SPH with graphene
Figure 12 B: Stretched
Figure 12 C: Returned to original length.



Video of Sensor

SEM

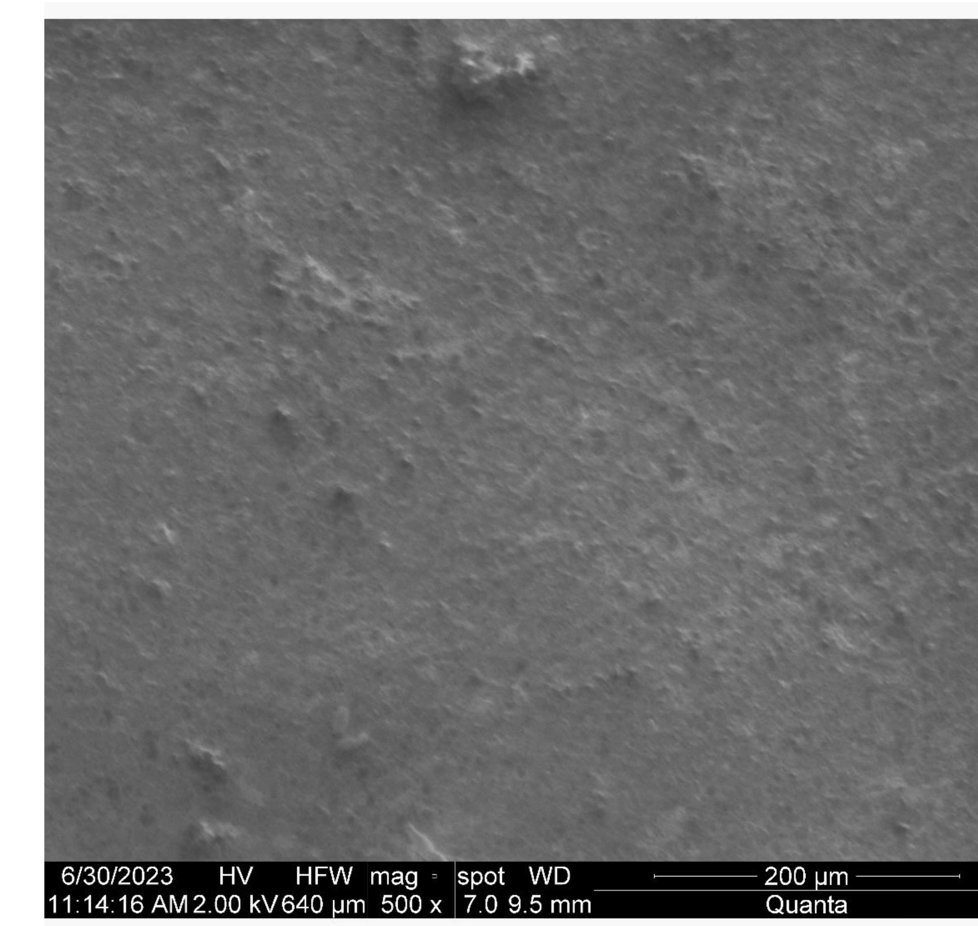


Figure 14: SHP with graphene on the surface

Future Work

- Sensor development
- Greener synthesis
- 3D printing

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