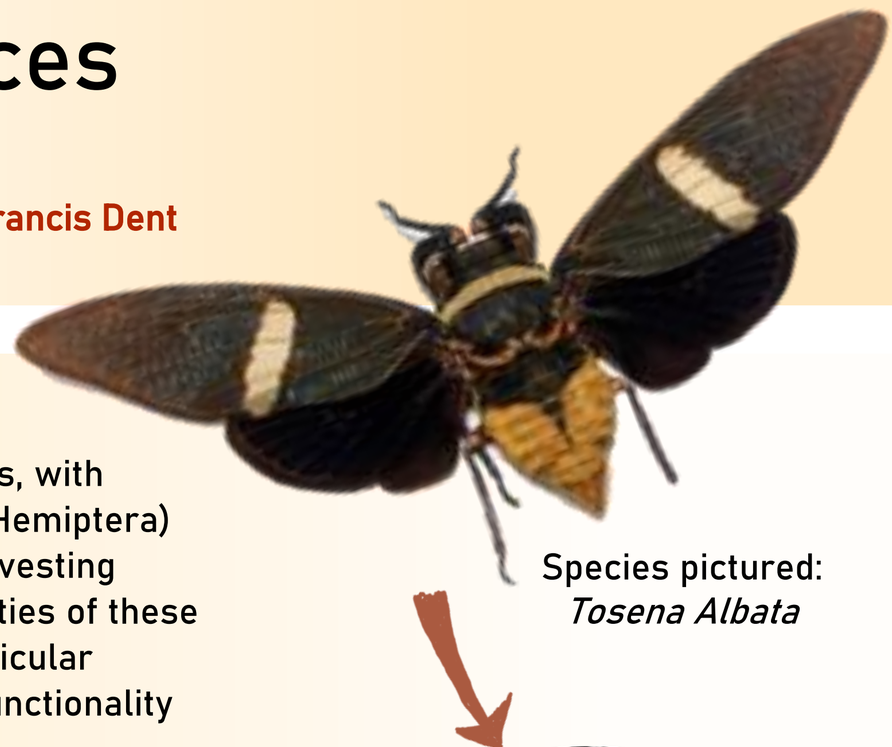
Development and Characterization of Biomimetic Micropatterned surfaces

Gulana Anwar
Supervised by Dr. Sepideh Khodaparast and PhD student Francis Dent
School of Mechanical Engineering

Introduction

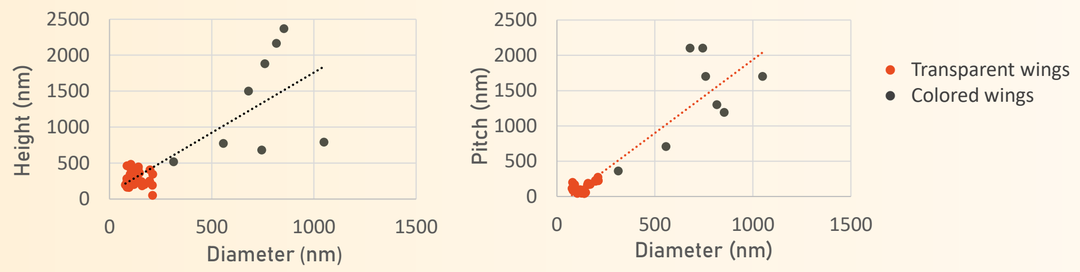
Biological specimens serve as promising templates for applications in a multitude of technologies, with many of them demonstrating superiority to man-made surfaces. In particular, the Cicada (order Hemiptera) insect presents notable properties relating to self-cleaning, wettability, bactericidal and light harvesting which have attracted the interest of biomimetic researchers for decades. The remarkable properties of these insects can be attributed to the wide variety of nano-features and patterns found on their epi-cuticular surface. Currently, knowledge of variations in topographies and its impact on the self-cleaning functionality is limited. The aims of this research are to

1. Characterize micro/nano topographies found on wings from existing literature and SEM
2. Produce a replication technique using the polydimethylsiloxane (PDMS)
3. Determine the feasibility of the replication technique by testing functionalities such as wetting



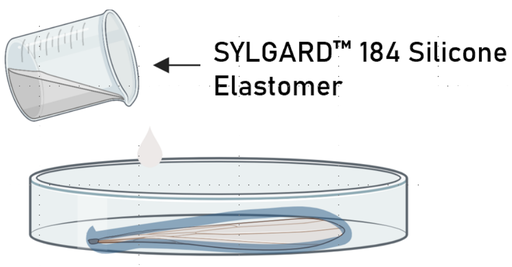
Characterization

Topographic data analysis of 50 species of Cicada insects wings from existing literature and current research revealed a correlation between height, spacing and diameter of the micro/nanopillars.

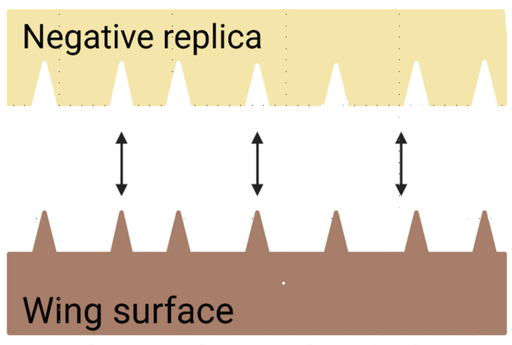


Figures 1 and 2: Graphs of topographical analysis.

Replica preparation

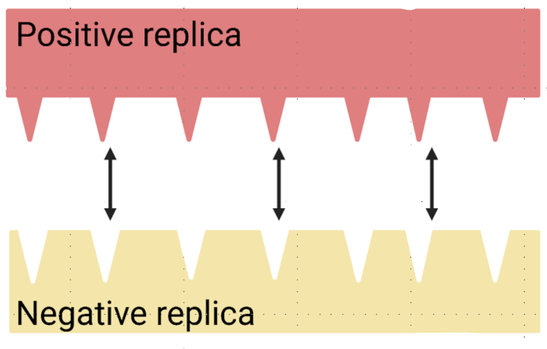


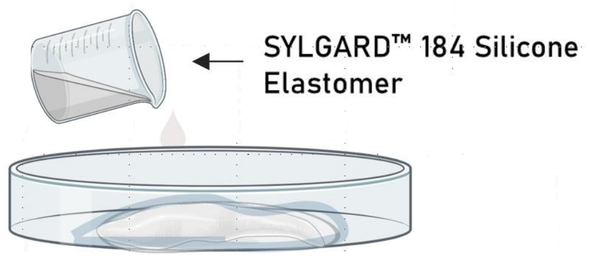
2x2cm sample of wing enclosed in Blu-tack



Sample is cured in oven at 40°C for 72 hours, then carefully peeled off using tweezers.

Sampleis silanized and cured in oven at 40°C for 72 hours, then carefully peeled off using tweezers.





2x2xm sample of negative replica enclosed in Blu-tack

Results

The resulting replicas were then analysed and imaged using SEM as shown. The replicas showed a significant increase in hydrophobicity by 25% on the *A. Floridula* species and 15% on the *T. Albata* species. The diameters of the patterns on the resulting replicas ranged within the original wing surface diameters. The results display a successful replication of two differing species of Cicada insects using PDMS/PDMS replication.

Species	Original CA (°)	Negative replica CA (°)	Positive replica CA (°)
PDMS (smooth)	103	103	103
T. Albata	135	128	118
A. Floridula	58	123	129

Figure 3: Contact angle (CA) measurements on the wings and their replicas.

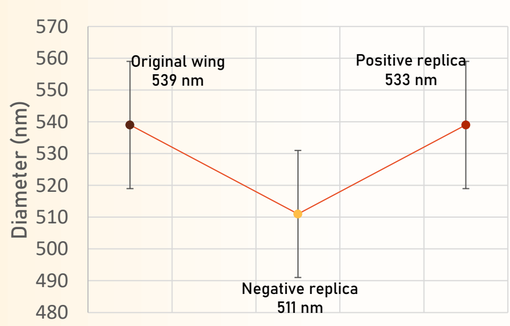


Figure 4: Graph of topographical analysis of replicated patterns for *T. Albata.*

Conclusions

This work demonstrates an efficient and cost-effective manner of patterning polymer surfaces, making it an effective way of fabricating micropatterned surfaces that possess key biological properties such as anti-reflection, anti-fouling and hydrophobicity. These results can be translated into real-world applications such as biomedical antibacterial coatings, lenses, solar cells and increasing the efficiency of photonics.