

Development of Biomimetic Polymer Structures at Small Scales for Responsible and Adaptable Adhesion Applications

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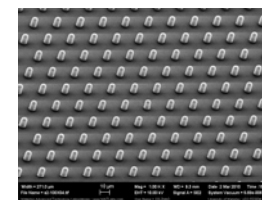
Introduction

- Conventional adhesives cannot be used for repeatable use, they adsorb contamination, and they cannot adapt for different exposure conditions.
- Mimicking biological adhesion systems can help to solve the drawbacks of conventional adhesives.
- The best prototype in nature is gecko, a kind of lizard which benefits from its dry adhesion system for locomotion.

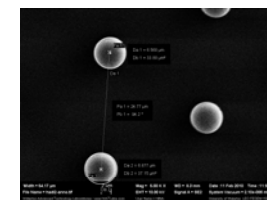
Objectives

- Fabrication of micro- and nanostructures resembling gecko toe pad hierarchical structure
- Synthesizing functional polymers resembling Beta-Keratin mechanical and chemical properties
- Characterizing the topography, adhesive properties, adaptability, and responsiveness of fabricated surfaces

Results



PDMS micro-pillars (45° view)



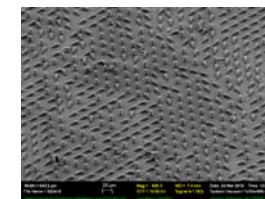
PDMS micro-pillars (top view)



Unpatterned PDMS (Contact angle ≈ 110°)



Patterned PDMS (Contact angle ≈ 142°)

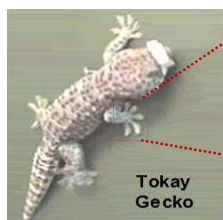


PDMS micro-pillars after washing with ethanol (45° view)

- The microstructures were successfully fabricated by soft-molding technique.
- Microstructures increased the hydrophobicity of the surface.
- Exposure conditions showed great effects on stability of microstructures.

Gecko Adhesion

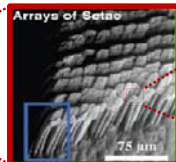
- The animals using dry adhesion system (spiders and lizards), despite of those using wet adhesion system (insects), do not secrete any liquid-like material between their foot pads and the substrate they attach.
- Gecko is the biggest animal using dry adhesion system.
- Gecko can attach to almost any surface (wheatear it is a wall or a ceiling, it is dry or wet, or it is smooth or rough).
- **Gecko responsive and directional adhesion ability relies on the hierarchical structure of its toe pad.**
- **Gecko toe pad has different levels of hierarchy:**



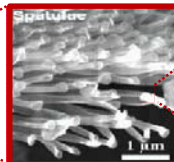
Tokay Gecko



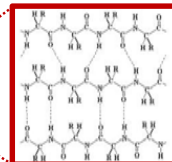
1st Level – Macro-Scale



2nd Level – Micro-Scale



3rd Level – Nano-Scale



Beta-Keratin

4th Level – Molecular-Scale

Micro-structure Fabrication

- Soft-molding technique was used because it is:
 - Cost-effective
 - Precise
 - Fast and simple

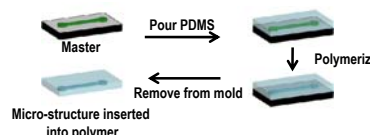


Image References:

- Gecko hierarchy images were adopted from Zhao, B. and Israelachvili, J.: *World Congress of Chemical Engineering*, Montreal, QC, August 23-27, 2009.
- Soft molding image was adopted from University of Cambridge, Department of Chemical Engineering and Biotechnology Website.

Future Plan

- Synthesizing developed diblock copolymers as adaptable and responsive elements of surface
- Applying synthesized diblock copolymers in fabricated microstructures to make them adaptable to different exposure conditions
- Characterizing adhesive properties and adaptability of polymeric surfaces by micro/nano tribological studies

Acknowledgement

- This work was supported by Natural Sciences and Engineering Research Council of Canada (NSERC). The master template was provided by Prof. Kimberly L. Turner, Mechanical Engineering Department, University of California, Santa Barbara, US.