Cell BioMechanics

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INTRODUCTION & BACKGROUND

Abstract

The mission is to understand the mechanics of cells within specific environments and the forces they generate. We looked at methods to develop micro-platforms to place cells on so we could simulate specific and controllable environments. We can use the knowledge of how cells exert force in specific environment to build systems that offer quick, accurate prognosis for patients under specific circumstances. Through this we can gain an understanding of normal and diseased physiology at a fundamental level.

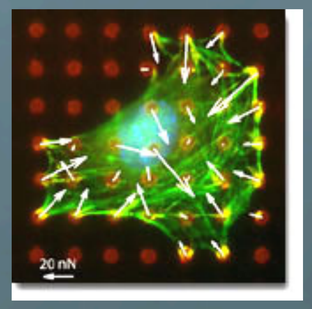

Fig. 1 Credit: Cell BioMechanics Lab

Our Main Goals

- Calculate force generated by mechanical movement of cells
- Control the environment of cells using nano wires and PDMS – micropost
- Gain an understanding of normal and diseased physiology through cell movement, and force generation

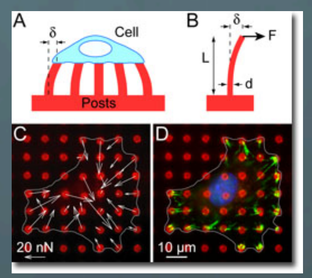

Fig. 2 Credit: Cell BioMechanics Lab

APPROACH AND EXPERIMENTAL METHODS:

PDMS Micropost Testing

In this investigation we wanted to look at how different temperatures and baking times affected the PDMS polymer that builds the micropost platform.

We evaluated the stiffness of the PDMS material by means of tensile testing to produce a stress vs. strain graph.

We measured the PDMS materials under the following baking conditions:

- 10 min at 60C
- 2hr at 60C
- 2hr at 110C
- 4 days at 60C
- 4 days 1t 110c

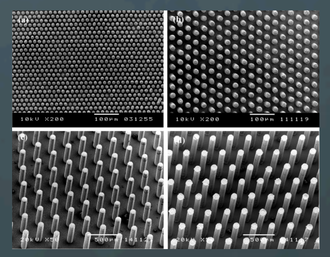

Fig. 3 Credit: Cell BioMechanics Lab

Nano Wire Embedding

In this investigation we wanted to look at more effective means of embedding nano wires within micropost. To do this we experimented with different rotational speeds and times in a centrifuge, which is the conventionally used method of embedding wires within the micropost structures.

We evaluated the effectiveness of the new techniques by hand counting under a microscope.

We tested the embedding under the following conditions:

- 5 minutes centrifuging at 1000 RPM
- 25 minutes centrifuging at 1000 RPM
- 5 minutes centrifuging at 4000 RPM
- 25 minutes centrifuging at 4000 RPM

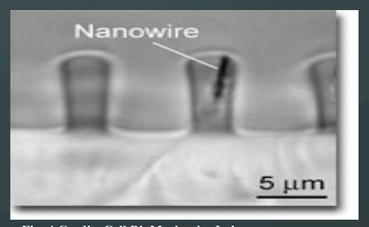

Fig. 4 Credit: Cell BioMechanics Lab

RESULTS

PDMS – Tensile Testing

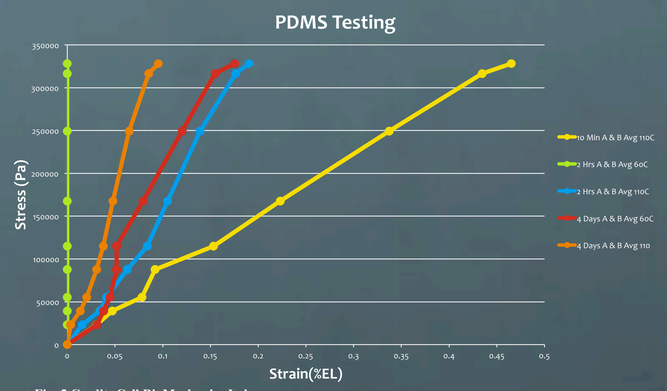

Fig. 5 Credit: Cell BioMechanics Lab

Fig 5 represents the stress strain curves for the five different PDMS micropost conditions. In this graph the PDMS that was baked for four days at 110C had the highest slope, and therefore the highest modulus of elasticity. This means that it has the greatest resistance to deformation, or elongation when force is applied. The green curve has been out ruled as inconsistent due to human error. The reason for only one 10 minute testing was due to the fact that cooking the PDMS material could not harden enough for testing after being cooked for 10 minutes at only 60C.

Nano Wires

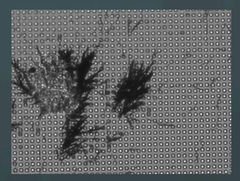

Fig. 6 Credit: Cell BioMechanics Lab

Fig 6 illustrates 1,000 rotations per minute (RPM) for five minutes. This image shows clumping of wires as a result of low speeds. It can be deduced that lower speeds are not effective for getting nanowires within the micropost.

Fig 7 represents the effects of centrifuging the nano wires into the micro post at 4000 RPM for five minutes. Under these conditions only a few nanowires made it inside the microposts. The gray, circular posts show the posts that have been created correctly. The empty circles are empty posts that are ineffective. Fig 7 shows that this condition was unsuccessful.

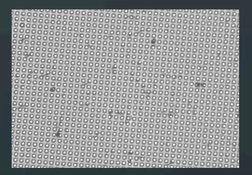

Fig. 7 Credit: Cell BioMechanics Lab

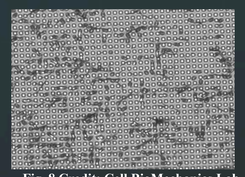

Fig. 8 Credit: Cell BioMechanics Lab

Fig 8 shows the affects of 4,000 RPM for 25 minutes. In the picture many of the wires were floating above the posts and were not able to make it inside the microposts, making for very ineffective conditions.

CONCLUSION

Nano Wires

Our results with the nano wires are inconclusive due to a few reasons; human error, limited time, very new technology. We were not able to conclude an effective method of embedding nano wires within the micro post due to the previous mentioned circumstances. If we had more time we would do more trials, and look for more efficient and effective technology.

Fig. 9 Credit: Cell BioMechanics Lab

PDMS – Tensile Testing

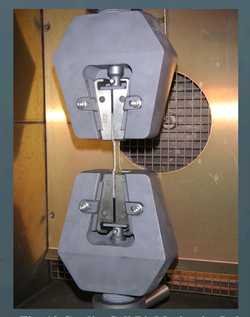

Fig. 10 Credit: Cell BioMechanics Lab

The tensile testing yielding very conclusive results once we exclude our outlier. Our data states that the longer you cook the polymer, and the higher temperature you cook it at, the stiffer the substance becomes, which aligns with our initial prediction, and results elsewhere.

Real World Applications

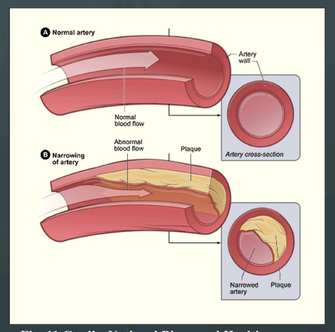

Fig. 11 Credit: National Bloog and Health Institute

During this investigation we looked at the movement of cells, and the force they generate in difference environments. When arteries have plaque build up as demonstrated in fig. 11, turbulent flow occurs, and subsequently the force that cells are able to generate are directly affected. With knowledge of how cells generate force during turbulent flow problem areas can be identified, and better medical diagnosis can be preformed.

Another big application for the knowledge of cell force is for trauma analysis. Platelets are currently being study for the force they generate when clotting. We know that the higher the trauma, the more force the cells generate. With this knowledge we can quickly assess how traumatic an injury is by quick analysis of how much force is generated at the point of injury.

Fig. 12 Credit: National Bloog and Health Institute

ACKNOWLEDGEMENTS:

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