DESCRIPTION OF WORK

- Use of photolithography to create patterns for PDMS stamps
  - Stamps used to pattern extra cellular matrix proteins
- Use of photolithography to fabricate microfluidic protein delivery devices
  - Patterned delivery of desired proteins for substrate functionalization and/or cell adhesion
  - Development of a highly-aligned monolayer of vascular smooth muscle cells to mimic arterial lamellae

MAJOR OBSERVATIONS

- Microfluidic devices yield highly-confluent, highly-aligned tissues that mimic native arterial lamellae and are similar to those fabricated using traditional microcontact printing methods
- Microfluidic protein patterning allows for long-term surface functionalization of PDMS substrates with genipin, allowing for increased temporal tissue viability and long-term vascular contractility experimentation

**Temporal Comparison of Fabrication Techniques**

_Schematic of Contractility Experiment_

**Long-Term Microfluidic Tissue Fabrication Procedure**

1. UVO Treatment
2. Placement of Device
3. Application of Treatment Solution
4. Solution Drawn Through Device Via Vacuum
5. Incubate @ 37°C
6. Remove Device
7. Cell Seeding

Scale bars: 200 μm
Capture of Isolated Single Muscle Fibers  
Edgar Arriaga (PI), Matthew Keefe  
Chemistry, University of Minnesota  
NNIN Facility utilized: Minnesota Nano Center

OUTLINE OF WORK

- Soft-Photolithography techniques were utilized at NFC to make SU-8 molds on 4” silicon disks for a microfluidic device capable of capturing single mouse muscle fibers
- Equipment used included CEE precision spinners, Contact Mask Aligners, and P-16 surface profiler

MAJOR OBSERVATIONS

- SU-8 2050 was found to be the best negative photoresist for achieving feature heights of ~100 micrometers
- High aspect ratio of the SU-8 photoresist is perfectly suited for the detail required in this device

2-D schematic of two channeled device capable of capturing muscle fibers, fibers flow through device, and are trapped in the channels as they narrow. In the mold, the SU-8 is represented by the white spaces of the schematic, while the white spaces represent fluid filled channels in the actual PDMS device.
**Cancer-on-a-Chip**

David Wood, Marie-Elena Brett, Alexandra Schonnesen, Alexandra Crampton

**Biomedical Engineering, UMN**

*NNIN Facility utilized: Minnesota Nano Center*

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**DESCRIPTION OF WORK**

- We have been working on a microfluidic model for intravasation and extravasation in cancer metastasis.
- Our lab uses the NFC facilities to fabricate master molds using soft photolithography techniques.

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**MAJOR OBSERVATIONS**

- Using the capillary burst model for our design we have been able to create cancer “tissues” within the microfluidic device and flow media adjacent to this tissue acting as a blood vessel (below left).
- Currently, media channels are lined with epithelial cells to create a more physiologically relevant blood vessel (below).
DESCRIPTION OF WORK

◆ Our lab utilizes the nanofabrication center at the University of Minnesota to create microfluidic devices capable of recapitulating physiological conditions in order to study Sickle Cell Disease.

MAJOR OBSERVATIONS

◆ By creating these devices, we can flow diseased blood through actually blood capillary sized channels and control the oxygen environment around the blood in hopes of discovering more about the process by which the disease affects patients.

◆ We are also developing a computational model of sickle hemoglobin based on thermodynamic principles. The goal of the project is to inspire novel therapies by understanding the molecular events of polymerization.

Publications

DNA Stretching in Nanochannel Confinement

Kevin D. Dorfman (PI), Julian Sheats, Damini Gupta
Chemical Engineering and Material Science, University of Minnesota
NNIN facility utilized: Minnesota Nano Center

DESCRIPTION OF WORK

- DNA molecules are injected into channels smaller than the radius of gyration to induce elongation
- Extension and diffusion measured as a function of channel size for rapid barcoding sequencing
- DNA molecules need to move smoothly through channels in order to measure equilibrium properties.

MAJOR OBSERVATIONS

- Roughness in channel surface likely cause of DNA sticking in channel.
- Residual conductive layer particles are the likely cause of roughness during etch.
- Placing the conductive layer on top of the ebeam resist removes roughness.
Goal: Develop flexible, ZnO nanowire based sensor for replicating human touch perception.

Photo: Training test run. ZnO seed layer on top of Cr layer using AJA sputtering system. Uniform, high quality result.
**DESCRIPTION OF WORK**

- Investigation of neutrophil chemotaxis under various stimuli (different chemoattractants or cytokines, enzyme inhibitor, other cell types, and drug effects)
- Evaluation of platelet adhesion upon exposure to mesoporous silica nanoparticles

**MAJOR OBSERVATIONS**

- The presence of various stimuli regulates neutrophil chemotactic behaviors by influencing hierarchy of chemoattractants and migration rates.
- Surface marker expression is altered in the context of neutrophil activation compared to naïve cells.
- High nanoparticle doses increase platelet adhesion and aggregation on endothelial cell layer.

**Publications**