Influence of surface topography and elastic modulus on protein adsorption and resulting cell response

Jie Li[1], Kyla Sask[1,2]

1. School of Biomedical Engineering, McMaster University, Hamilton, ON, Canada

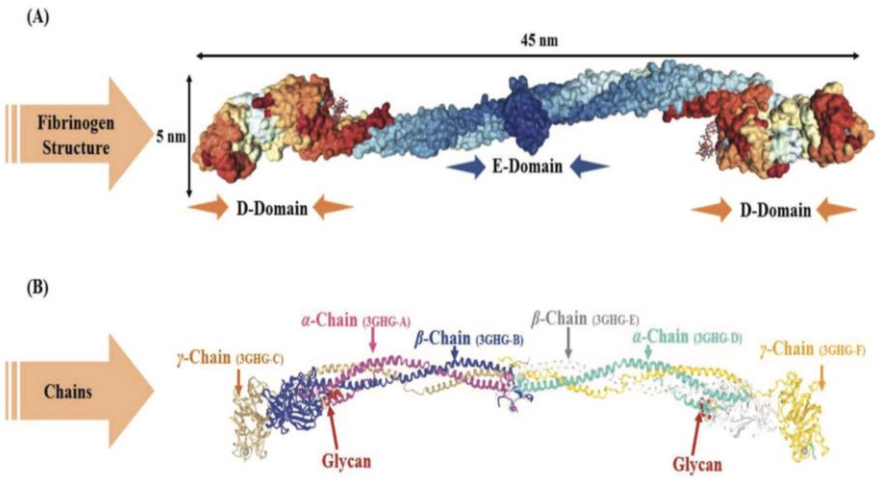
2. Department of Materials Science and Engineering, McMaster University, Hamilton, ON, Canada

May 13th, 2021

Email: Jie Li: **lij513@mcmaster.ca**

Background

- **Protein adsorption** to a material is a complex process which can cause thrombus formation, infection and inflammation leading to failure of devices.
- Surface properties such as chemistry, **topography** and **mechanics** influence protein adsorption and structural changes.
- **Fibrinogen** plays a dominant role in mediating platelet and leukocyte interactions with surfaces**.**
- **Macrophages** are essential in the immune response to biomaterials and the effect of protein conformational changes on their activation is not fully understood.

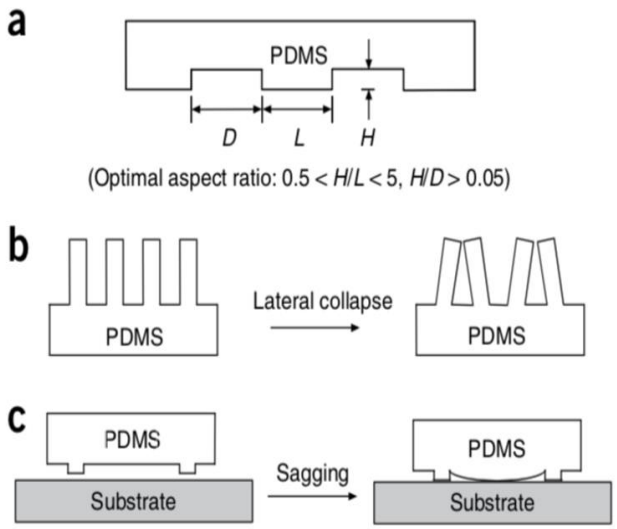


- This work aims to characterize **protein adsorption** and **conformational changes** on planar and patterned polydimethylsiloxane (PDMS) with varying **elastic moduli** and determine the relationship to **monocyte/macrophage response**.

Visalakshan RM, et al. *Adv Funct Mater,* 2019

Methods

- **Microscale pattern** ratios:
  (depth : groove width : ridge width)
  1. **20:20:15 µm**
  2. **10:10:10 µm**
  3. **20:20:10 µm**
  4. **10:10:5 µm**

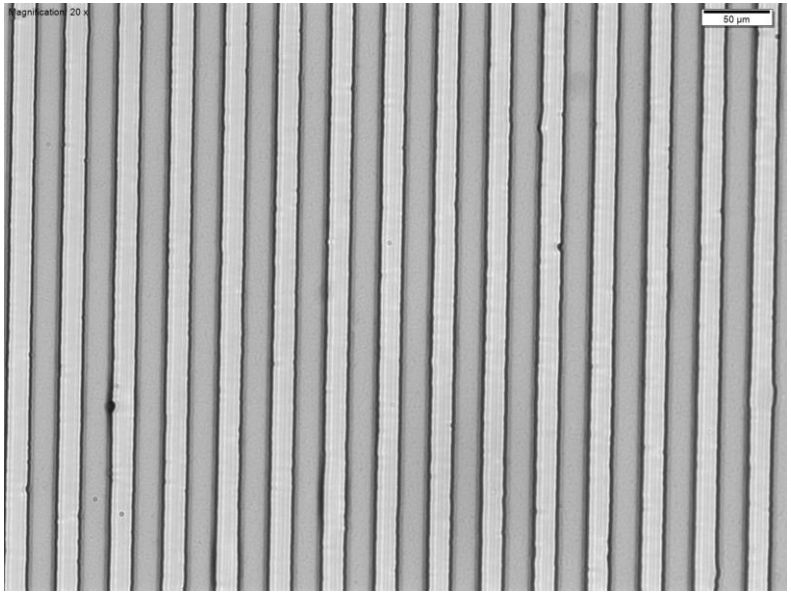


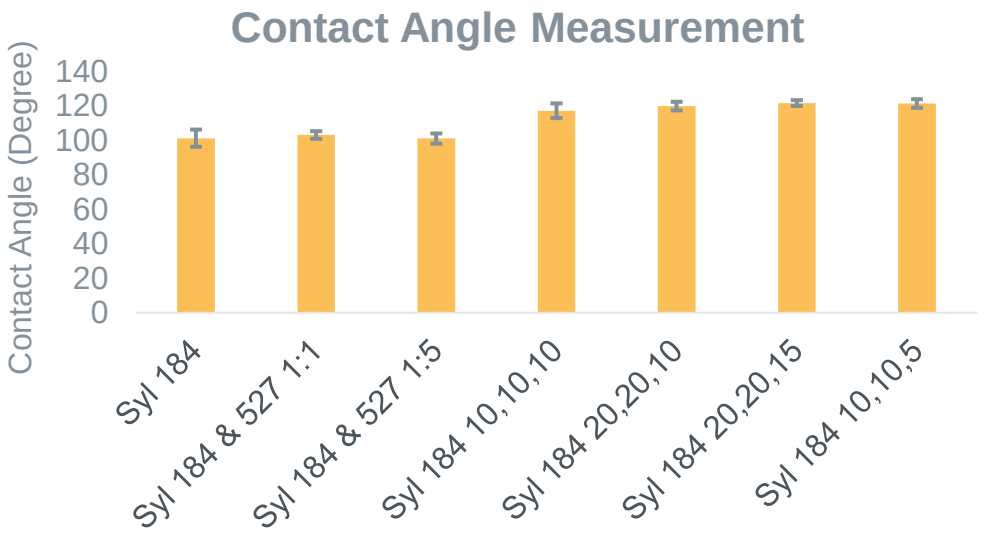
*Qin. D, et al. *Nature Protocols,* 2010.

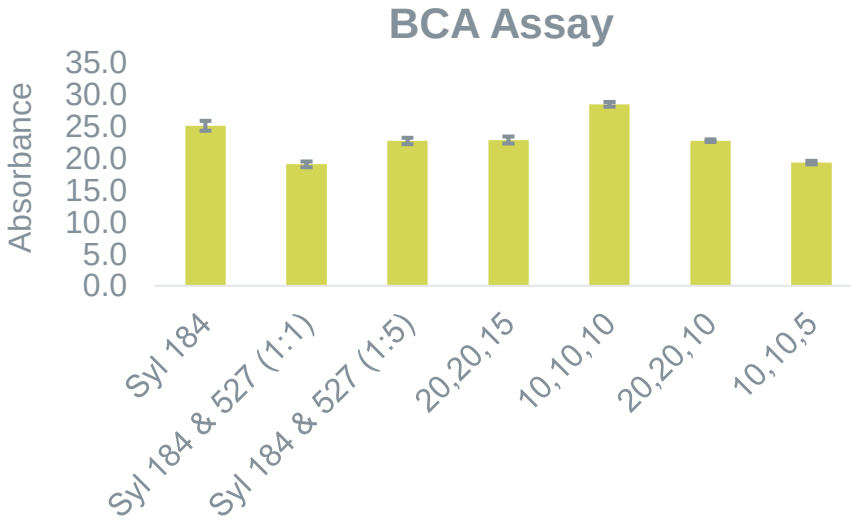
- **Photolithography** and **soft lithography**
  - Transfer micropattern patterns to polydimethylsiloxane (PDMS) substrates with varying ratios of Sylgard 184 and 527 or with PDMS-PEG (polyethylene glycol) (0.5%)
- **Micro-BCA assay**
  - To determine the amounts of fibrinogen adsorption on PDMS with the range of stiffnesses.
- **Antibody Binding Assay**
  - To investigate conformational and orientational changes of proteins using an antibody specific to the fibrinogen gamma chain.
- **RAW 264.7 monocyte/macrophage** cell line
  - To interrogate the role of protein conformation on leukocyte interactions.

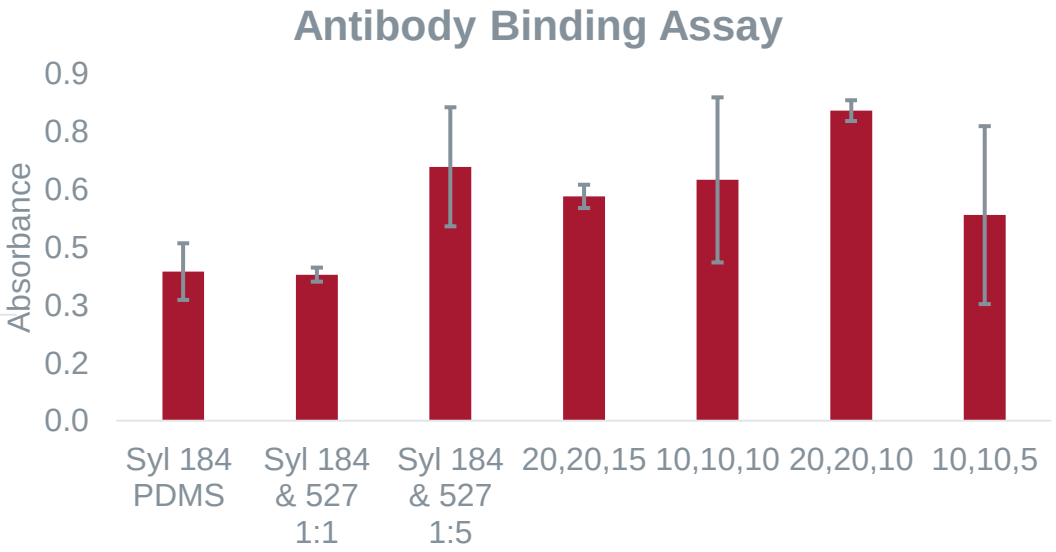
Results

20,20,10 µm









Summary

- We have successfully produced four different dimensions of microgroove patterns on PDMS substrates.
- Contact angle measurements demonstrate that the surface wettability is maintained despite changes to the substrate elastic modulus.
- The pattern surface with dimension 10,10,10 had the highest protein adsorption amounts, while planar surface Syl 184 & 527 (1:1) adsorbed the least.
- From a single fibrinogen solution, there is no indication of protein conformational changes.

Future Work

- **Protein interactions**
  - Antibody assay from plasma to assess conformational changes
  - Western blotting for various proteins
- **Cell response**
  - RAW 264.7 monocyte/macrophage cell line
  - Scanning electron microscopy (SEM), immunostaining, cytokine secretion

Acknowledgements

McMaster University ENGINEERING
ccem Canadian Centre for Electron Microscopy
Centre for Emerging Device Technologies
Biointerfaces Institute