Simplification of a microfluidic device fabrication method

Antoine Bassil[1], Areli Munive Olarte[2], Gwendolen Reilly[2]

1 Department of Bioengineering, University of Sheffield, UK.
2 Department of Materials Science and Engineering, University of Sheffield, UK

Background information:

Microfluidic devices containing cells enhances biological and pharmaceutical analysis due to its cost-effective results through its optimized scale-down. However, the fabrication of the devices is complex, expensive, and time-consuming.
In this project, silanization of PDMS moulds to facilitate the peeling of two types of porous emulsion-templated polymers was tested. Moreover, the attachment of Y201 hMSC cells seeded on a microfluidic device when under flow was observed through a fluorescent microscope.

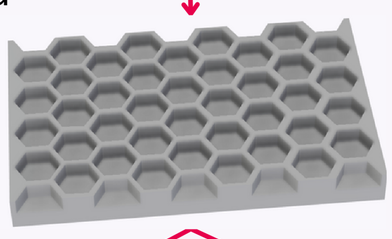
Methods:

- Microfluidic Device Fabrication:

1. PolyHIPE Scaffold

3D printed Positive Mold

PDMS Cast Negative Mold Ratio 8:1



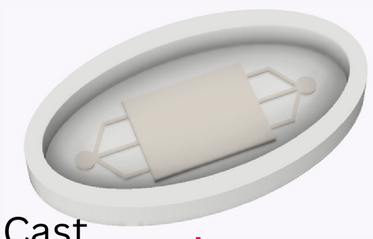
EHA-IBOA PolyHIPE

Control[1]: Surfactant 80%vol internal phase

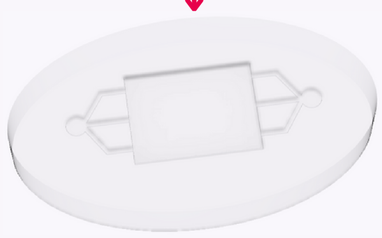
Pickering[2]: 85%vol internal phase

2. Chamber

3D printed Negative Mold



PDMS Cast Chamber Ratio 9:1



3. Bone Microfluidic Chip Assembly:

PolyHIPE: Plasma coat: 50W, 60s, 0.8mbar

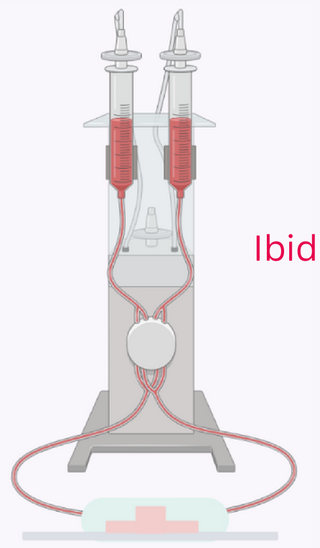
Chamber and Glass Slide: Plasma coat: 99W, 30s, 0.8mbar

→ Assemble Parts and Compress to Seal

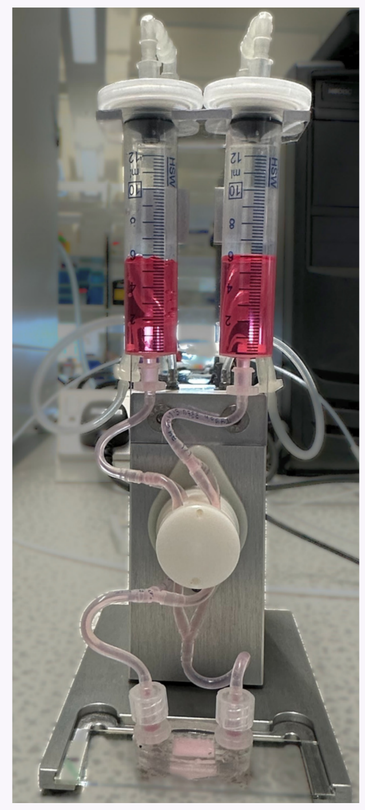
Bad Peeling of PolyHIPE from PDMS with Pickering due to the similar hydrophobicity and surface energy of PDMS and the polyHIPE, therefore suggested change in surface energy using surface modifications: plasma (hydrophilic), silanization (superhydrophobic).

- Microfluidic Device Testing:

hMSC (Y201)Cell Line Attachment:



Ibidi Pump

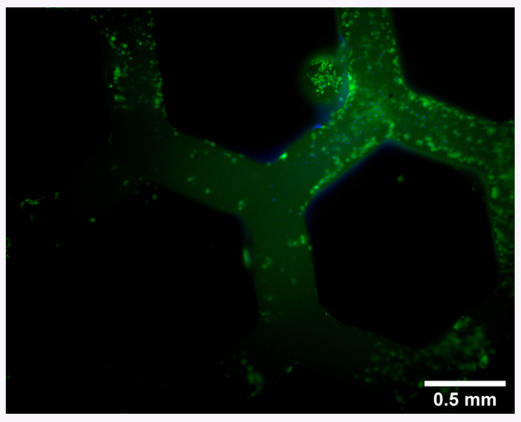


1. Sterilize with 70% ethanol
2. Wash with PBS then DMEM
3. Seed 1.5M cells statically
4. Unidirectional flow for 20hr at a rate of 2ml/min

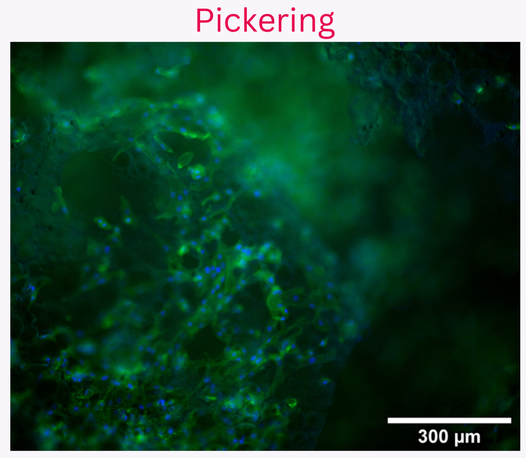
- Cell Morphology after perfusion:

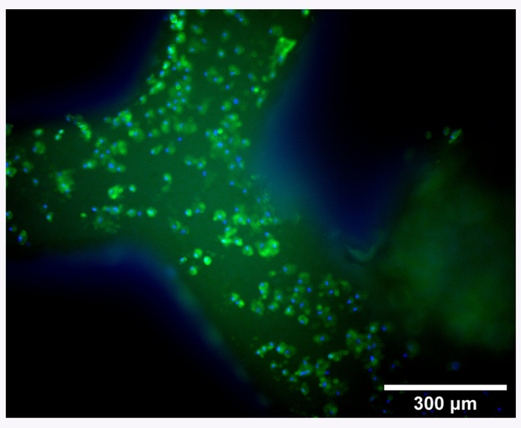
Surfactant: Irregular hMSC morphology, no migration through hexagons.
Pickering: Regular stretched morphology of cells, migration and detection within hexagon centers.

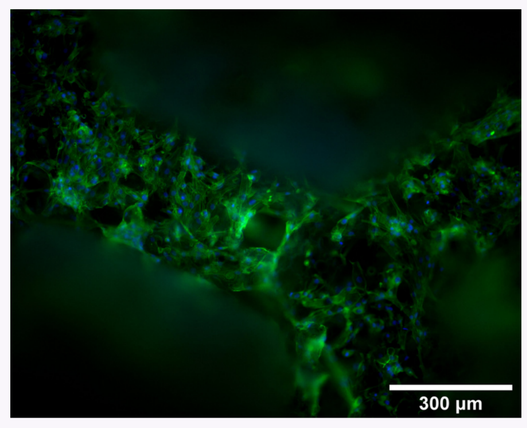
Surfactant



Pickering



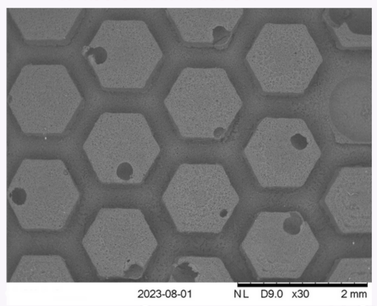




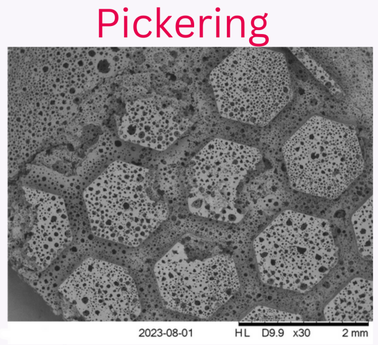
Results:

1. SEM:

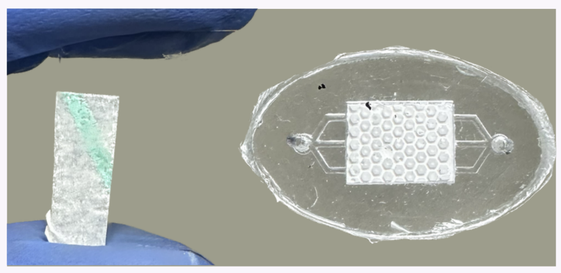
Surfactant

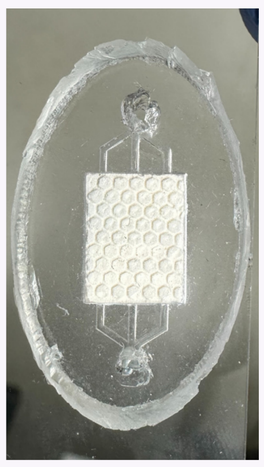


Pickering



2. Sealing:





3. Surface Modification:

	Untreated	Plasma	Silanization	Plasma and Silanization
Contact Angle	89°	56°	113°	99°

Peeling was improved using plasma or silanization.

Conclusion and Future Work:

Surface modification improved peeling of polyHIPEs in general regardless of its type. Silanization increased the hydrophobicity of the mold and in consequence the peeling. Cell attachment was observed on both polyHIPEs; however, cell migration within Pickering-based hexagons occurred due to its higher pore size and interconnectivity.
Can the use of a flat Pickering scaffold have similar perfusion without the hexagons?

In partnership with:

Doncaster and Bassetlaw Teaching Hospitals NHS Foundation Trust
Sheffield Teaching Hospitals NHS Foundation Trust
Sheffield Children's NHS Foundation Trust

Acknowledgement: Insigneo Institute for the opportunity of Summer Research Placement

Contact: abassil1@sheffield.ac.uk

References:
1. H. Bahamaee. et al., Front. Bioeng. Biotechnol. 8, (2020)
2. E. Durgut et al., Langmuir. 38, (2022)