Tissue Engineering

BioMEMS Shortcourse

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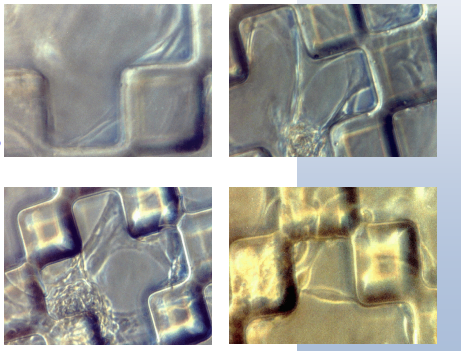
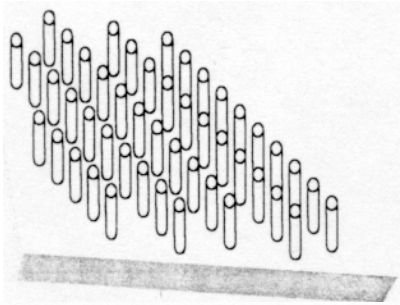
Cell Culture Results

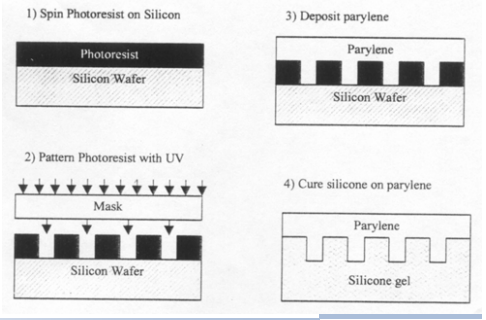
- Cells Cultured on PDMS Substrates (Plus-sign shaped structure)
  - Cell density in the smooth areas was only slightly higher than that in the microstructures
  - Two ends of cells attach to the two sidewalls of the corner
  - Cells migrate to the locations of highest surface area and then expand from there



Peg Scaffold

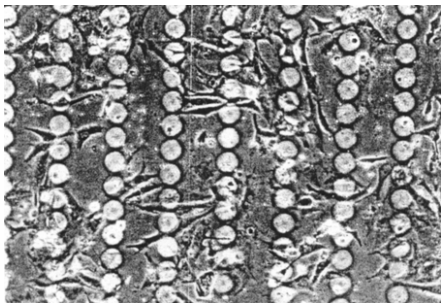
- PDMS cell culture scaffold
- Pegs with height 5 microns, diameter 10 microns
- Pegs spaced 20 microns center-to-center, in rows, 30 microns between rows
- Surface coated with laminin
- Cells grown in standard cell cultures are:
  - Not oriented properly
  - Weakly adherent to the substrate
  - Not 3-dimensional





Peg Results

- Cells frequently terminated with a blunt end on a peg
- Tendency for cells to straddle between rows



Cardiac myocytes cultured on silicone structure

Scaffolds Using Stacked 2-D Structures

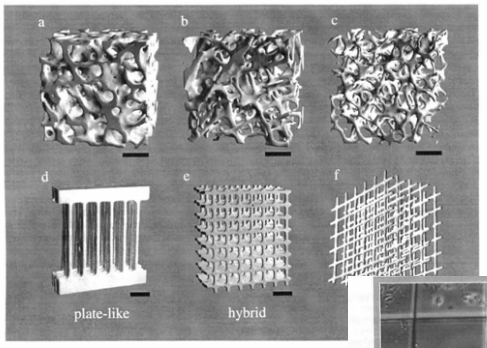


Fig. 3. Comparison of trabecular bone architectures with corresponding micromolded PU structures. architecture as found at different anatomical sites in the human skeleton have been used for the model spine), and hybrid (b, iliac crest). The images correspond to a 4mm × 4mm × 4mm portion of the sam micromolded (d–f) structures were measured using a desktop micro-CT at 17 μm nominal resolution.

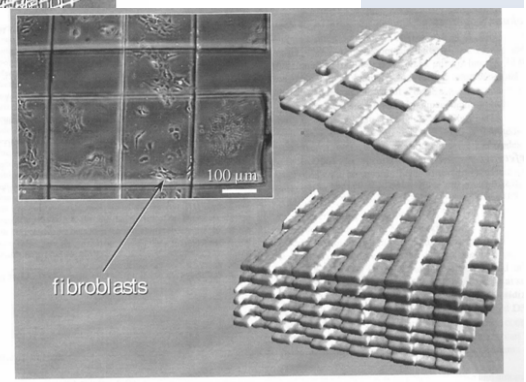
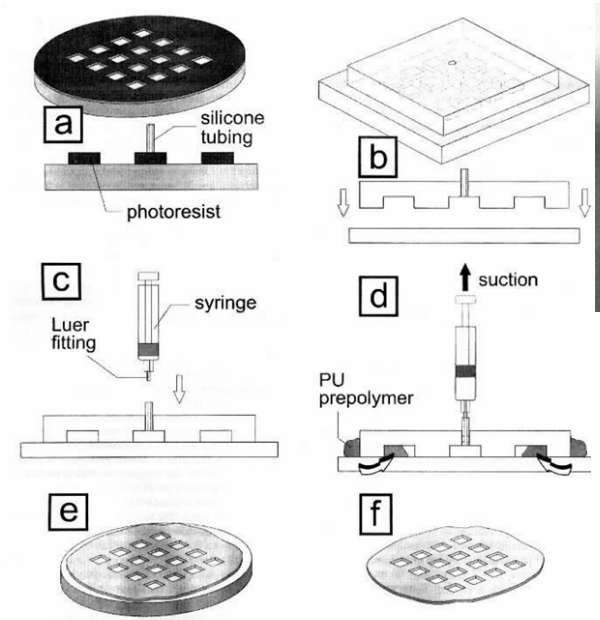


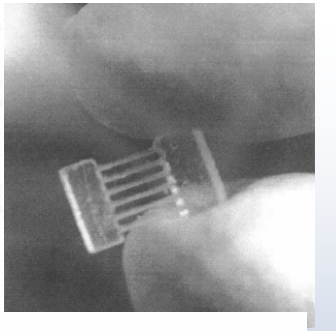
Fig. 4. (top left) Phase-contrast optical micrograph of 3T3-J2 fibroblasts cultured on a PU microstructure featuring 200 μm-wide intercrossing beams, (top right) micro-CT of the PU microstructure. (bottom right) micro-CT image of a 7-layer stack of the same microstructure.

Stacks of microstructures for tissue engineering

Fabricated using polymer injection method

PDMS molds





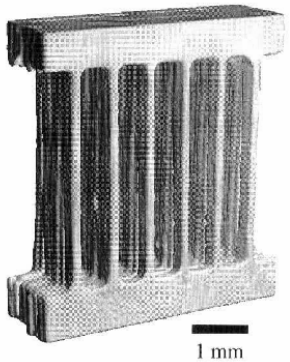
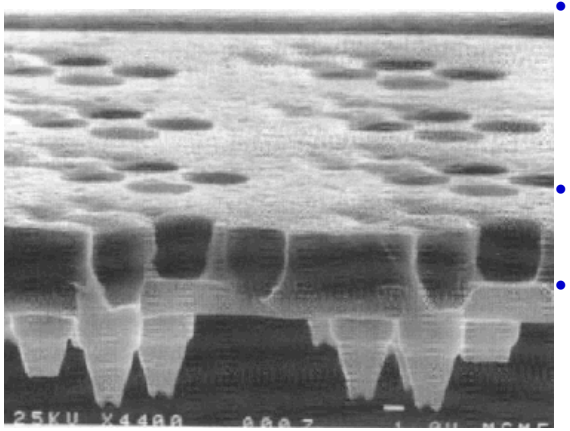


Fig. 1. Microfluidic patterning of stand-alone PU microstructures. a) A master wafer is photolithographically patterned and a piece of silicone tubing for the inlet is placed on the master. b) A PDMS replica of the master (containing the embedded silicone tubing inlet) is sealed against a flat PDMS base. c) A syringe is manually interfaced with the inlet through a Luer-lock connector. d) PU pre-polymer is added onto the outlet areas and suction is applied at the inlet to allow PU pre-polymer into the PDMS microchannel. e) After curing the PU within the PDMS microchannels, the microchannels are separated from the PDMS base. f) The PU structure is peeled off the PDMS base.

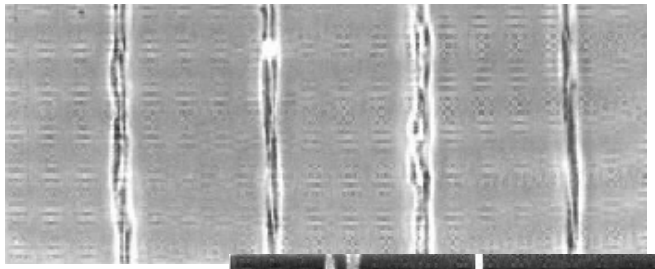
Cell Encapsulants

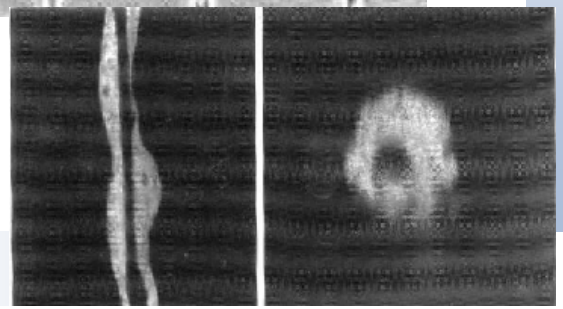


- Encapsulated cells protected from immune system
  - Antibodies repelled
- 18 nm pores fabricated using sacrificial oxide
- Encapsulated islet cells survive and respond to glucose levels

Functional Capillaries on a Chip

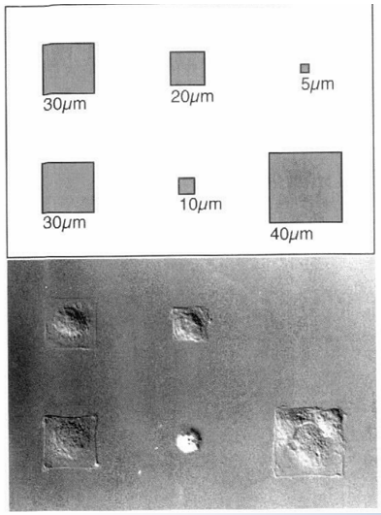
- 10 micrometer lines induce capillary formation in endothelial cells

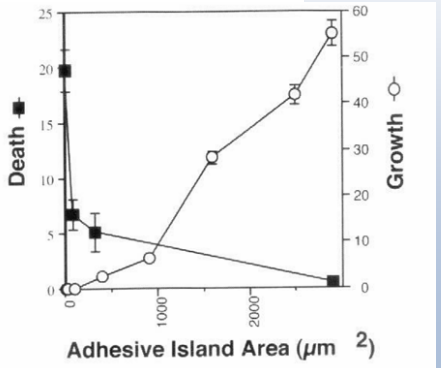


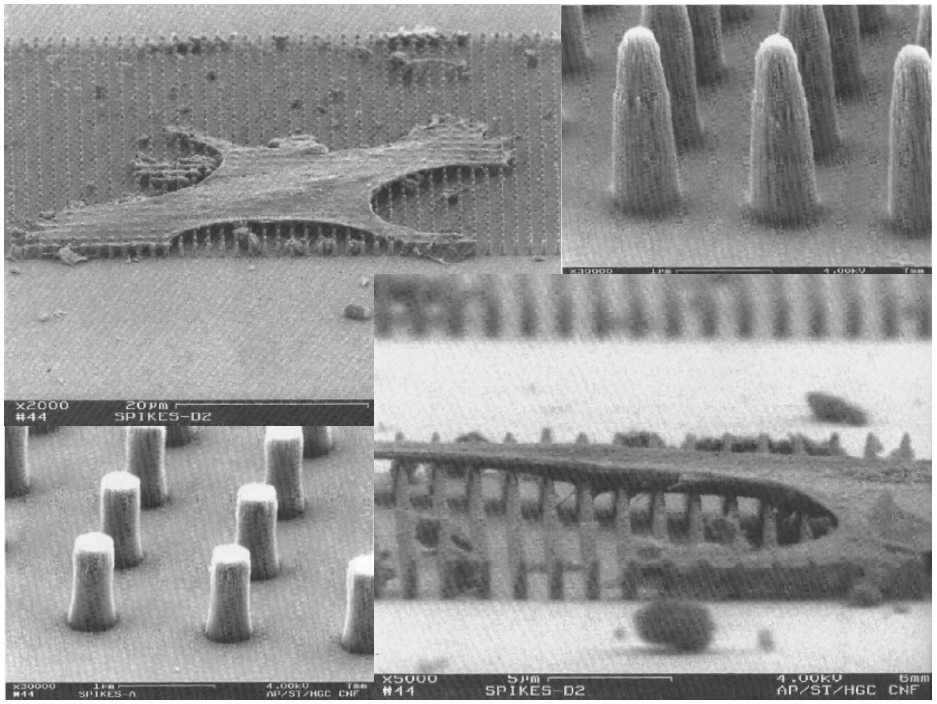


Controlled Cell Death

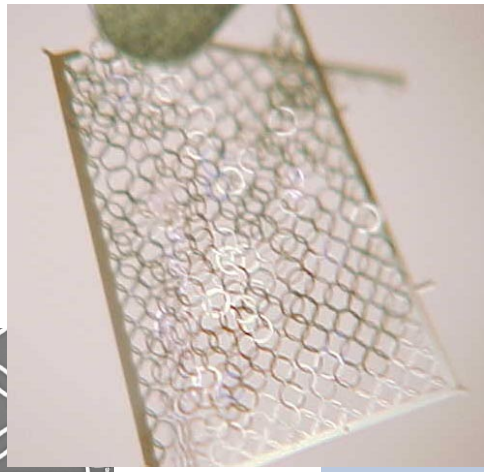
- Cell areas linked to apoptosis (cell suicide)

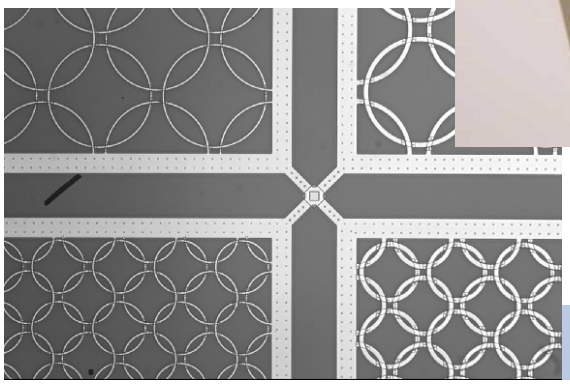






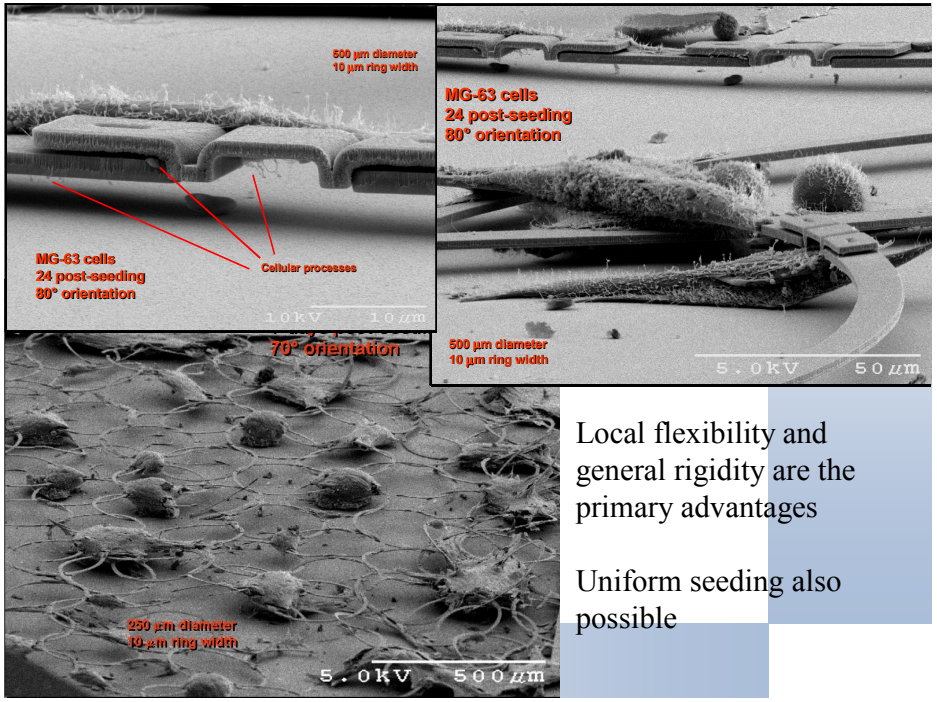
Chain Mail for Bone Engineering





Multi layer polysilicon process

Made using metals, polysilicon, and SiO_2



Local flexibility and general rigidity are the primary advantages

Uniform seeding also possible