Bioprinting of Hybrid Tissue Engineering Constructs

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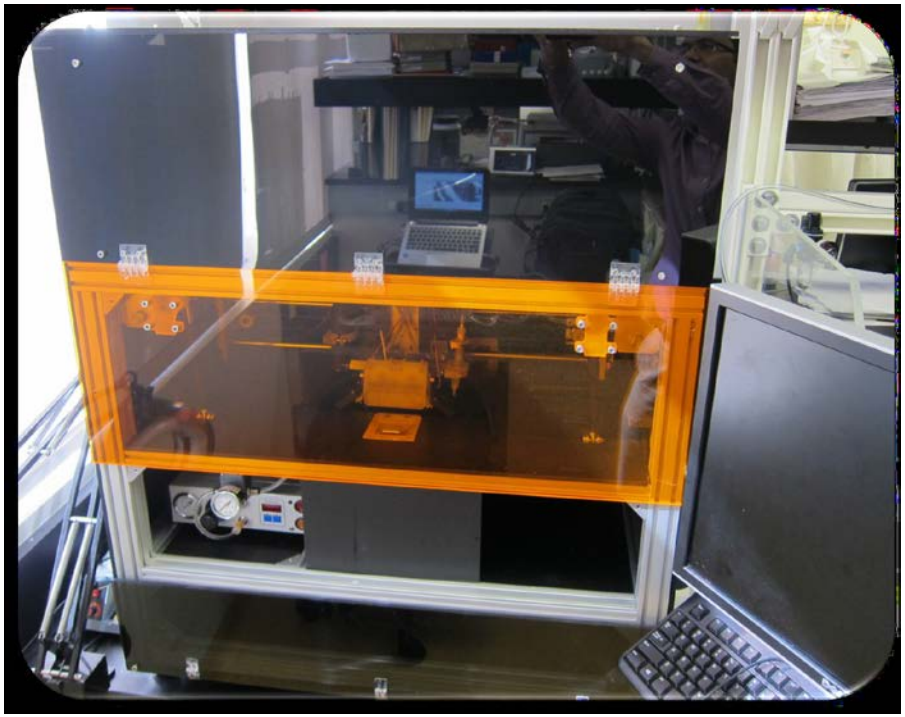
Living Tissue Printing is Currently Limited

Lack of a multifunctional platform for printing combinational constructs with both rigid structure for mechanical support and soft materials that can be cell-laden

Invention from the Lab of Prof. Peter Yunzhi Yang



"Hybprinter"

Multi-materials platform that includes:

- FDM of rigid plastics & ceramic composites
- SLA of fine hydrogel structures
- Syringe deposition of cell types

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Details

- **FDM (molten extrusion)** of poly-(ε-caprolactone) and its ceramic composite
- **DLP-SLA (Digital Light Projector-Stereolithography)** of poly-ethylene glycol diacrylate hydrogel of human umbilical vein endothelial cells that express GFP, with photo-initiator
- **Syringe deposition** of human mesenchymal stem cells

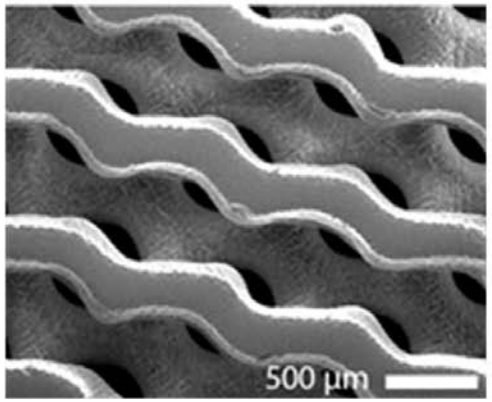
- Even with 90% hydrogel and 10% plastic, the modulus is 6 MPa (versus 0.1 MPa for the hydrogel alone)

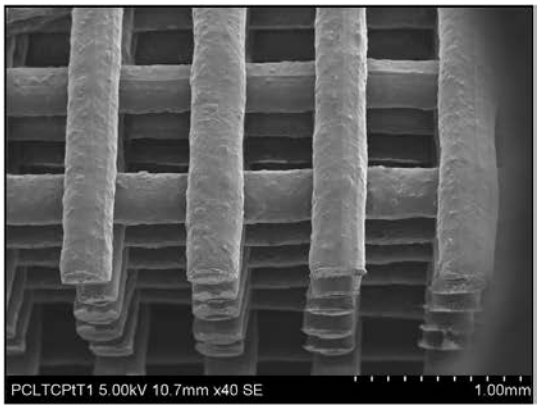
The Hydrogel

- Photo-sensitive and can be patterned on a fine scale
- Can contain cells and growth factors
- Structures can have graded properties, simply by altering the light exposure
- This can control the release profiles of growth factors as a function of location

3D Printing of Porous Rigid Structures

- ✓Fine micro-architecture
- ✓Controlled porosity , pore size and shape
- ✓Functionally-graded internal architecture





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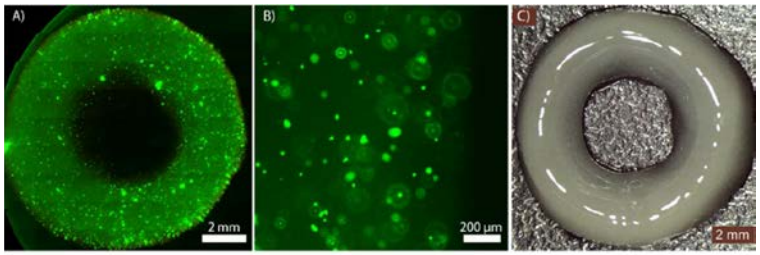
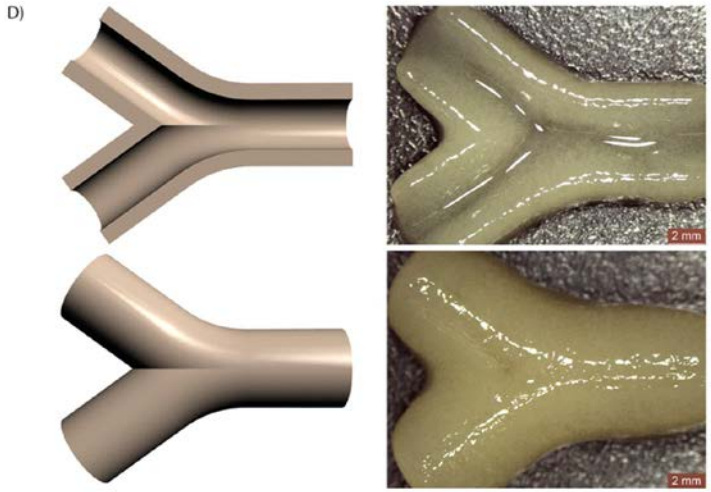
3D Printing of Cell-laden Soft Hydrogels

Functionally-graded physical and mechanical properties in X,Y,Z directions:

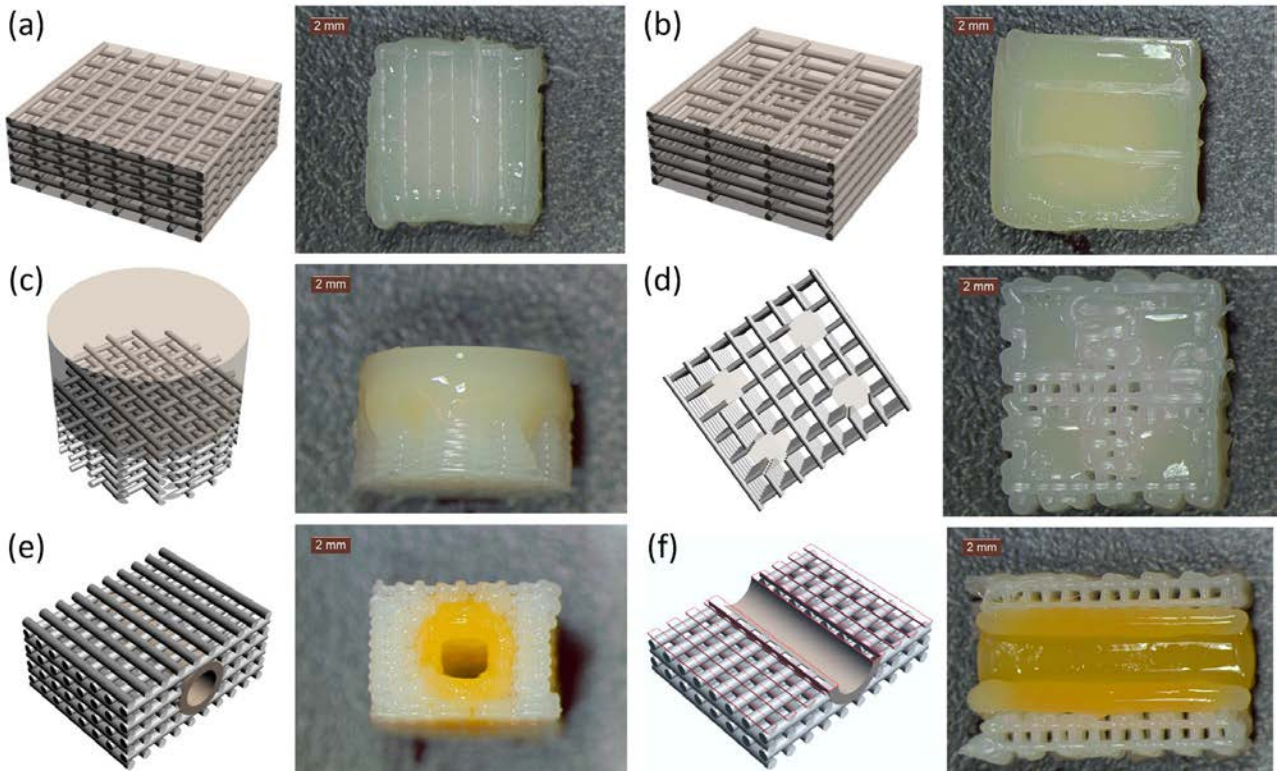
- ✓Control of mechanical properties
- ✓Control of swelling ratio
- ✓High cell viability
- ✓High diffusibility



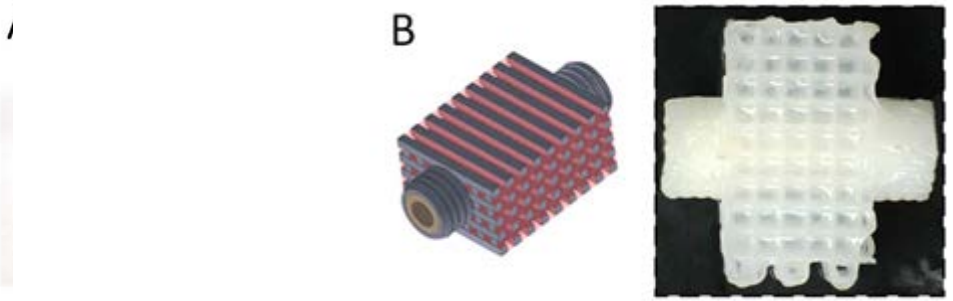


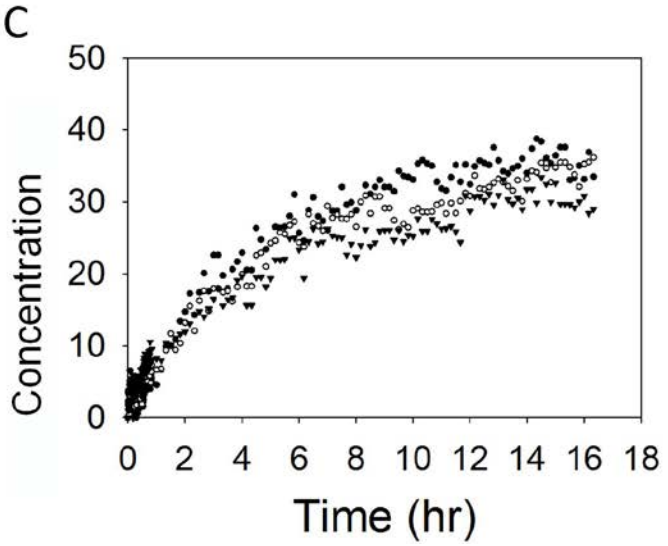
3D Printing of Hybrid Rigid-Soft Constructs

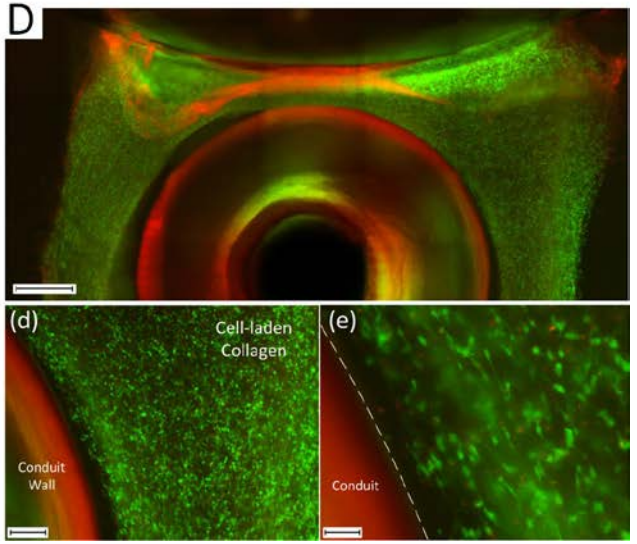
- ✓Porous scaffold infilled with hydrogel
- ✓Bulk hydrogel reinforced with rigid structure
- ✓Biphasic construct
- ✓Porous scaffold with spatially distributed hydrogel components for local cell and drug delivery
- ✓Scaffold with a hydrogel conduit passing throughout
- ✓Combination of thermoset and thermoplastic polymers to benefit from the high elastic modulus/stiffness of the former and the high break/yield elongation of the latter



Connectable macro-conduit built in porous tissue engineering constructs and perfusion of nutrients







Intellectual Property

DocketNumber	Title	
S14-335	Hybprinter - A novel method and system for bioprinting of hybrid tissue engineering constructs and 3D printing of multi-material objects	pending US
S15-218	Hybrid Suture Anchor-Tendon Graft to Repair Bone-Tendon Interfaces	pending US
S15-027	Implant for improved treatment of early stage osteonecrosis of the hip	pending US
S13-081	Crosslinked chitosan-lactide matrices for the controlled delivery of therapeutic agents	granted US: 9,814,779 pending EPO, JP, HongKong
S17-165	New graft geometry for large segmental bone defect repair	pending US provisional

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