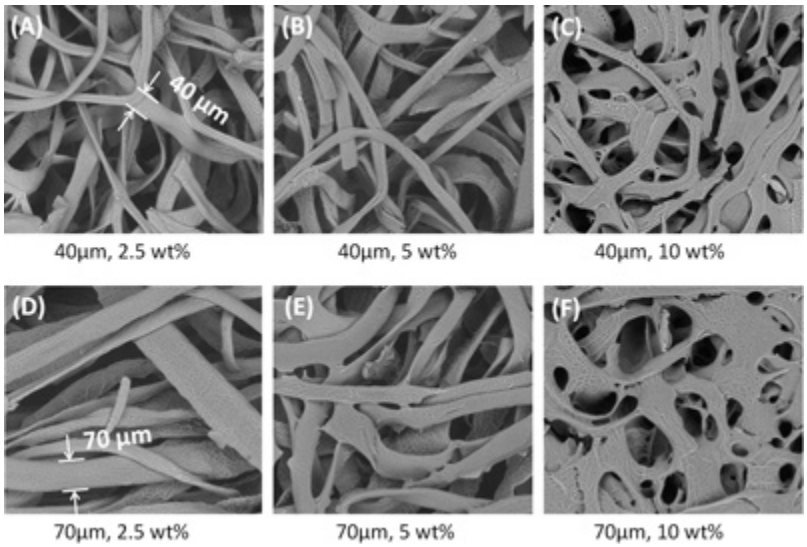
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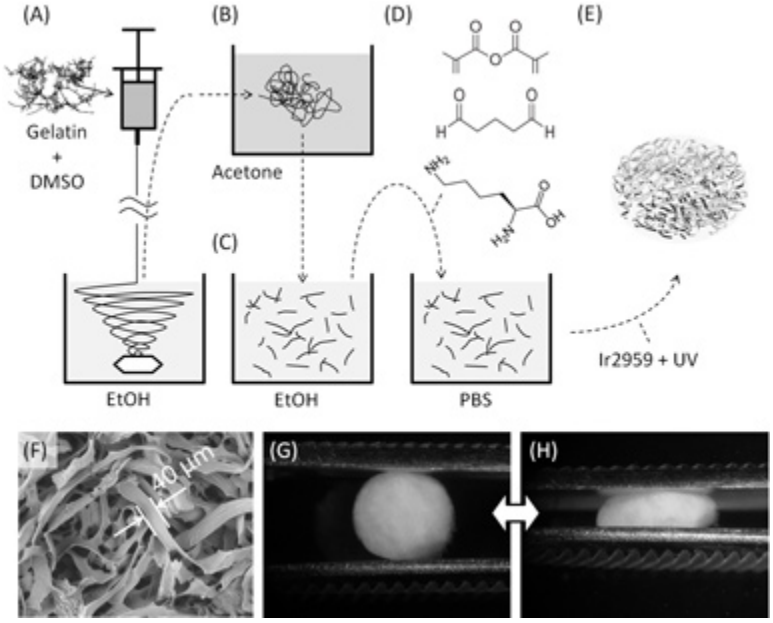
Customizable, Porous Tissue Engineering Scaffold for 3D Cell Proliferation

Hydrogel-based tissue engineering scaffolds are widely used for culturing cells in three dimensions (3D) due to their tissue-like water content, tunable biochemical and physical properties, and ease of cell encapsulation and distribution in 3D. However, most conventional hydrogels lack the macroporosity desirable for efficient cell proliferation and migration, and have limited flexibility when subject to mechanical load. Microfiber-based scaffolds, on the other hand, are inherently macroporous and flexible, but are often associated with cell-unfriendly fabrication procedures which make microfibers unsuitable for direct cell-encapsulation.

To overcome these limitations, Stanford researchers have created a novel scaffold material consisting of crosslinkable, microribbon-like elastomers, which can assemble into highly macroporous scaffolds that facilitate cell encapsulation and support cell proliferation in 3D.



The biochemical composition, macroporosity level, and mechanical properties of the microribbon-based scaffolds can be independently adjusted to influence cell behaviors associated with biochemical, topographical and mechanical cues. Furthermore, the geometry of microribbons enables the microribbon-based scaffolds to sustain large deformation and mechanical stress.



In published results, the researchers showed that, when encapsulated in the microribbon-based scaffold, human adipose derived stromal cells proliferated up to 30-fold within 3 weeks. Furthermore, microribbon-based scaffolds demonstrate great flexibility and can sustain up to 90% strain and 3 MPa stress without failing. Such unique macroporosity and flexibility of the microribbon-based scaffolds make them promising for engineering shock-absorbing tissues such as cartilage and intervertebral discs.

Applications

- 3D scaffolds of customized macroporosity, biochemical properties, and mechanical properties
  - Implants customized for specific tissue-regeneration (ex: skin, cartilages, bones)
  - A novel research platform for studying cell-responses to different microenvironments of customized biochemical, biophysical, and topographical cues

- Substrates for 3D cell culture

Advantages

- **Highly Tunable Properties** – control over porosity, biochemical and mechanical properties
- **Direct Cell-Encapsulation** – enables control over cell distribution
- **Flexibility** – can sustain up to 90% strain and return to its original shape
- **This technology enables combination of the benefits of both hydrogel and microfiber-based tissue engineering scaffolds**
    - Flexible
    - Macroporous
    - Direct Cell-Encapsulation

Publications

- Li-Hsin Han et al. "Microribbon-Like Elastomers for Fabricating Macroporous and Highly Flexible Scaffolds that Support Cell Proliferation in 3D". Sep 2012. *Adv Funct Mat*. 10.1002/adfm.201201212
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- Gegg C, Yang F. Spatially patterned microribbon-based hydrogels induce zonally-organized cartilage regeneration by stem cells in 3D *Acta Biomater* 2020 Jan 1;101:196-205. Epub 2019 Oct 19. PMID: 31634627.
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- Tang Y, Tong X, Conrad B, Yang F Injectable and in situ Crosslinkable Gelatin Microribbon Hydrogels for Stem Cell Delivery and Bone Regeneration *in vivo* *Theranostics* 2020 May 15;10(13):6035-6047.

Patents

- Published Application: 20140017284
- Published Application: 20160331508
- Issued: 9,402,710 (USA)
- Issued: 10,004,587 (USA)

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