Integrated Biomanufacturing System for Fiber-Reinforced Tissue Composites

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Technology description

The Need

Recent advances in biofabrication introduced by additive manufacturing/3D printing (AM/3DP) have significantly improved the overall architecture control in tissue engineered constructs. These constructs have a wide variety of important research and clinical applications including, but not limited to, cosmetics and pharmaceutical testing, cancer research, and tissue grafting. Due to these innovations and its relevance, bioprinting is a $306 million USD global market and is expected to grow to $1.4 billion USD by 2024 at a compound annual growth rate (CAGR) of 35.4% (BCC, BIO176A). According to the same BCC report, scaffold-based printing makes up 65% of the total bioprinting share.
Currently, AM/3DP technology alone is limited in terms of usable hydrogel materials and to strut sizes on an order of magnitude of 100 µm. This is often not compatible with the proteinaceous fiber-reinforced microenvironment present in the extracellular matrix (ECM) of connective tissues and can lead to deficiencies in scaffold stiffness. There is, therefore, a need for a biofabrication system which produces composite scaffolds consisting of both hydrogel and proteinaceous components in an automated and continuous manner.

The Technology

To account for this unmet need researchers at The Ohio State University have developed a hybrid tissue manufacturing system that integrates electrospinning (ES), additive manufacturing/3D printing (AM/3DP) and cell dispensing technologies that can be used to produce high-quality engineered tissues with high physiological relevance. The system consists of three core elements: an extrusion-based 3D printing module used to create hydrogel architecture; an electrospinning module used to deposit fibrous component with the aid of guiding electrodes; and a pressure-actuated liquid dispenser used to dispense living cells into the tissue scaffolds (Figure 1). The system combines the advantages of AM methods - spatial control, mechanical stability and full 3D capability - and those of ES methods - high resolution, large surface area and wide material selection.
The produced tissue construct features hierarchical porous architectures made up of a hydrogel filament network (hundreds of µm range) and sub-micrometer fibrous structures (Figure 2). This allows

the scaffold to recapitulate the ECM environment of connective tissues. Due to fiber-reinforcement, the produced tissue composites also exhibit enhanced mechanical properties suitable for multiple engineering applications.
An automated technique and system which combines electrospinning, additive manufacturing, and cell dispensing for generating high-quality tissue constructs with high physiological relevance.

Application area

Drug discovery and toxicology testing
Cancer research
Cosmetic testing
Tissue engineering and regenerative medicine

Advantages

Automated tissue fabrication
Turn-key approach to hybrid tissue manufacturing for greater quality assurance
Engineered scaffold stiffness
High physiological relevance

Institution

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