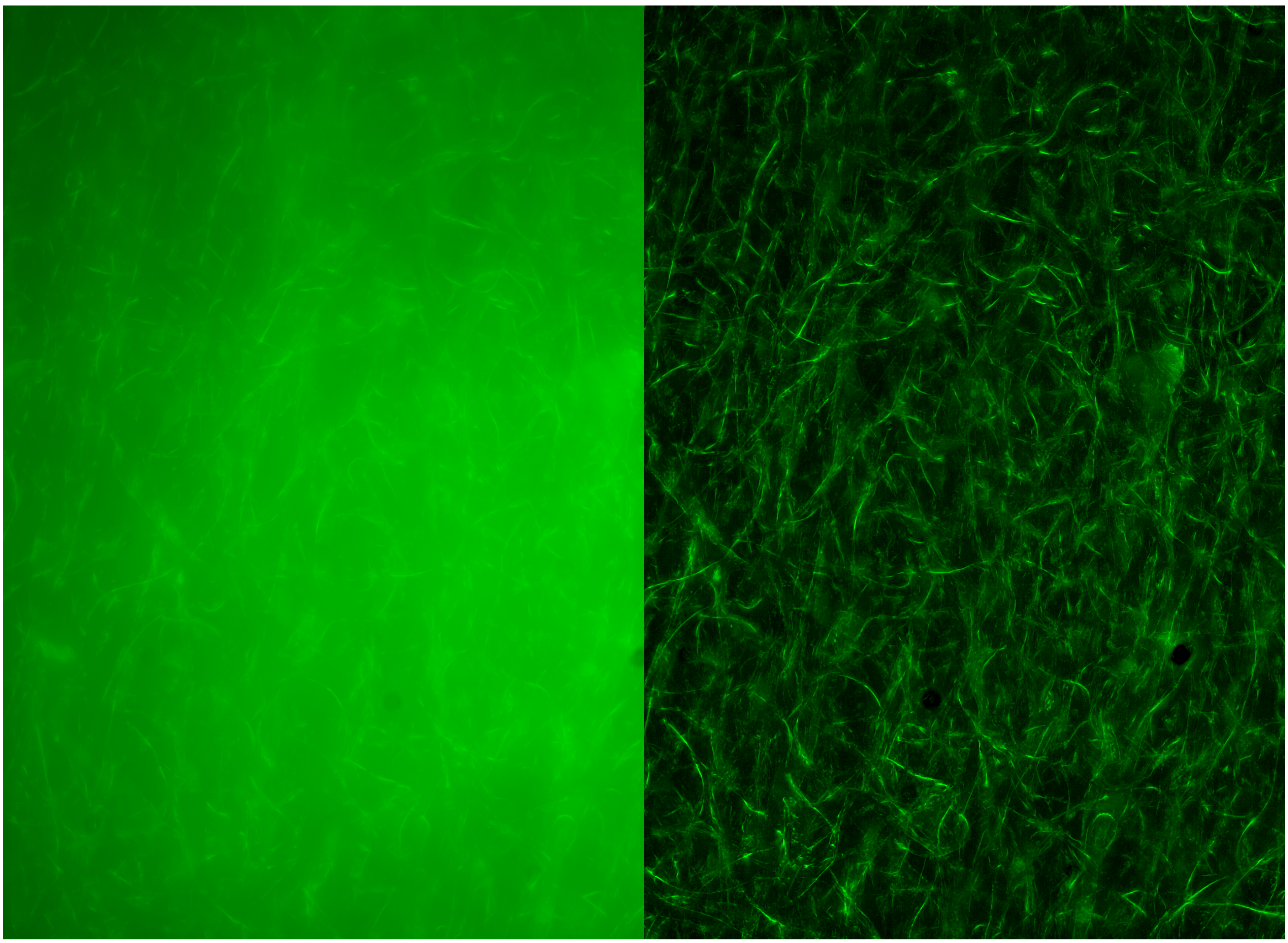
From Eye to Insight

FINDING NEW SCAFFOLDS FOR TISSUE ENGINEERING

High-resolution imaging of bioengineered materials.



Authors

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Abstract

Tissue engineers use biomaterials for a variety of applications from drug delivery to supporting the regeneration of damaged or lost tissues to creating in vitro disease models. Scaffold architecture can be tailored to specific tissue engineering applications. Characterizing scaffold morphology and porosity through imaging is crucial to the fabrication of modular biomaterials. Widefield microscopy can reach its limits when used for tissue engineering due to the thickness and optical characteristics of the tissue. THUNDER Imagers equipped with the Computational Clearing technology offer the advantages of widefield microscopy, but overcome the out-of-focus blur or "haze" typical when imaging thick, 3D specimens.

Introduction

Tissue engineering develops materials that mimic biological tissues. Often the basis for these materials are cells which are cultured on scaffolds The engineered tissues can be used to repair or even replace the body's own material.

Mollie Smoak's research focuses on the synthesis, processing, and evaluation of new biomaterials for use as scaffolds to support the regeneration of musculoskeletal tissues. Specifically, these materials recapitulate the biochemical cues, physicochemical stimuli, and native architecture found in these tissues. Moreover, these biomaterials could be utilized as carriers for controlled drug delivery, non-viral vectors for gene therapy, and platforms for modeling disease.

Challenges

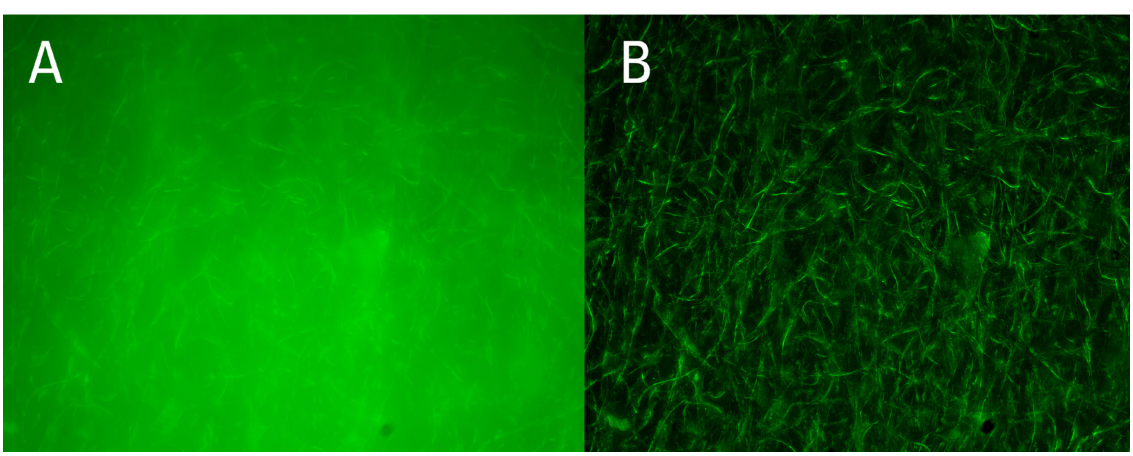
Depending on their thickness, sharp imaging of the utilized material and scaffolds can be a challenge for optical widefield microscopy. For this study, fibers were visualized with conventional widefield imaging, but, unfortunately, there is a lot of unwanted background signal which makes image interpretation difficult.

Methods

The scaffold developed for this experimental work is composed of electrospun fibers which were labeled with fluorescein. The goal was to study the fiber morphology and pore characteristics of the scaffold. The fibers were imaged with a THUNDER Imager 3D Cell Culture, an inverted microscope platform equipped with opto-digital LVCC (Large Volume Computational Clearing) technology. It enables users to obtain a clear view of details, even deep within a whole, intact sample, in real time without the out-of-focus blur typical of conventional widefield systems.

Results

With a THUNDER Imager using LVCC, the final processed image is much sharper compared to the original raw image. The individual fibers of the scaffold can be clearly resolved and then analyzed more precisely.



Images of the scaffold composed of fluorescent fibers: A) raw widefield image and B) THUNDER image with LVVC. Both images are maximal projections of a z stack of 55 images (total height of 130 µm). Images courtesy of Mollie Smoak, Department of Bioengineering, Rice University, Houston, TX, USA.

MICROSYSTEMS

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