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Visualization of 3D Bioprinted Tissue Scaffolds Using Synchrotron-Based Phase Contrast Imaging

Progress in tissue engineering has opened up enormous possibilities for the repair of injured or damaged tissues, like nerve tissues, with produced scaffolds (Figure A). In nerve tissue engineering, a scaffold is a porous construct produced to assist the reconnection of disruptive nerves by providing sufficient structural and biological cues (Figure B). To create such a scaffold, three-dimensional (3D) bioprinting in combination with hydrogels have been developed and utilized through the regulated deposition of cells and hydrogels. However, due to the inherent properties of hydrogel itself, printing hydrogel-based scaffolds into the designed structure is challenging. We developed a synchrotron-based x-ray inline phase contrast imaging-computed tomography (SR-inline-PCI-CT) at the BMIT Facility of Canadian Light Source to visualize the printed hydrogel-based scaffolds. This technique shows a high imaging depth which allows the examination of thick constructs that normally cannot be detected by regular 3D imaging techniques. It also shows a high image contrast which overcomes issues faced by the traditional CT techniques. The porous structure of scaffold captured by using this technique (Figure C and D) indicates the effectiveness of combined hydrogel and the bioprinting process to create scaffolds with designed structural properties. Quantitative measurements on these images will provide us information to understand the effects of main factors such as hydrogel properties and the bioprinting process parameters on scaffold bioprinting, which in turn guide the bioprinting to create scaffolds with customized structures in high reliability and accuracy, for nerve tissue engineering applications.

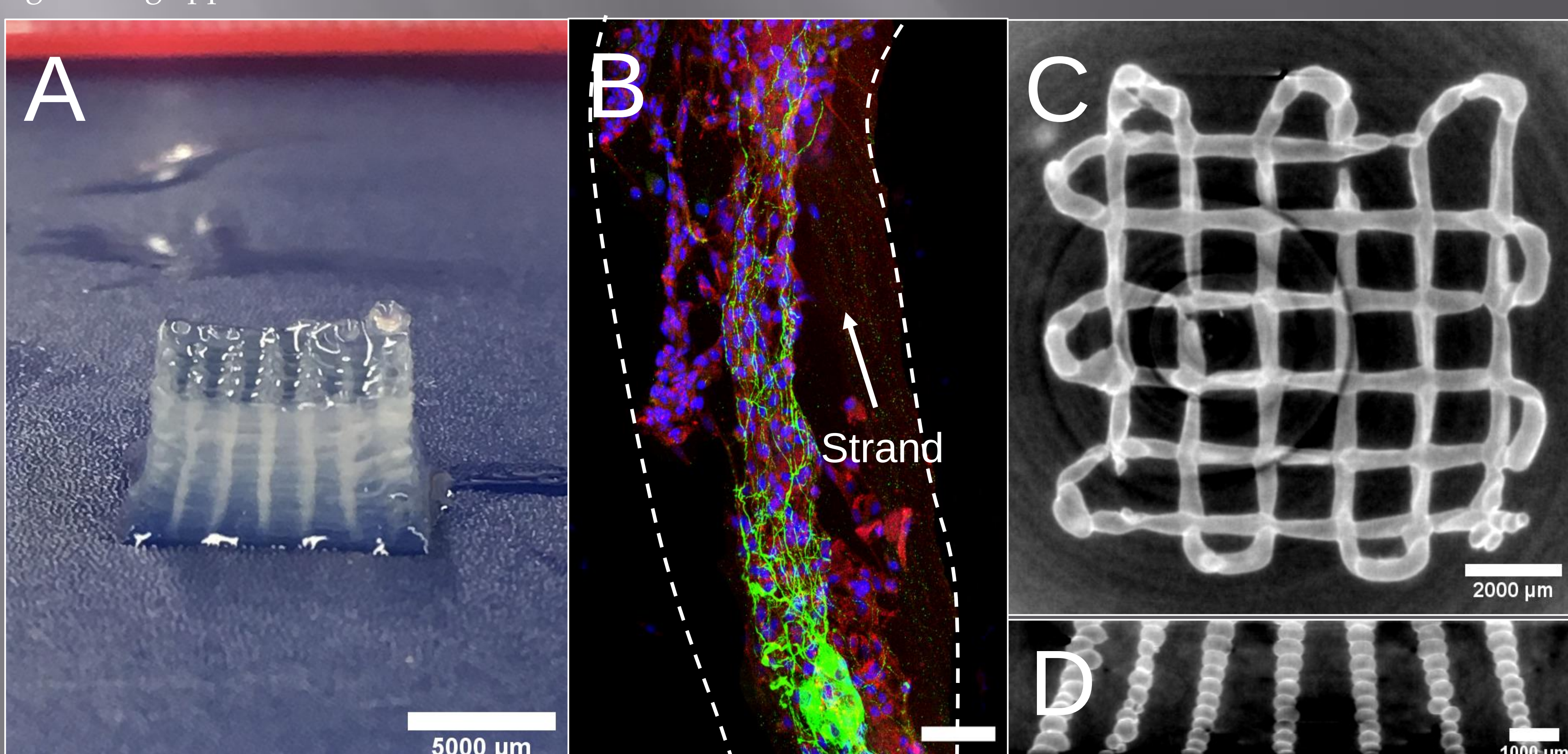

Figure. A, Hydrogel-based tissue scaffold created using 3D bioprinting; B, The growth of neuron neurites on the printed scaffolds. Cells were stained using immunocytochemistry. Neurons and neurites were in green, Schwann cells were in red, and cell nuclei were in blue. C, one slice of hydrogel scaffold captured from SR-inline-PCI-CT, top view; and D, one slice of hydrogel scaffold captured from SR-inline-PCI-CT, side view.