Title

3D Printing of Alginates into Tubular Structures Resembling Human Airways

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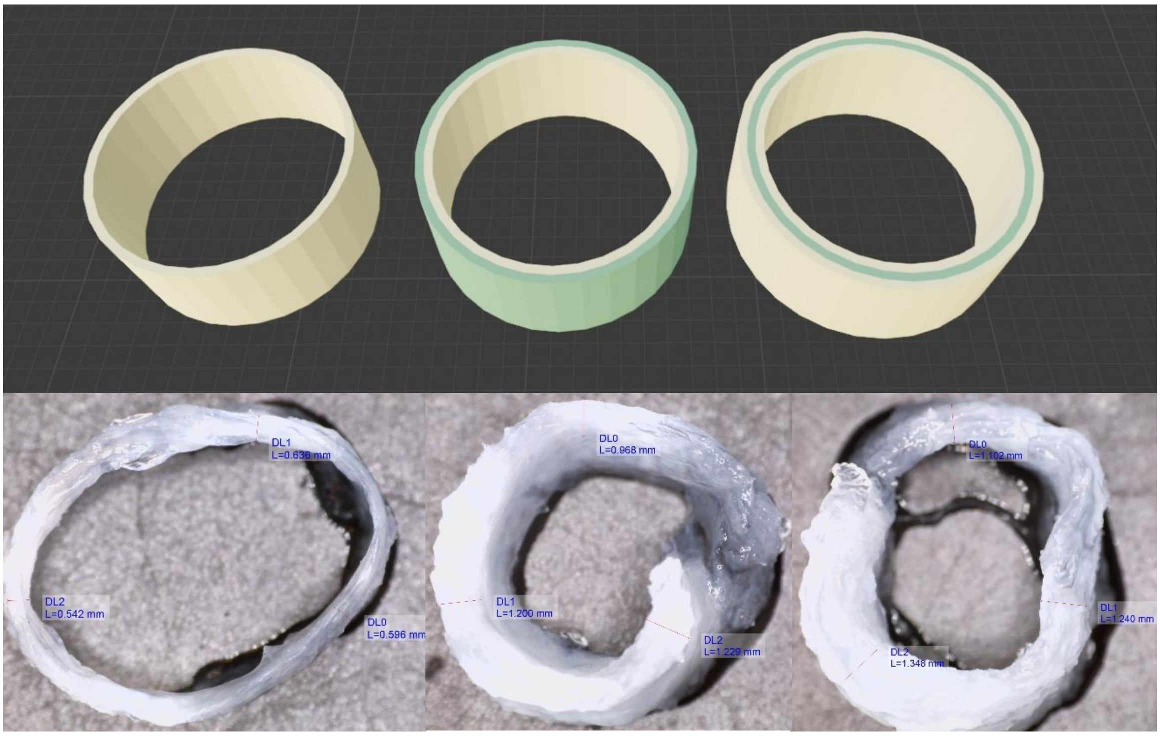
Popular summary

Tissue and organ shortage for lung transplantation remains a problem worldwide as lung transplantation is often the only available option with numerous possible complications. Tissue engineering has been proposed as one way to potentially overcome this shortage. This technique is one potential strategy to either repair, replace or regenerate damaged tissue and organs. In this thesis, several experiments were conducted with the goal of improving the 3D printing process of sodium alginate that can be used as a scaffold by seeding it with cells. The 3D printing process was studied using a locally modified MakerBot 3D printer to find out how to make the results more consistent and reproducible. The form and structure of the sodium alginate after crosslinking with calcium chloride was studied and compared between different alginate types and concentrations. Similarly to previous studies, it was found that both alginate type and the concentration affect parameters such as dissolution over time, ability to be crosslinked into a stable hydrogel (three-dimensional polymeric network filled with water), and use in extrusion-based 3D printing (similar technique as the standard inkjet desktop printers). The size and shape of the resulting tube-like alginate structures after crosslinking was also studied, and any shape, size or geometry changes due to the crosslinking itself and independent from the 3D printing method. Additionally, data was gathered on how the crosslinked alginate degraded or dissolved after a number of days in an environment simulating a cell culture. It was found that the resorption rate of compounds from cell media varied between different sodium alginate types. Furthermore, 3D printing parameters were explored in order to accurately print 3D models of tube-like structures with controlled shape and size considering alginate behavior. There were deviations found in the comparison between the digital rendering and the actual final print. However, the project resulted in specific suggestions for future improvements of the current techniques. The various parameters investigated in this thesis can with further studies lead to printing with higher precision and accuracy of actual prints. Consequently, contributing to reducing the gap to the digital rendering which corresponds to the desired geometry that could be implanted into a human body in the future.



Digital rendering with multiple layers (top) and the resulting print comprised of a calcium alginate hydrogel (bottom).