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3D printing gelatin-alginate hydrogels in cross-linking solution: role of concentration, syringe gauge, and extrusion rate on the hydrogel layering

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3D bioprinting is used as an additive manufacturing approach to create 3D scaffolds for biomedical applications. It often generates multilayer hydrogel structures using various biomaterials on top of each other layer by layer using 3D bioprinting. Controlling a 3D multilayer structure is essential for regenerative medicine and tissue engineering up to micrometer scale. Such structure should be biodegradable, using hydrogel either natural or synthetic. Hydrogels are hydrated 3D polymer networks that are crosslinked by chemical or physical interactions. In this study we combined two hydrogel types (gelatin and alginate) to improve the structural strength of the 3D scaffolds. 3D (scaffolds) have received a considerable attention due to their use in studies of cell migration and adhesion as well as their various medical applications including drug delivery. Using a homemade 3D bioprinter several parameters were investigated to control the diameter of the printed thread which determines the thickness of the walls of the scaffolds, e.g., crosslinking solution of various concentrations, different tip sizes in a liquid phase environment and different extrusion rate with distance size=0.5 mm. Depending on these parameters the hydrogel can be optimized to create 3D scaffolds with user-defined structures for biomedical applications. In this work, all parameters tested show an important effect on the shape and the size of the hydrogel printed, e.g., applying an extrusion rate of 0.15 E/mm during printing in 20 mM CaCl2 solution using a syringe tip inner diameter of 0.58 mm results in a hydrogel with a height of 0.50±0.05 mm. Increasing the extrusion rate to 0.35 E/mm increases the hydrogel height by 50% to 1.10±0.05 mm. Our results indicate a need to better define the printing parameters of hydrogel to improve 3D scaffolds especially in a liquid phase.

Biography

Maha Alruwaili has completed her Bachelor's degree in Physics. She moved to Dublin to complete her MSc in Nano Bio-science from the School of Physics, University College Dublin (UCD). She graduated in 2013 with a thesis titled "Second-harmonic imaging of cornea and sclera tissues". Currently she is pursuing her PhD in the School of Physics at UCD. Her PhD involves using polymers for liquid phase 3D bioprinting.

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