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MELT ELECTROWRITING OF SHAPE MEMORY POLYMERS: A NOVEL APPROACH FOR SMART MATERIAL FABRICATION

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ABSTRACT

Melt electrowriting (MEW) is a novel additive manufacturing technique that uniquely incorporates two 3D printing principles melt electrospinning and fused deposition modelling (FDM), to deposit ultrathin, precisely placed fibers. MEW enables the fabrication of high-resolution scaffolds with intricate geometries. There is the possibility to produce shape-changing structures with the use of smart materials. Shape memory polymers (SMPs), a class of thermo-responsive polymer materials, can be programmed to store a temporary shape and recover an original permanent shape upon the application of an external stimuli. Polylactic acid (PLA) has been shown to exhibit shape memory properties. Therefore, MEW scaffolds made with PLA can be designed as highly customizable, complex structures with built-in shape-shifting capabilities. MEW scaffolds have been limited to planar or tubular geometries due to the instabilities that arise in the polymer jet when the deposition distance to the collector surface is altered. There is a need for further investigation into MEW fiber deposition on curved collector surfaces and in varying geometries to better mimic biological tissue in applications that require a high level of conformity to native structures in the body. Scaffolds printed in a curved configuration can be temporarily flattened and later recover their original shape when subjected to a temperature change. In this study, we varied the radius of curvature of the collector surface to examine the feasibility and limitations of fabricating a shape-responsive material using MEW technique in an out-of-plane configuration. We investigated the shape recovery properties of the printed scaffolds, such as the speed of recovery and total percentage of shape recovery. Our research demonstrates the potential of MEW for developing customizable, shape memory scaffolds that are responsive to environmental changes. This would enable the development of novel medical devices and tissue engineering constructs that can dynamically adapt to the body's needs, such as stents, bone implants and soft tissue patches. It would also be largely applicable in biomedical modelling and soft robotics for mimicking biological soft tissue.