In situ 4D Printing of Light-Activated Liquid Crystal Elastomers

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The growing field of materials sciences and more specifically stimuli-responsive materials in the past decades has led to the development of liquid crystal elastomers (LCEs), first introduced by H. Finkelmann in 1981. These materials possess the rubber-like properties of elastomers as well as the reversible ordering of mesogens found within liquid crystal materials resulting in unique shape-morphing capabilities. In this research, the printing of light-actuated LCE's was explored using a custom-built bioprinter apparatus. Two additives, Polydopamine nanoparticles, and the dye Disperse Blue 14 were added to the LCE mixture prior to printing. These materials have previously demonstrated photothermal properties, capable of efficiently converting photo-stimuli into the heat-stimuli necessary for LCE actuation. Here we report that LCEs doped with Polydopamine NPs demonstrate effective response to photo-stimuli as well as successful crosslinking under UV light during printing process. LCEs doped with Disperse Blue 14 similarly actuated under photo-stimuli to a lesser degree. Furthermore, the feasibility and efficacy of a custom-built Direct Ink Write printing apparatus was proven in the printing process. Polydopamine NPs and Disperse Blue 14 offer unique methods for the photo-sensitization of LCEs, presenting novel opportunities for non-invasive stimuli-responsive materials in a variety of applications including, drug loading, tissue scaffolds, soft-robotics, etc.

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