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3D printer for extrusion based printing of silicone inks

P R Selvaganapathy, M Zlatin, S Zheng and **M A Brook**
McMaster University, Canada

Silicone elastomers are of commercial interest in a number of areas because of their distinctive properties. 3D printing (additive manufacturing) is increasingly attractive over conventional technologies for the fabrication of sophisticated structures. Current printing technologies for silicones are limited to extrusion of high-viscosity uncured elastomers, which are needed to retain shape due to long curing times. Lower viscosity materials are required to achieve finer printing resolution and also to avoid formation of pores and cavities during the printing process. Here, we develop a custom designed 3D printer with microfluidic printheads and pneumatic control systems to switch between multiple inks rapidly and combine it with a UV exposure system that produces an instantaneous cure of the low viscosity silicone pre-polymer as it emerges from the printhead. The fast curing inks and the printhead to extrude and cure it instantaneously, allow for the first time, 3D extrusion printing of such low-viscosity materials without any support. We demonstrate that this technique could be used to print a variety of features including both supported and unsupported overhanging structures, discrete and continuous structures, as well as multi material structures using a single nozzle which are difficult to achieve in conventional 3D extrusion type printing. The technology developed here is scalable to produce higher resolution, multimaterial structures of silicones which can find applications in biomedical implants, rapid prototyping and mould making where both the shape and the mechanical property distributions of the part needs to be accurately replicated.

selvaga@mcmaster.ca