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ADDITIVE MANUFACTURING OF CELLULAR MATERIALS WITH TAILORED PROPERTIES

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The ability to pattern complex materials with high-speed and low-cost three-dimensional (3D) printing techniques is highly desirable. Here, we present progress on developing siloxane-based feedstock formulations, known as “inks,” for a unique 3D printing approach called Direct Ink Writing (DIW). DIW is a low-cost, mask-less printing route that enables rapid design and patterning of planar and three-dimensional (3D) microstructures. In this filamentary printing approach, a concentrated ink with tailored viscoelastic properties is deposited through a micro-nozzle that is translated using a multi-axis positioning stage. The ink rapidly solidifies as it is extruded so that 3D structures with fine features may be built up in a layer-by-layer fashion. We introduce the concept of tailoring the macro-scale mechanical properties by designing the 3D micro-architecture of the printed cellular silicone materials. We show the ability to obtain highly uniform or graded properties by simply adjusting the pattern design. Moreover, by understanding the materials-structure-processing property relationships, we have created a modeling-design-fabrication approach to achieve tailored mechanical properties. For example, we have created porous architectures that, in one case, are well suited for pure compression and, in a separate case, are better suited for shear environments. We expect that the ability to deterministically program mechanical performance from part-to-part and within a part will prove useful for many applications.

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