Engineering Conferences International
ECI Digital Archives

Composites at Lake Louise (CALL 2015)

Proceedings

Fall 11-9-2015

Additive manufacturing of cellular materials with tailored properties

Eric Duoss
Lawrence Livermore National Laboratory, duoss1@llnl.gov

Todd Weisgraber
Lawrence Livermore National Laboratory

Christopher Spadaccini
Lawrence Livermore National Laboratory

Thomas Wilson
Lawrence Livermore National Laboratory

ADDITIVE MANUFACTURING OF CELLULAR MATERIALS WITH TAILORED PROPERTIES

Eric Duoss, Lawrence Livermore National Laboratory (LLNL)
Duoss1@llnl.gov
Todd Weisgraber, LLNL
Christopher Spadaccini, LLNL
Thomas Wilson, LLNL

Key Words: 3D printing, cellular solids, negative stiffness, mechanical metamaterials.

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.

This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.