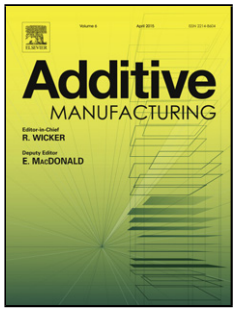

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A New Photopolymer Extrusion 5-Axis 3D Printer

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Abstract

Popular 3D printing techniques such as fused deposition modelling (FDM) and stereolithography (SLA) have certain limitations and challenges. Although printing multi-material functional parts combining smart and conventional materials is a promising area, existing printers are not ideally suited to this, with FDM printers typically requiring high operating temperatures and SLA using a tank containing one single material. Common 3D printers also require the deposition of additional "support" material to hold the shape of an object when printing overhang structures. The concept of adding additional rotational axes to the system to eliminate this problem has shown promising results, but such systems still lack the capability to print complex structures without supports. To overcome these limitations there is a need to develop a new 3D printing techniques that combine the strengths of existing methods. A photopolymer extrusion 3D printing technique, which combines the strengths of FDM and UV assisted 3D printing technology is demonstrated in this paper. By using photopolymer extrusion in combination with two additional rotational axes, the printer developed in this work not only allows the traditional layer upon layer printing, but is also capable of free form printing. Fumed silica is used as a filler in order to control the material viscosity for proper extrusion and curing. Mechanical tests were conducted on objects printed using different concentrations of filler in the photopolymer to understand its effect and determine the range of suitable filler concentration. Then, printing of free-form and self-supported structures is successfully demonstrated.