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Abstract

3D multiphoton polymerization meets stereolithography – towards bioprinting

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Additive manufacturing came a long way from laboratory-level demonstrations to extensive industry, with optical 3D printing being one of the most versatile and expansive sub-type within the field [1]. Naturally, the idea to apply the general progress of 3D printing to biofabrication towards medical use and even artificial organs seems like a natural evolution of technology. However, there are numerous challenges involving printing resolution, throughput, materials, and biocompatibility complicating development and mass adoption of such solutions [2]. Therefore, progress on bioprinting lags behind the overall progress of additive manufacturing with no truly dominant solution and general fragmentation of the field.

Here we present an approach of employing multiphoton polymerization (MPP) towards true bioprinting. The general idea is to apply MPP as the underlying technique but base the whole process on the architecture of a stereolithographic 3D printer. This allows easy implementation of material vat towards large prints (50x50x100 mm in the case of the presented device) and potentially easy adoption due to a simple, highly automated process. Additionally, MPP throughput is increased more than by two orders of magnitude by employing beam-shaping solutions [3]. The resulting system is a highly efficient, tabletop MPP stereolithography 3D printer capable of producing a ~ cm-sized structure with 1 µm resolution/feature size in a matter of minutes to hours. To validate our technology, we print various medicine-inspired structures, such as stents, scaffolds, and microfluidic devices. We also tested the selection of relevant materials such as hybrid polymers, elastomers, and hydrogels. Furthermore, we show some initial experiments involving bioinks containing cells and discuss why MPP is superior to any other currently available bioprinting solutions when printing living 3D structures. Overall, we consider such a system to be a major step towards simple and affordable medical 3D printing, capable of producing a vast selection of relevant bio-structures.

AUTHOR'S STATEMENT

Conflict of interest: all authors are employees of the company Vital3D Technologies which produces and sells 3D bioprinters and related services.

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