Accelerated discovery of multi component glass structures from machine-supported admixture via 3D printing

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Abstract

Having unrivalled optical clarity, exceptional mechanical, chemical, and thermal resistance, as well a thermal and electrical insulating qualities, glass is one of the most significant high-performance materials used in science, industry, and society. (1) Therefore, companies and scientists have a big urge to find new glass compositions to improve the properties or enable the use of glass in new fields of application. The combinatorial method is the most reliable strategy for creating innovative multi-material glass structures. The need of high amount of material and time is the major drawback of this method.
In our approach for accelerated discovery of multi material glass composition additive manufacturing is used to create admixture of different materials in a small volume to reduce the required resources for the combinatorial method. The admixtures are produced by photopolymerization based 3D printing which is an additive manufacturing process that selectively cures a photopolymerizable material by light-activated polymerization. Due to changes in the printing pattern the composition of the admixtures can be tuned.

In this study, we have proposed a novel approach for the creation of a two-component glass structure via 3-D- printing, that are the base of our approach for accelerated discovery of multi material glass compositions. Two different types of glass powder-based slurries are developed and characterized respectively for photopolymerization based two component printing of glass structures. Acrylate based photocurable resin composition have been optimized with higher solid loading (around 80 percent) for the slurries and their viscosities are examined. Rheological characterizations enable the production of samples with accurate structures that offer crucial insights into the printing process. Other properties such as polymerization curability were investigated with stereolithography based microscopic method. Afterwards, these two different slurries were printed on a commercial printer operating with visible light which further leads to fabricate a two-component glass structure. The layer resolution was 10 to 50 μm. For debinding, the decomposition temperatures for the printed green bodies were determined by thermogravimetric analysis in order to produce stable samples.

References
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