3D printing of glasses by digital light processing, binder jetting, fused deposition modelling & direct melt printing

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Abstract

3D printing of glasses has been an area of interest for the past few years because of its ability to produce glasses in
complicated shapes which cannot be achieved by traditional glass manufacturing techniques. Glass 3D printing is
generally conducted by either heating it to its liquid state or by sintering of glass particles. Fused deposition modeling
(FDM) and direct melt printing (DMP) techniques have been used to 3D print a glass by heating a filament (1) or
directly by melting a batch in a kiln (2). Digital light processing (DLP) and direct ink writing (DIW) have also been
used to synthesize 3D printed parts by sintering Nanosized glass particles (3, 4). Binder jetting (BJ) is another 3D
printing technique which requires sintering to get a transparent glass. 3D printing of glasses involving the process of
sintering has been mostly limited to silica-based solutions because of their high thermal stability against crystallization.

In this work, much focus has been given to the 3D printing of fluorophosphate (FP) glass using FDM, DMP, DLP, and BJ
3D printing technologies. The results obtained by 3D printing of FP glass using each technique will be compared.
DSC has been used to determine the drying and debindering reaction of the organic materials used during DLP and
BJ processes and the crystallization temperature of the 3D printed objects. In FDM and DMP the viscosity-temperature
dependence on the FP glass is important to estimate the nozzle temperature for the 3D printing process. In all the
techniques we applied so far, bubbles were inevitable in the final 3D-printed glass objects, which affected their

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transmittance.

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