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3D Printed and Stimulus Responsive Drug Delivery Systems based on Synthetic Polyelectrolyte Hydrogels

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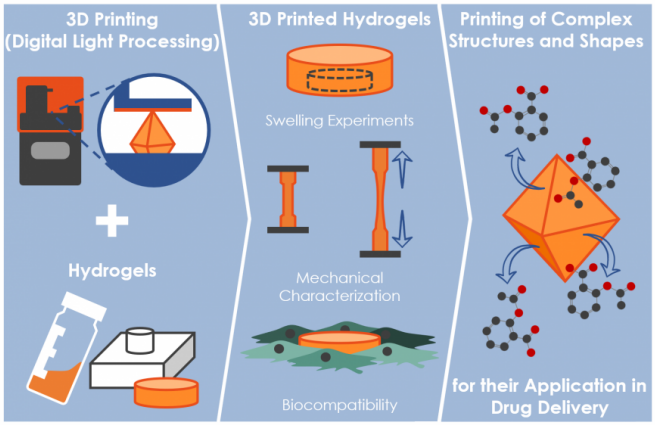
PURPOSE OF THE ABSTRACT

Hydrogels are three-dimensional hydrophilic polymeric networks absorbing up to 90% of water. These superabsorbent polymers retain their shape during this swelling process while enlarging their volume and mass.[1;2] In addition to their swelling behavior, hydrogels can possess other interesting properties, such as biocompatibility, flexibility, tunable physical properties and good rheological behavior or even an antimicrobial activity.[3;4] This versatility is qualifying hydrogels for many medical applications, especially drug delivery systems. In one of our previous works, we reported synthetic hydrogels consisting of the positively charged monomer [2-(acryloyloxy) ethyl]trimethylammonium chloride (AETMA) or the negatively charged monomer 3-sulfopropylmethacrylate potassium salt (MAESO3) crosslinked with N,N?-Methylenebis(acrylamide) (MBAA) or different length of poly(ethyleneglycol)-diacrylate (PEGDA).[5] The synthesized hydrogels were loaded with timolol maleate or ibuprofen according to the opposing charge of the monomer. In the drug release studies, we observed more of an ion exchange triggered release profile than a pure diffusion-controlled release behavior.

Besides challenges, such as the controlled release or biocompatibility, the fabrication of complex structures and shapes can be difficult to achieve. This obstacle can be overcome by the usage of 3D printing. The 3D printing technology is gaining more and more interest as a new method producing materials for biomedical applications and medical devices. In another previous study, we printed PEGDA with different amounts of water via Digital Light Processing (DLP).[6] It was possible to print complex and even hollow geometries, such as a frontal sinus implant. However, these materials lacked in flexibility with low water contents and low printing accuracy with high water contents.

In this work, we printed hydrogels, consisting AETMA and PEGDA, via DLP with photopolymerization using the photo initiator lithium phenyl-2,4,6-trimethyl-benzoylphosphinate (LAP) (Fig. 1). The obtained hydrogels were characterized with respect to their swelling behavior, biocompatibility, and mechanical properties. A pH sensitivity was observed during this process. Additionally, we embedded the model drug acetylsalicylic acid while printing it into the hydrogels. The resulting drug depots were investigated in their drug release behavior. The received 3D printed drug delivery system could also be printed in a complex hollow geometry, a frontal sinus implant (Fig. 2). Consequential we yielded a drug releasing, flexible and swellable material, combining the best of both worlds: the properties of hydrogels and the possibility of complex shapes of 3D printing.

FIGURES



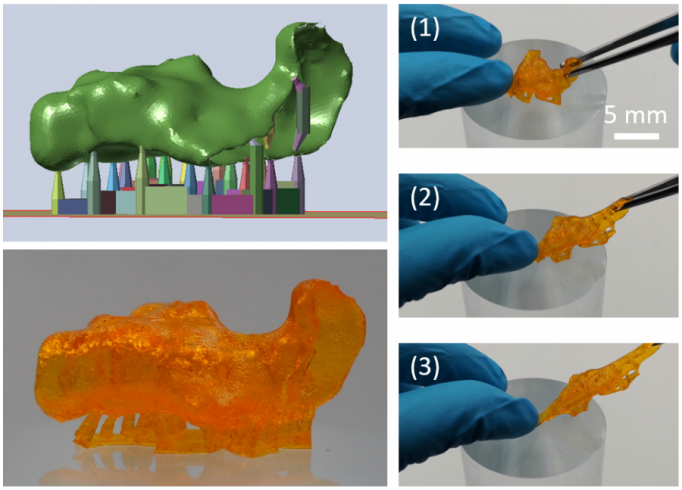


FIGURE 1

Figure 1

Schematic overview of the work presented in this abstract.

FIGURE 2

Figure 2

Image of the complex sinus implant structure printable with the investigated hydrogel and their promising rheological properties.

KEYWORDS

hydrogel | 3D printing | digital light processing | drug delivery sytem

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