PCL based toughness modifiers for biophotopolymers

C. Hofstetter,[1] S. Orman,[2] F. Reinauer,[3] A. Aksu,[3] R. Liska,[2] S. Baudis,[2] J. Stampfl [1]

[1]Institute of Materials Science and Technology, TU Wien, Getreidemarkt 9/308, A-1060 Vienna, Austria
[2]Institute for Applied Synthetic Chemistry, TU Wien, Getreidemarkt 9/163, A-1060 Vienna, Austria
[3]Karl Leibinger Medizintechnik GmbH & Co. KG, Kolbinger Str. 10, D-78570 Mühlheim, Germany

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I. Abstract

In the last decade, lithography-based additive manufacturing (L-AMT) particularly digital light processing (DLP) based stereolithography has become a valuable tool for the fabrication of patient specific (bone)implants of including 3D microstructures.[1] However, a main issue of common photopolymers i.e. (meth)acrylates are the high cytotoxicity and low biocompatibility, especially if applied as biodegradable implant. Moreover, due to brittle mechanical properties, an appropriate use as bone substitution material for oral or maxillofacial traumata is hardly possible.
In this work, we present an optimized vinyl ester based biophotopolymer with low cytotoxicity, good biocompatibility and enhanced mechanical properties. The base formulation containing divinyl adipate, (DVA) was modified with thiol-ene chemistry (trimethylpropane tri(3-mercaptopropionate) (TMPMP))[2], along with high molecular weight additives, poly(caprolactone) (PCL), divinyl carbonate (DVC) and urethane dithiol (UDT), both based on poly(caprolactone) (PCL), to improve curing reactivity and toughness, respectively (Figure 1). These formulations were characterized by realtime-near infrared-photorheology (RT- NIR-photorheology) to investigate curing- and material parameters (i.e. reactivity, double bond conversion and shrinkage stress)[3]. Furthermore, the mechanical properties were tested via tensile test, dynamic mechanical thermal analysis (DMTA), and dynstat impact resistance test.
Finally, it was possible to print 3D test structures to prove the applicability as a possible bone substitution material in future.

II. Image

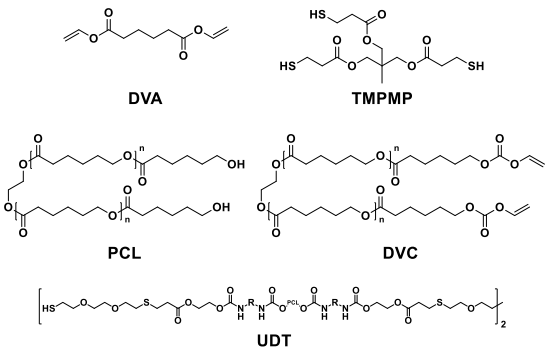


Figure 1. DVA as base component, TMPMP as reactivity- and PCL, DVC and UDT as toughness modifier.

III. Reference

1. G. Russmueller, R. Liska, J. Stampfl, C. Heller, A. Mautner, K. Macfelda, B. Kapeller, R. Lieber, A. Haider, K. Mika, C. Schopper, C. Perisanidis, R. Seemann and D. Moser, Materials, 2015, 8, 3685.

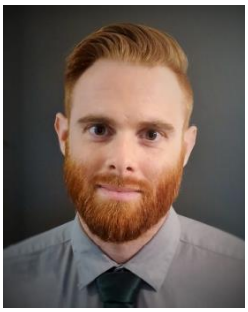
2. A. Mautner, X. Qin, H. Wutzel, S. C. Ligon, B. Kapeller, D. Moser, G. Russmueller, J. Stampfl and R. Liska, J. Polym. Sci., Part A: Polym. Chem., 2013, 51, 203-212, S203/201-S203/206.

3. C. Gorsche, R. Harikrishna, S. Baudis, P. Knaack, B. Husar, J. Laeuger, H. Hoffmann and R. Liska, Analytical Chemistry, 2017, 89, 4958-4968.

IV. Biography

Christoph Hofstetter is doing his PhD at the Institute of Materials Science and -Technology at the Vienna University of Technology, Austria in the field of additive manufacturing of biocompatible, biodegradable photopolymers. After his studies in mechanical engineering (B. Sc.) and biomedical engineering (M. Sc.), he worked as a development engineer at a medical technology company.

V. Presenting author details



Full Name:	Christoph Hofstetter
Contact number:	+43 58801 30871
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