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INVESTIGATION OF BIOCOMPATIBLE THIOL/YNE FORMULATIONS FOR 3D PRINTING OF MEDICAL SCAFFOLDS

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In recent years UV-based 3D printing technologies such as stereolithography have become a growing field of research in biomedical engineering. The fabrication of drilling guides for dental implants or ear-shaped hearing aids is already considered as standard. More novel applications such as bone scaffolds are yet to be mastered. With the advance of this novel technique production cost and time are expected to drastically decrease. For these applications, including bone screws and stents, a variety of materials, reaching from metals, ceramics to polymers can be considered. Polymers represent the most adaptable class of materials due to the great freedom of design in their molecular structure. Commonly used resins for lithographic 3D printing are multifunctional (meth-)acrylates, which polymerize via chain-growth mechanism. This results in a heterogeneous network structure with a high internal stress and a monomer conversion ranging from 60-90%. The remaining (meth-)acrylates, which are known to act as Michael acceptors can migrate and interact with physiological thiols and amines, e.g. proteins or DNA molecules. Thiol-yne systems have been explored as biocompatible photoreactive resins. The polymerization of these monomers proceeds via step-growth mechanism, causing a delayed gelation point, which results in a significantly lower internal stress and a higher overall conversion of >98%. In our work we present the direct modification of commercially used bifunctional acrylate to obtain multifunctional alkynes which can be used for thiol/yne formulations. We report on the synthesis, the photochemical characterization, the mechanical properties of the cured monomers, the biocompatibility and the 3D printing behavior. The increased monomer conversion, and the resulting improved biocompatibility make the proposed thiol/yne systems interesting candidates for photoreactive resins for the 3D printing of biocompatible structures for hard tissue engineering.

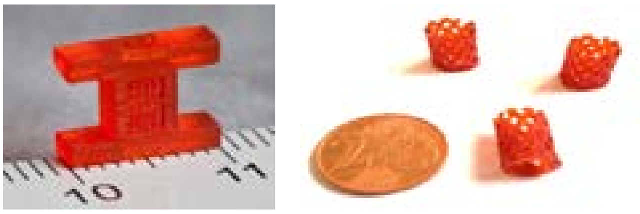

Figure 1: 3D printed test patterns out of a thiol/yne formulation; using Sudan II as a light absorber. (Scale on the left shown in cm).

Recent Publications

1. F Valente, G Schiroli and A Sbrenna (2009) Accuracy of computer-aided oral implant surgery: a clinical and radiographic study. Int. J. Oral Maxillofac. Implants. 24(2)234-242.
2. A Dawood, B M Marti, V Sauret Jackson and A Darwood (2015) 3D printing in dentistry. Br. Dent. J. 219(11):521-529.
3. Li Xiaoling, Schwacha M G, Chaudry I H and Choudhry M A (2008) Acute alcohol intoxication potentiates neutrophil-mediated intestinal tissue damage after burn injury. Shock. 29(3):377-383.
4. M Schuster et al. (2009) Gelatin based photopolymers for bone replacement materials. J. Polym. Sci: Part A Polym. Chem. 47(24):7078-7089.
5. S C Ligon Auer et al. (2016) Toughening of photo-curable polymer networks: a review. J. Poly. Chem. 7(2):257-286.

Biography

Daniel Hennen studied Chemistry at the University of Bonn (Germany) and obtained his Master´s Degree in the field of Macromolecular Chemistry in the working group of Professor Doctor S Höger. He is currently a PhD candidate at the Christian Doppler Laboratory for Functional and Polymer Based Ink-Jet Inks at the University of Leoben (Austria) in the working group of Professor Doctor T Griesser. He is working in the field of biocompatible photopolymers and investigates novel compounds for thiol/yne and thiol/ene formulations which are used for rapid prototyping. Additionally, he works on the synthesis of novel water-soluble photoinitiators for UV curable water-based inkjet inks.

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