Design of Biocompatible Non-Isocyanate Polyurethane Elastomers for the 3D Printing of Biomedical Implants

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Polyurethanes are polymers produced in very large quantities each year and used in many everyday applications, particularly due to their remarkable and tunable mechanical properties. Their biocompatibility also makes them suitable for the biomedical field, in which they are currently clinically employed. Unfortunately, they are industrially synthesized from highly toxic isocyanates, which are responsible for environmental and health issues. To avoid this synthesis problem, safer and greener alternative synthetic routes have been developed, leading to so-called non-isocyanate polyurethanes (NIPUs), that in some cases bear additional hydroxyl groups next to their urethane linkages.

In this work, we take advantage of these hydroxyl groups by functionalizing those of a new polyether-based NIPU by a CO_2-sourced cyclic carbonate molecule carrying a pendant unsaturation, which subsequently allows its photocrosslinking with various polythiols by thiol-ene reaction. NIPU elastomeric networks with adjustable physico-chemical properties, and especially excellent tunable mechanical properties, are thereby designed. Rheology experiments performed on the formulations demonstrated short gel times, which confirmed their suitability for light-based 3D-printing processes. The digital light processing printing technique was then chosen to 3D print various objects with a resolution down to the micrometer scale. Finally, *in vitro* biocompatibility and hemocompatibility tests proved the non-toxicity of these NIPUs towards human fibroblasts and blood components, respectively.

These biocompatible 3D-printable polyether-NIPU elastomers are therefore suitable for the design of various structures adapted to the needs of personalized medicine and have great potential for future biomedical applications, including the elaboration of elastic scaffolds for the tissue engineering of soft tissues.