Biodegradable, elastomeric copolymers that can be used in continuous digital light processing 3D printing applications

Duke LICENSING & VENTURES

Unmet Need

The global market for 3D printing, or additive manufacturing, is growing rapidly with a compound annual growth rate of approximately 22.0% predicted to occur until 2024. Medical and dental products account for about 16% of the end-user products, with $1.3 billion of sales reported in 2018. Continuous digital light processing (cDLP) has emerged as a popular 3D printing method due to its much faster build time compared to other additive manufacturing methods. However, the cDLP-compatible materials demonstrated thus far that are applicable biomedical applications have suffered from limited tuning of the mechanical properties, low control of the molecular mass, or possible toxic metal contamination introduced by the catalyst. There is a need for degradable materials that can be quickly 3D printed and are useful for biomedical applications.

Technology

Duke inventors have developed a copolymer that can be used in continuous digital light processing 3D printing applications. Specifically, this is a poly(propylene) fumarate (PPF)-derivative ABA type triblock copolymer with a flexible propylene succinate core unit synthesized through ring-opening copolymerization using a $Mg(BHT)_2(THF)_2$ catalyst followed by isomerization. 3D printing is achieved with the copolymer using thiol-ene chemistry, and the resulting material is fully degraded in hydrolytic conditions. The inventors have demonstrated this technology with cDLP 3D printed various tensile bars using maleic anhydride and succinic anhydride with propylene oxide, where it was found the mechanical properties and degradation rate are tailored based on the polymer composition and resin formulation.

Advantages

- The only material that can be 3D printed, is degradable, and covers nearly the entire range of what is useful in soft tissue repair, tissue engineering, and orthopedic medicine applications

Duke File (IDF)

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Links

- From the lab of Dr. Matthew Becker

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- Properties can be tuned with monomer composition and resin formulation
- Narrow molecular mass distributions demonstrated
- Avoids use of toxic chromium-based catalysts like related technologies

Publications

- Alternating ring-opening copolymerization of epoxides with saturated and unsaturated cyclic anhydrides: reduced viscosity poly(propylene fumarate) oligomers for use in cDLP 3D printing (Polymer Chemistry, 2020)
- Regio-Random Clemmensen Reduction of Biodegradable Polyesters for Photochemically Triggered 3D Printing (Macromolecules, 2021)
- Gradient versus End-Capped Degradable Polymer Sequence Variations Result in Stiff to Elastic Photochemically 3D-Printed Substrates (Biomacromolecules, 2022)
- PCT application US2022/018326