Bio-renewable epoxidized photocurable resins for 3D printing applications

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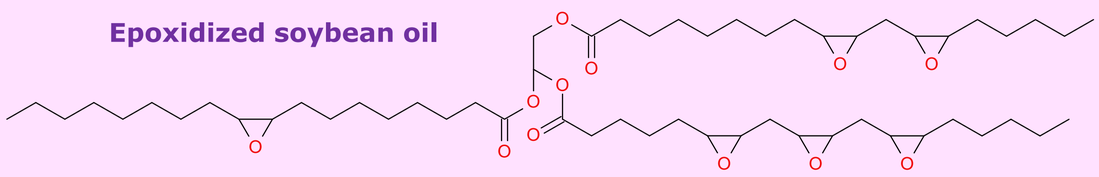
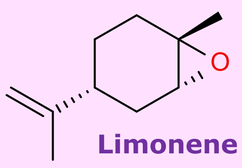
Photopolymerization processes are getting an increased attention in modern polymer technologies. The photopolymerization is usually very fast, which is its basic advantage in practical applications, such as production of solvent-free polymer coatings applied on different products, such as furniture, car bodies, electronic components, as well as packaging materials for chemical and food industry. Photopolymerization is of course also used in 3D printing, where it takes advantage of the spectroscopic properties of the corresponding resins. The use of natural compounds in the 3D printing industry greatly expands the potential applications of its products. For this study, 2 plant-derived monomers were used: epoxidized soybean oil, limonene oxide. Compositions consisting of thioxanthone as a photosensitizer, iodonium salt and various combinations of plant-derived monomers and epoxy CADE monomer were prepared. Real-time FT-IR studies were performed using a light source emitting radiation at λ = 365 nm and λ = 405 nm. Very high conversions of the monomer limonene oxide and low conversions of the epoxidized oil were obtained during the study. The next stage of the research is to check the suitability of the prepared compositions for 3D printing using the SLA technique.

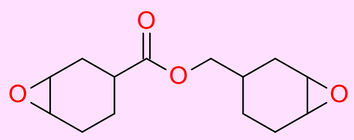
Monomers

Epoxidized soybean oil





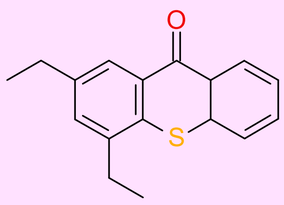
Limonene oxide



3,4-Epoxycyclohexylmethyl-3′,4′ -epoxy-cyclohexane carboxylate

CADE

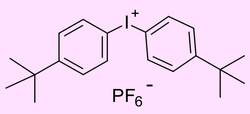
Photosensitizer



Diethyl thioxanthone

DETHX

Initiator



SpeedCure 938

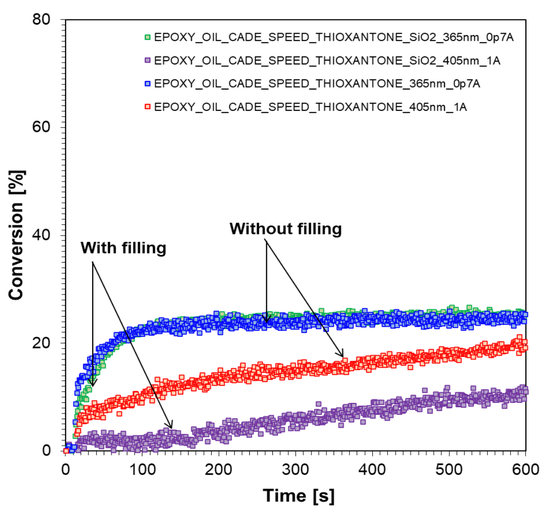


Fig. 1. Conversion of CADE epoxy monomer and epoxidized oil during cationic photopolymerization at λ = 365nm and λ = 405nm using SpeedCure® 938 iodonium salt (1%wt.) and DETHX thioxanthone (0.25%wt.).

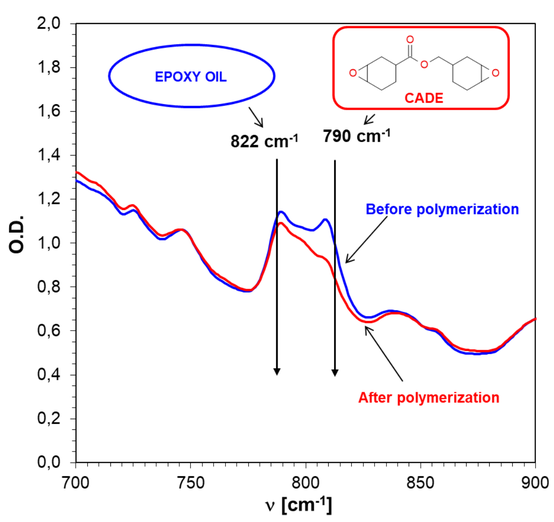


Fig. 2. Example FT-IR spectra before and after polymerization of CADE epoxy monomer and epoxidized oil.

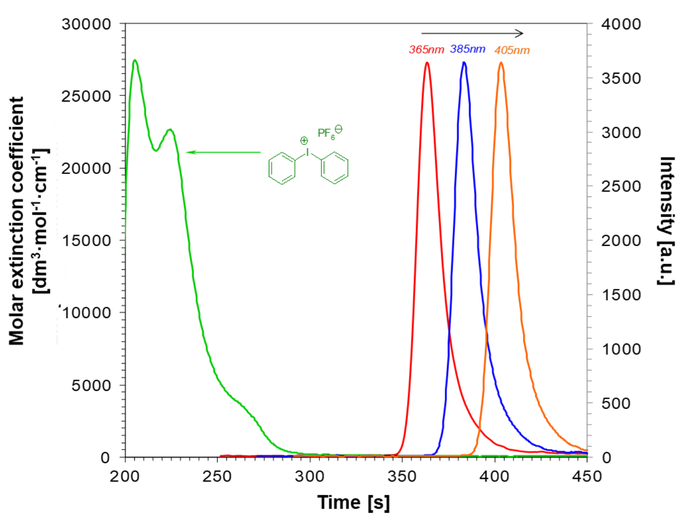


Fig. 3. Comparison of the absorption characteristics of a commercially available photoinitiator with the emission characteristics of UV-LEDs and Vis-LEDs.

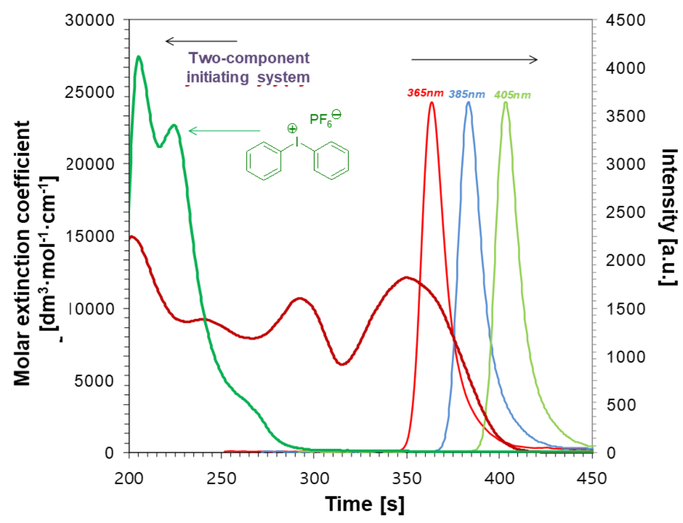


Fig. 4. Comparison of the absorption characteristics of innovative initiator systems and a commercially available photoinitiator with the emission characteristics of UV-LEDs and Vis-LEDs

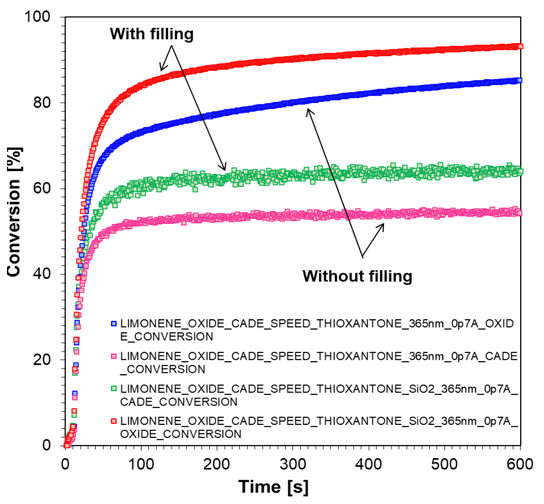


Fig. 5. Conversion of CADE epoxy monomer and limonene oxide during cationic photopolymerization at 365nm using SpeedCure® 938 iodonium salt (1%wt.) and DETHX thioxanthone (0.25%wt.).

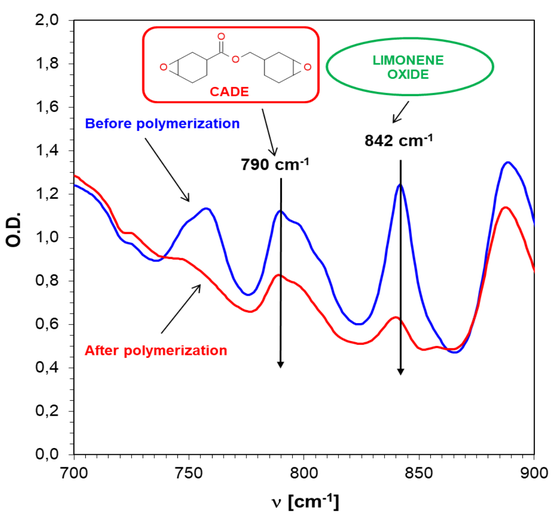
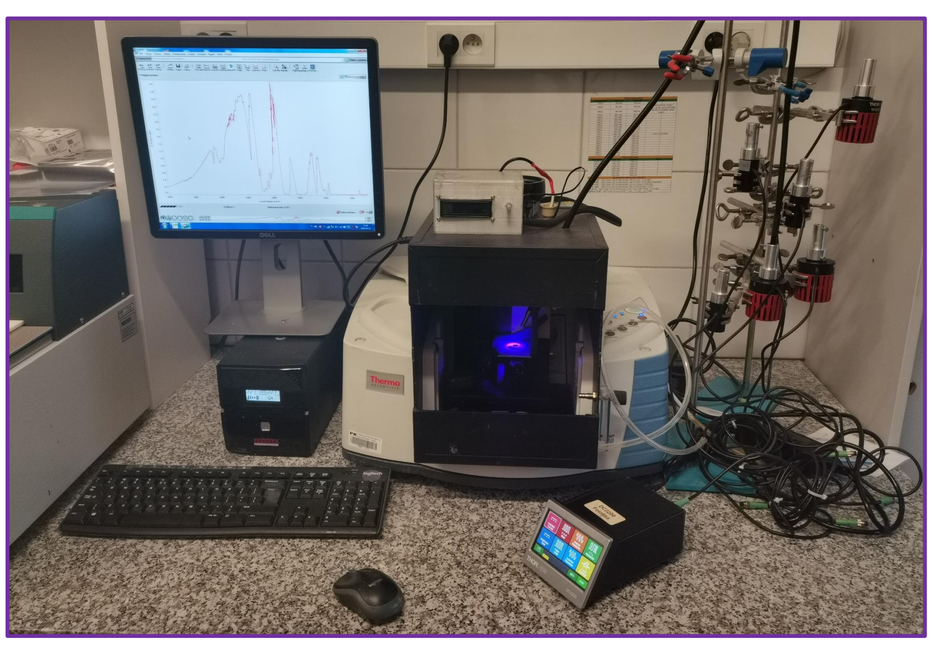
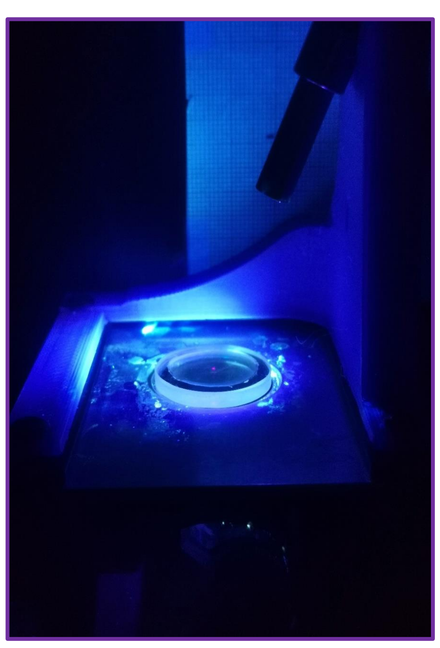


Fig. 6. Examples of FT-IR spectra before and after polymerization of epoxy monomer CADE and limonene oxide





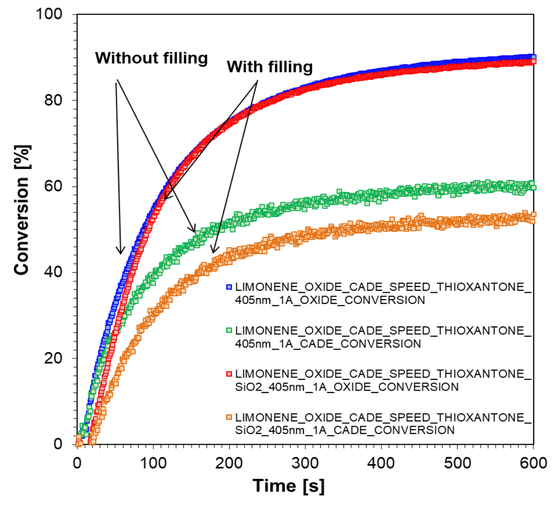


Fig. 5. Conversion of CADE epoxy monomer and limonene oxide during cationic photopolymerization at 405 nm using SpeedCure® 938 iodonium salt (1%wt.) and DETHX thioxanthone (0.25%wt.).

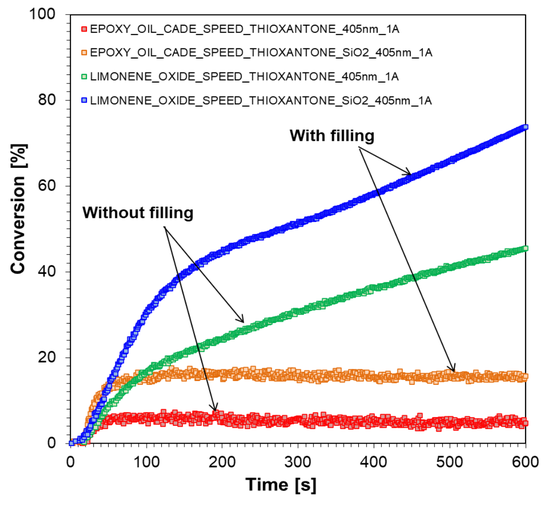
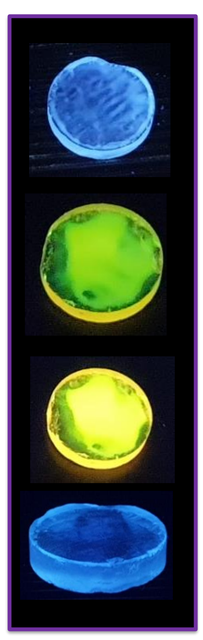


Fig. 6. Conversion of epoxidized oil monomer and limonene oxide during cationic photopolymerization at 405 nm using SpeedCure® 938 iodonium salt (1%wt.) and DETHX thioxanthone (0.25%wt.).



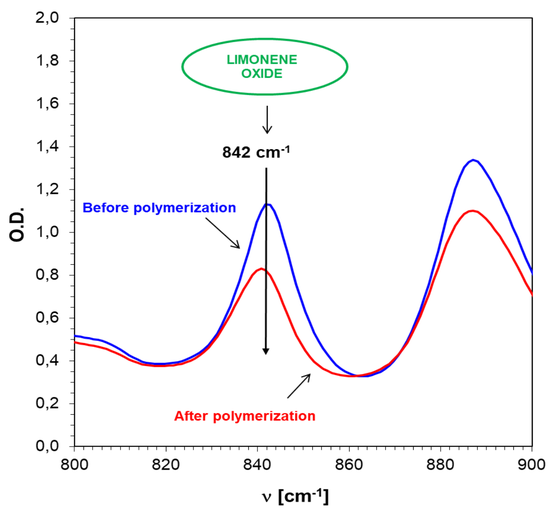


Fig. 7. Examples of FT-IR spectra before and after polymerization of epoxy monomer CADE and limonene oxide

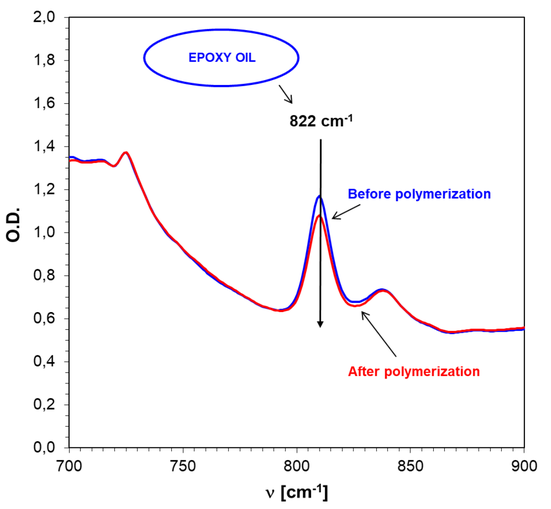


Fig. 8. Examples of FT-IR spectra before and after polymerization of epoxy monomer CADE and limonene oxide

Acknowledgments

The authors are grateful to the Foundation for Polish Science (Warsaw, Poland) – **Project TEAM TECH** (Contract No. POIR.04.04.00-00-204B/16-00 – TEAM TECH/2016-2/15 – "Molecular design, synthesis and application of photoinitiator-catalysts (PICs) for photopolymerization reactions") for financial support of the research.