MSc Eng. Michał Wrzecionek
(professional title, name)
Faculty of Chemistry
Department of Polymer Chemistry and Technology
(Faculty/Unit)
Warsaw University of Technology
(University)

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ABSTRACT OF THE DISSERTATION

„Biodegradable polyesters of glycerol and dicarboxylic acids - synthesis, optimization, scaling up and potential applications"

dissertation supervisor: WUT prof. DSc PhD Eng. Agnieszka Gadomska-Gajadhur

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Glycerol polyesters are materials intensively studied in the first two decades of the 21st century. Due to their biocompatibility and biodegradability, they could be potentially used in medicine applications, such as building materials for tissue scaffolds and drug delivery systems (DDS). This work focuses on poly(glycerol sebacate) (PGS), poly(glycerol succinate) (PGSu), and poly(glycerol butenedioate) (PGB).

The first research thread of this work concerned saturated polyesters (PGS and PGSu). Based on polymerization theories, a synthesis method was developed and then optimized. Prepolymers with a reaction extent close to the gel point were obtained. The process was scaled up 40 times to a reactor with a working volume of 2 L. The prepolymers were thermally crosslinked by compression molding. Both processes were significantly shortened compared to previously published studies. The produced films were solid structures without any defects. Mechanical and thermal properties, cytotoxicity, degradation time, equilibrium swelling coefficient, wettability and surface free energy were analyzed.

The second research thread concerned the cross-linking of α,β-unsaturated glycerol polyester (PGB) in the aza-Michael addition. For this purpose, a synthesis was developed and optimized to obtain short chains of poly(glycerol butenedate) with the lowest possible degree of branching and isomerization. The scale of the synthesis was then increased 40 times. The parameters of chemical crosslinking with triethylenetetramine (TETA) in the aza-Michael reaction were determined. Hydrogel materials were obtained by addition of TETA and natural amines (spermidine, spermine) to PGB. Analyzes of thermal properties, cytotoxicity, degradation time, and equilibrium swelling coefficient of the produced materials were determined.

In this work, materials with potential applications in drug delivery systems and tissue engineering were obtained. These materials are novel and require refinement due to their cytotoxicity and rapid degradation. The obtained PGSu film showed self-healing and stress-relaxing properties, which have not been described in the literature so far. The hydrogels produced in the addition can buffer the acidic environment, which could be used to reduce inflammation during the degradation of the polyester implant. Moreover, their sensitivity to pH and temperature can be useful in DDS designing. The developed synthesis methods have great potential for industrial implementation due to the significant reduction in the duration of the processes and the use of simple apparatus.

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