Optimization of PEG-Polyurethane Polymers for Biomedical Applications

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Hypothesis

Analyzing the properties of PEG-Polyurethane through a variety of characterization techniques (molecular weight, swelling & degradation) can lead to an optimized PEG-Polyurethane polymer, able to be utilized for different biomedical applications

Introduction

- PEG-Polyurethane has advantages due to its degradability, injectability, growing traction in surface modification, grafting, and blood biocompatibility [1]
- PEG-Polyurethane is being used for biomedical applications such as in catheters, heart valves, and tissue regeneration [2]
- Optimizing PEG-Polyurethane can lead to further improvements in these clinical needs

Methods

- Poly (ethylene glycol) (PEG)-Polyurethane
- Synthesis Conditions
  - -1hr & 24hr
  - 60°C, 80°C, 90°C, 100°C
  - -Two Catalysts:
    - Dibutyltin dilaurate (DBTDL)
    - 1,4-diazabicyclo[2.2.2]octane (DABCO)
- Characterization Techniques
  - H Nuclear Magnetic Resonance (H-NMR)
  - Swelling & Degradation
  - Gel Permeation Chromatography (GPC)
  - Fourier Transform IR Spectroscopy (FTIR)

Results

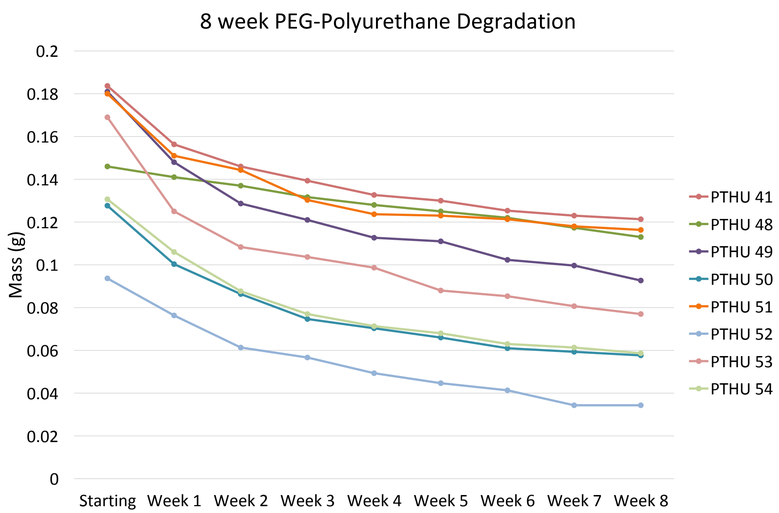


Figure 1: PEG-Polyurethane Degradation

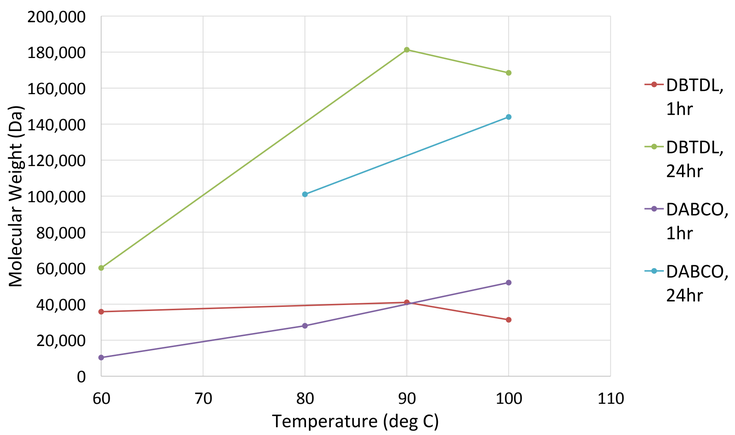
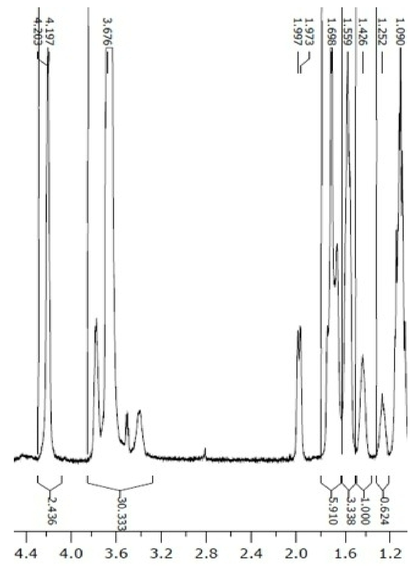


Figure 2: Molecular Weight Based on Synthesis Conditions



Proton	Chemical Shift
Methylene CH_2	1.252
Methylene CH_2(ring CH)	1.426
NH(ring$CHCH_2CH_2$)	1.559
NH(ring$CHCH_2CH_2$)	1.698
NH(ring CH) and OCH_2CH_2	3.676
$C(O)OCH_2$	4.203

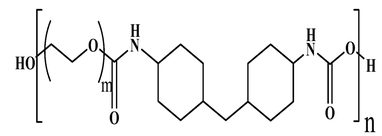


Figure 3: H-NMR Representation of Poly(ethylene) Glycol + Diisocyanate

Discussion

- H-NMR Characterization illustrates the overall chemical structure of the PEG-Polyurethane polymer
- 24-hour syntheses indicate greater MW when compared to 1-hour syntheses
- Temperature and MW indicate a positive correlation
- **90°C has the largest molecular weight**, greater than 100°C
- Largest MW (90°C, DBTDL, 24 hours): **181,307 Da**
- 90°C indicates a possible temperature sweet spot for PEG-Polyurethane synthesis
- PEG-Polyurethane polymers swelled **50.68 ± 12.92% (n=26)**
- After 8 weeks, the polymers degraded **47.10 ± 15.42% (n=24)**
- Higher MW polymers degraded less over the 8-week period

Acknowledgements

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References

[1] Ghassemi, Toktam, et al. “Current Concepts in Scaffolding for Bone Tissue Engineering.”The Archives of Bone and Joint Surgery, Archives of Bone and Joint Surgery Co., Mar. 2018.
[2] Guelcher, Scott. “Biodegradable Polyurethanes: Synthesis and Applications in Regenerative Medicine.” TISSUE ENGINEERING: Part B, Volume 14, Number 1, 2008.

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