Synthesis and Characterization of pH Responsive Polyurethane

Lucas Polo Fonseca*, Maria Isabel Felisberti.

Abstract

Polyurethanes present a great potential in biomedical applications due to their biocompatibility and highly tunable properties such as hydrophilicity and hydrophobicity. Between these properties one that deserves special attention is the pH-responsiveness that allows drug delivery under specific pH conditions. In this study we present the synthesis and structural characterization of two novel pH responsive polyurethanes.

Key words:

Polyurethanes, pH responsive, biomedical.

Introduction

Polyurethanes are a versatile class of materials. A rather new application of polyurethanes is its use in drug delivery systems. For such applications the insertion of pH-responsive groups attached to the polyurethane chain can trigger the drug release in a specific regions of the body with a particular pH.¹ The use of acid or basic chain extensors that deprotonate or protonate in basic or acid media, respectively, is reported as an strategy for achieving this goal. In this study we present the synthesis and characterization of two novel pH-responsive polyurethanes based on hexamethylene diisocyanate (HDI) and hydroxyethyl piperazine (HEP), which contains a tertiary amine group, and on HDI and bis-2,2-hydroxymethyl propionic acid (DMPA), which contains carboxylic acid as a pendent group, named PUH and PUD respectively.

Results and Discussion

The chemical structures of the pH-responsive polyurethanes (PU) are presented in Figure 1.

Figure 1: Structures of the pH-responsive polyurethanes PUD and PUH

Fourier transform infrared spectra, Figure 2, show peaks at 1650 and 3300 cm^{-1} assigned to C-N and N-H bonds, respectively, demonstrating the formation of the urethane group therefore the success of the polyurethane synthesis. Peaks in the wavenumbers between 1650 – 1750 cm^{-1} assigned to the carbonyl bonds are also observed for the polyurethanes.

Figure 2: Fourier transform Infrared spectra of PUD and PUH. The pH-response of the polyurethanes were demonstrated by solubility tests using buffer solutions at different pH's. The images in Figure 3 show that PUD is soluble only in aqueous solutions of pH 7 and 10, due to deprotonation of pendent carboxylic acid group. On the other hand PUH do not solubilize in any buffer solution probably due to high molar mass (~ 40 kg mol^{-1} , determined by Gel Permeation Chromatography).

Figure 3: PUD solubility in different pH

Conclusions

Both PU were successfully synthesized. PUD presented responsive character to pH being only soluble in pHs above 7. The study now is focusing on synthesize triblock copolymers with central block of acid or base PU and lateral blocks of polyethylene glycol (PEG).

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