Biodegradation of Poly(etherurethanes)

Neha Arora[2], Asif Ali[1], Nandan Kumar Jana[2], Piyali Basak[1]*

[1]*School of Bioscience and Engineering, Jadavpur University, Kolkata.*
[2]*Department of Biotechnology, Heritage Institute of Technology, Kolkata*
**Email: piyali_basak@yahoo.com (Corresponding Author)*

Abstract. Polyurethanes have found widespread applications in biomedical engineering, such as implant coat material, catheter coat material and drug delivery among others, for their biocompatibility and biodegradability. These polyurethanes have been found to degrade with time when implanted. For medical purpose, studies on degradation of polyurethanes have attracted great interest. Hydrolytic, oxidative and enzymatic degradation of polyurethane membrane was investigated for one week. The in vitro degradation medium used was such that mimic in vivo conditions. Hydrolytic degradation was performed in simulated body fluid at 37°C. Oxidative degradation was performed with 0.1M cobalt chloride in hydrogen peroxide at 37°C. Enzymatic degradation was performed using esterase enzyme (40Units/ml) in phosphate buffer solution (pH 7.4) at 37°C.The degradation was characterized by x ray diffraction. Results of polyurethane degradation with three types of degrading medium were compared.

Keywords: Hydrolytic degradation, Oxidative degradation, Enzymatic degradation, XRD.

INTRODUCTION

Several medical-grade polyurethanes [1,2] have been found to degrade when implanted for long periods [3,4].Investigators [5–7] have proposed that the material breakdown associated with in vivo environmental stress cracking (ESC) results from several factors including residual stress in the materials, crack-inducing agents derived from mammalian tissues, as well as chemical, physical, and morphological structures in polyurethanes[5,8].SPUs prepared from aliphatic diisocyanates have been reported to degrade into nontoxic decomposition products [9-12]; therefore, aliphatic diisocyanates are preferred over conventional aromatic diisocyanates for biodegradable segmented polyurethane copolymer synthesis. Hydrolytic, oxidative and enzymatic degradation of polyurethane membrane was investigated.

EXPERIMENTAL

Materials

Tetrahydrofuran(THF), Polyethylene glycol 400, cobalt(II) chloride hexahydrate, hydrogen peroxide, Merck India Ltd. Hexamethylene diisocyanate, esterase enzyme, Sigma aldrich.Distilled water.

Method

Hydrolytic Degradation Study
Hydrolytic degradation study of PEU membrane was investigated by immersing membrane in SBF. Swelling of the membrane was carried out in THF and water and the membrane was weighed prior to dipping in hydrolytic medium. The membranes were incubated at 37°C. Weight loss was calculated as follows:

$$Weight\ loss\ (\%) = \frac{(W_F - W_I)}{W_F} \times 100 \quad \text{(Equation 1)}$$

Where W_I and W_F are the weights of film before and after degradation.

Oxidative Degradation Study
Cobalt chloride solution (0.1 M) in 20% H_2O_2 was prepared from a 30% H_2O_2 solution by proper dilution with distilled water[13]. The membranes were dipped in the medium, incubated at 37°C and weighed periodically. Weight loss was calculated in same way as mentioned in equation 1.

Enzymatic Degradation Study
Membranes were incubated at 37C in medium containing 8ml PBS and 2%(v/v) streptomycin. 40Unit/ml enzyme stock solution was prepared. 200µl was added to each sample test tube. Weight loss was calculated in same way as mentioned in equation 1.

RESULT AND DISCUSSION

Degradation Studies

Results show that oxidative degradation(16.263%) and hydrolytic degradation(14.685%) showed a greater

Proceeding of International Conference on Recent Trends in Applied Physics and Material Science
AIP Conf. Proc. 1536, 1225-1226 (2013); doi: 10.1063/1.4810682