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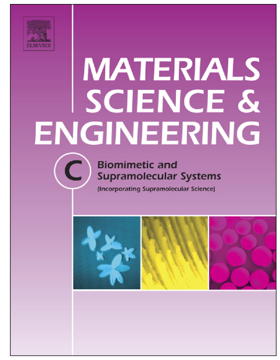

Biodegradable shape-memory polymers using polycaprolactone and isosorbide based polyurethane blends

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Biodegradable shape-memory polymers using polycaprolactone and isosorbide based polyurethane blends

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Abstract: Thermally responsive shape-memory polymers have received widespread attention in the biomedical field. In this study, biocompatible and biodegradable polyurethane (PU) and polycaprolactone (PCL) were blended to obtain shape-memory properties. Highly crystalline PCL was used as a hard segment, and PU synthesized from isosorbide, which is non-toxic and chemically and thermally stable, was used as a soft segment. The obtained PU/PCL blends containing the 30%, 50%, and 70% PU by weight were investigated for their thermal properties, mechanical properties, and shape-memory behavior. The 30%PU/PCL polymer has the best shape-memory characteristics and can be knotted by itself in the hot water bath, indicating that it can be applied in smart suture applications. The degradation test performed at 37 °C in phosphate buffered solution showed a mass loss of 2–4% for the obtained PU/PCL blends after 6 weeks. Finally, MC3T3-E1 cells cultured on PU/PCL blends showed high biocompatibility due to high adhesion and proliferation.

Keywords: Biodegradability, Biocompatibility, Shape-memory polymer, Isosorbide, Polyurethane/polycaprolactone blends

1. Introduction

Shape-memory material refers to a new functional material with the property of recovering its original shape from its deformed state (obtained by an external stimulus) under the application of secondary external stimuli [1]. Shape-memory alloys have found a wide range of technical applications such as sensors, transducers, actuators, and medical implants [2,3]. Ni–Ti and other alloys used in medical equipment show distinct advantages like small size and high strength, but also have disadvantages of high manufacturing costs, limited recoverable deformation, complex surgical procedures, and toxicity [1–4]. Compared to the above-mentioned metal alloys, shape-memory polymers offer a variety of chemical structures, reduced manufacturing costs, ease of preprocessing, high restorative deformation, and low recovery temperatures [1,5–9]. These shape-memory polymers (SMPs) are "smart" materials with dual-type capacity under appropriate external stimuli like heat, humidity, magnetic field, and dielectric [10–14].

Thermal-response SMPs are one of the most extensively studied systems, and their shape memory is generally based on the glass transition and melting temperatures [2,15,16]. If the temperature exceeds the melting temperature or the glass transition temperature of the switch segment, the material can be deformed to a temporary form by applying an external force, and if the deformed portion is cooled to a temperature lower than that of the switch segment, the segmental motion of the polymer chain is frozen. Heating the SMP above its melting point releases the stored entropy, restoring the polymer chain to its original state and the SMP to its original shape [17,18]. Currently, many implantable medical devices require complex surgery