Biodegradable Star Shaped Poly(lactide)s for Biomedical Applications

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Abstract

Biodegradable polymers are widely utilized in medical devices for different biomedical applications. This allows to repair, restore or replace damaged or diseased tissue and to interact with biological systems. Poly(lactide) (PLA) and its copolymers are part of a diverse group of poly(α-hydroxy acid)s used in biomedical applications since the 1970's. While initially studied for packaging and agricultural applications these polymers are now mostly used as controlled drug delivery systems in the biomedical and pharmaceutical industries, as well as in the veterinary and agrochemical fields. In this area, active ingredients including proteins, DNA, pesticides, contraceptives, drugs and antibiotics are delivered through sustained release with the ultimate biodegradation of the carrier medium. Although controlled drug delivery has remained the common application of these polymers, surgical fixation devices have also received considerable attention where they are used as resorbable prostheses, sutures and scaffolds for wound dressing, tubular conformations, skin substitutes.

The improvement in synthesis and characterization techniques has allowed the preparation of a wide variety of polymers with architectural diversity and well-defined functionality. The research objectives are focused on the synthesis of star-shaped Poly(L-lactide)s (PLLA)s, Poly(D-lactide)s (PDLA)s and Poly(D,L-lactide)s (PDLLA)s with tailored functionalities. The ring opening polymerization (ROP) of L-lactide, D-lactide and D,L-lactide using multifunctional hydroxyl-terminated initiators and catalyst/initiator systems based on $Sn(Oct)_2$ afforded the preparation of star-shaped, poly(lactide)s (PLA)s of controlled molecular weight, narrow molar molecular weight distribution and well-defined chain end functionality. The different modifications of star-shaped PLA resulted in macromolecules with tailored functionalities for biomedical applications.

In the present work, linear, three and four branched Poly(L-lactide)s (PLLA's) and Poly(L-lactide-co-glycolide) (PLGA) with controlled molecular weight and low polydispersity index (PDI) have been synthesized by ROP of L-lactide using multifunctional initiators namely, Trimethylolpropane (TMP), Pentaerythritol (PET) and tin octoate catalyat. The branched polymers were characterized by solution viscosity, ^{1}H NMR spectroscopy, gel permeation chromatography and ^{31}P NMR spectroscopy.

Keywords: PLLA, PDLA, PLGA, Tin octoate, ROP, IV, GPC, ^{31}P NMR spectroscopy

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