Poly(lactide) Suprastructures: Structural Reorganization of Stereocomplex Nanoparticles

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Abstract

The design and synthesis of nanopaticles with tailored architectures is always an intense area of research in polymer science as it offers the platform to address the challenges in the field ranging from nanomedicine, catalysis, electronics and high performance materials. Stereocomplex (SC) formation in polymers is the association of pairs of optically active *S*- or *R*-polymers (L and D- polymer forms) or between optically inactive syndiotactic and isotactic polymers. The stereoselective association depends on structural fitting and the van der Waals forces between polymer chains.

The star polymers differ from linear polymers in that many linear polymers are attached to a core, thus star polymers allow for densely packed architectures with multiple chain ends. Due to their desirable properties, star polymers have been used in number of applications including drug and gene delivery, catalysis and diagnostics. In addition, PLA stars exhibit lower hydrodynamic volume and higher viscosity than the linear counterparts in solution. With a dual control over the stereochemistry and topology of the macromolecule, the synthesis of stereoregular star polyesters may provide exciting opportunities for developing new functional polymers with desirable properties for applications in conventional materials and emerging nanotechnologies.

The star PDLAs have been synthesised with different multifunctional initiators by the ring opening polymerization (ROP) of D-lactide using Tin octoate catalyst and characterized by solution viscosity (IV), nuclear magnetic resonance (NMR), gel permeation chromatography (GPC) and thermal analysis. The nanoparticles were prepared by blending the solutions of star PDLA and PLLA *via* nanoprecipitation and characterized by particle size analysis (PSA) and Scanning Electron Microscopy (SEM). The SEM showed seaweed and dendrimer type of morphology in star PDLA and linear PLLA stereocomplex nanoparticles. The morphology of reorganization of nanostructures in solution switches between basic patterns (e.g. dendrites and seaweed) depending primarily on the structural parameters such as the molecular weight and the ratio of enantiomers. However, the size and morphology nanoparticles prepared from the star PLLA shows only sphere type of nanoparticles having the particle size of <150 nm.

Keywords: PLLA, PDLA, Tin octoate, ROP, Stereocomplex nanoparticles, SEM, Solution viscosity, GPC, Particle size analysis

References

1. H. Tsuji, *Advanced drug delivery reviews* 107, 97-135 (2016).
2. B. Marek, B. Tadeusz, *Polymer International* 64(12), 1667-1675 (2015).
3. B.H. Tan, H. Hussain, T.T. Lin, Y.C. Chua, Y.W. Leong, W.W. Tjiu, P.K. Wong, C.B. He, *Langmuir* 27(17), 10538-10547 (2011).
4. M. Adam, M. Tomasz, B. Tadeusz, B. Marek, B. Tadeusz, *Polymer* 90, 242-248 (2016).